MECmate

WES Quick Connection Systems Stage 1 Public Report

Nova Innovation Ltd

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1 Project Introduction - MECmate

MECmate (Marine Energy Converter mate) was one of several successful bids in the WES Stage 1 Quick Connect System (QCS) call.

The MECmate team is led by Nova Innovation, with partners Wave Venture. Nova Innovation is a leading tidal energy developer with a vast amount of experience of MEC operation, particularly with electrical connector design and real-world offshore operations. Within the Nova Innovation team there are also many years of Wave Energy Converter (WEC) development experience. Wave Venture brings knowledge of the latest developments in WEC technology, as well as an excellent network of WEC developer contacts.

The team elicited detailed information from 7 leading WEC developers to determine their current and future needs in terms of electrical power transmission and communications requirements. The responses clearly show there is a real and immediate need to deliver a cost-effective wet-mate electrical connection product designed to meet specific WEC challenges.

Experience to date shows that the products currently available are generally very well matched to oil and gas applications rather than WECs. For example: WECs must currently rely on fitment of multiple power contact pins into existing O&G connector 'shell' footprints; separate connectors are required for power and communications; mate/de-mate cycles are designed for O&G applications where use of costly local actuation (diver or ROV) may be assumed; and available products usually assume operation in much more benign met ocean conditions than those of WECs.

Our proposed solution, the MECmate, is a single *hybrid electrical & communications* connector suitable for use alongside any mechanical quick connect system, or as a standalone connector. The vision is to deliver a WEC technology-agnostic, step-change product that provides a significantly more robust, reliable, and cost-effective solution for electrical connection of marine energy devices: LV or MV, kW or MW, and with broadband communications.

2 Description of Project Technology

Key MECmate connector features

1. A single robust 'jack' style pin with multiple passes.
2. Hybrid: power LV/MV, plus broadband communications.
3. Passive wet-mate connection – requires no secondary actuation.
4. Very robust design featuring proven NovaCAN 'back-end' cable termination and breakout.
5. Self-capping when unmated.
6. Designed from the ground up with MEC applications (rather than O&G) in mind.

Benefits of MECmate implementation

1. Single central pin connector removes one axis of alignment, allows for a much-increased overall misalignment tolerance thus facilitating easy integration (significantly lower alignment feature requirement) – advantageous to any WEC mooring connection system, or standalone operation.

2. Hybrid connector, providing suitable ratings for power (at LV or MV up to 15kV, kW to MW) and broadband communications in a single WEC specific package unlike existing market offerings.

3. Passive connection simplifies marine operations and actuation requirements over existing solutions reducing equipment cost, time, and H&S risks.

4. More robust design over existing multipin connectors, for use in a broad range of deployment conditions and built on Nova's existing and field proven MEC specific dry-mate connection technology (NovaCAN – see figure below).

5. Self-capping of unmated subsea connections has been identified in previous WES studies as a critical feature to avoid marine biofouling and connector failure. Biofouling is a particular issue in the highly energetic, nutritious, and well-lit waters in which MECs are being deployed. Self-capping also avoids the need for the extremely expensive external capping or cleaning operations normally carried out by divers or work-class ROVs.

6. MEC applications have relatively specific requirements in terms of power transmission (kW to MW), DNO grid compliance (voltage and fault levels) and high bandwidth long-distance communications. Cost and scale of the MECmate are appropriate for WEC developer's needs, offering a step-change from current products.

NovaCAN: operational MEC dry-mate connector variant with typical biofouling

3 Scope of Work

1. MECmate Initial Assessment

An initial assessment of the MECmate concept was carried out, the expected qualitative benefits of the proposed designs were assessed by review, and the technical risks identified and reviewed.

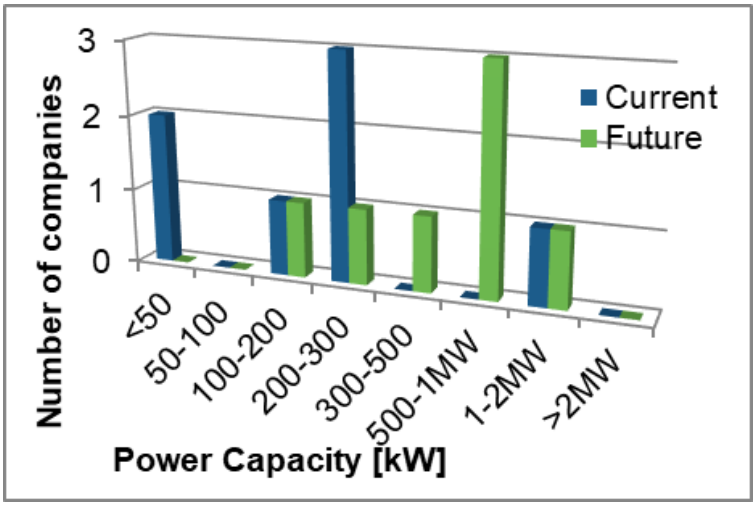
Deliverable 01 identified the *Test Cases*, likely mooring configurations, and detailed three usage storyboard sets for system connection and disconnection (vertically moored WEC, bottom mounted WEC, and WEC array subsea hub).

A *System Specification* was developed, and subsequently a more detailed *Requirements Specification*. Conceptual challenges were identified from which a development plan was created. Three specific MECmate areas requiring research focus were identified and addressed at this stage (electrical contacts, sealing, and flexible compliance). A suitable concept-design was then generated, and variants explored.

Finally, an initial Intellectual Property Rights investigation was made which concluded that there is significant freedom to operate.

2. MECmate Feasibility Assessment

Market consultation was carried out with currently active and leading wave developers plus other participants in the WES QCS project. This developed a clear understanding of the potential WEC and wider market requirements for the MECmate QCS. Overall results were summarised, together with detailed answers and commentary.



Distribution of planned WEC electrical power output capacities

System-level conceptual design was undertaken, to better define the specification for the MECmate connector.

To date, the limited range of available power connectors have perversely driven the electrical architecture of WEC systems, resulting in non-optimum overall systems. For example, the connector limits (power, voltage and current) have set the subsequent electrical architecture requiring additional voltage transformation, extra cable copper to avoid losses, non-standard (and therefore expensive and difficult to procure and maintain) switchgear, etc.

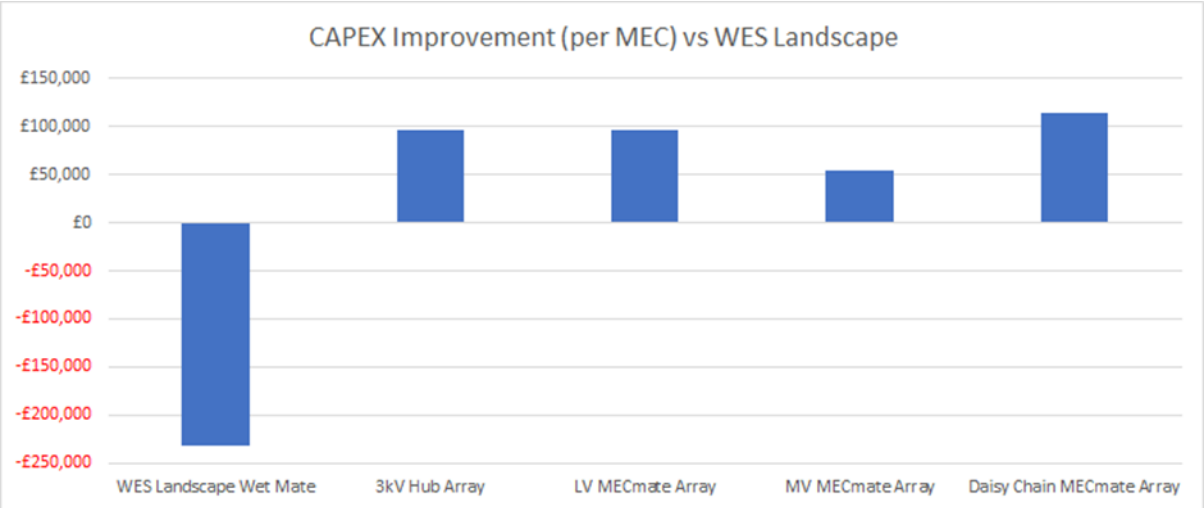
MECmate aims to be an integral part of a more cost-effective holistic system approach for grid integration, and the most applicable architectures including array scaled solutions were therefore identified.

Preliminary analysis utilised the MECmate plus holistic architectures identified in the feasibility assessment and derived their costs and benefits. This in turn guided the internal Nova Challenge Workshop decision that the MECmate concept shows definite cost and operational benefits over the available existing baseline electrical connectors (wet and dry mate) and is well worth pursuing beyond initial concept.

4 Project Achievements

Stage 1 was successful, meeting its proposed aims within the original timescales. In particular, productive discussions with WEC developers provided better market input than was expected within such a short project. This suggests that many developers recognise that their existing connector solutions do not meet their current or future needs. The current COVID-19 restrictions had a small impact on the project, resulting in the challenge workshop being held remotely. However, the team's flexibility meant that the overall impact on the project was negligible.

The project has shown that MECmate has not only the potential to be feasible, but also directly meets a business need within the wave industry for a suitable sectoral product that does not currently exist at an affordable price.



Per MEC CAPEX improvement versus WES Landscape Array Dry-mate Option

There is a high level of confidence from the Stage 1 results that the concept can be developed into a product with major benefits over existing offerings. This MEC device and mooring agnostic product will bring a robust and affordable wet-mate technology into reach for WEC developers and the broader marine energy industry.

5 Recommendations for Further Work

Appropriate modelling approaches have been identified, comprising of both simulation and focussed bench-top testing aiming to de-risk critical areas identified in the Stage 1 Initial Assessment.

Thereafter controlled onshore testing of specific technical risk areas will allow demonstration and capability testing of the main power transmission and communication functions, and offshore testing will provide realistic conditions for deployment trials of the connector to move towards commercial readiness.

Stage 2 will therefore look to undertake the following:

1. Concept Development Studies: dynamic cable loading, media connection variants, contact and pin form-factor variants.

2. Refined Design Definition: requirements, load cases, test design.

3. Design Development: partial discharge minimisation, sealing system, oil management and volume compensation, structural design, alignment and compliance, serviceability, and operations.

4. De-risk testing and Simulation for ensuring suitability and reliability of system components: water ingress rate, electric field simulation to eliminate partial discharge, resistance testing of contacts, electrical interference, fault current testing, impact, and misalignment tolerance.

5. Test Case Simulation of Developed Design: including structural FEA, electric field simulation, thermal analysis, dynamic mechanical performance during connection and operation, lifetime costing.

6 Communications and Publicity Activity

Nova Innovation website:
https://www.novainnovation.com/post/nova-wins-subsea-connector-contract

Offshore Energy News website:
https://www.offshore-energy.biz/nova-to-develop-subsea-connector-for-wes-breaks-crowdfunding-target/

7 Useful References and Additional Data

Deliverable 01: Nova Innovation D100203 *MECmate Initial Assessment* (WES QCS D01, Confidential).

Deliverable 02: Nova Innovation D100370 *MECmate Feasibility Assessment* (WES QCS D02, Confidential).

Deliverable 03: Nova Innovation D100397 *MECmate Stage 1 Final Report* (WES QCS D03, Confidential).

8 Publicity Material

Filename	Media Type	Description
Non applicable at this stage		