ASX Announcement

21 September 2018

CETO and Albany Update

Carnegie Clean Energy (ASX: CCE) is pleased to provide a market update on the progress of the Albany Wave Energy Project (AWEP) and the CETO technology development.

Project Status

Carnegie has submitted an invoice to the WA State Government for the first AWEP project milestone in July 2018 for $5.25m. Carnegie and the State are currently in discussions around the payment which we expect to resolve by the end of September 2018. The procurement activities of the project, and more generally, the timing of the delivery of AWEP is being impacted by the uncertainty associated with the proposed changes to the Federal Government's R&D Tax Incentive scheme.

Carnegie is currently seeking clarity from the Federal Government on whether these proposed changes are still likely to be implemented and, if so, in what form and with what effective timing. Any changes to the R&D tax incentive could lead to a delay in AWEP and/or the requirement to seek additional funding. Carnegie's ability to continue to progress the project is constrained until this uncertainty is resolved. Carnegie is continuing to progress the development of CETO in the meantime.

Project Activities

The offshore geophysical survey highlighted in a previous ASX announcement has now been successfully completed. A high quality dataset has been collected and analysed. This provides measurement of the depth of the granite layer and thickness maps of the younger sedimentary sequences. The survey also recorded accurate bathymetry over the proposed site. It also established that no marine archaeological artefacts are present on the site and the survey was conducted in accordance with all state and federal legislation regarding marine wildlife.

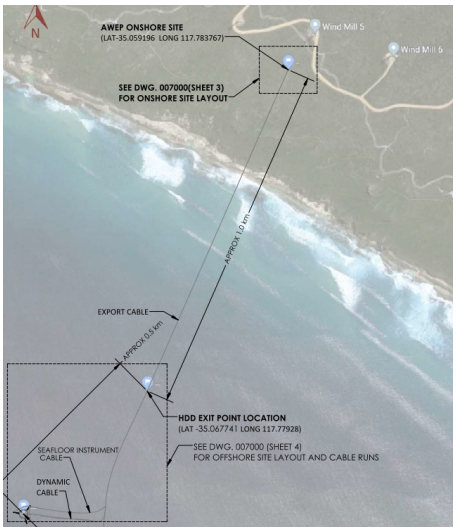
Results of this survey, experience gained during previous projects with similar geological profiles and access to data from onshore boreholes in the Sandpatch area has allowed Carnegie to develop a detailed understanding of the geology in the area. This represents crucial information that feeds into the design of foundations and cable shore-crossing for the CETO Unit and other wave energy technologies to be deployed in Albany.

Carnegie and UWA continue their collaboration through the Wave Energy Research Centre (WERC) on wave resource modelling. This work delivers detailed understanding of the wave conditions in the Torbay area needed for the development of the Project and providing useful data to future wave energy developers deploying at the Albany site. UWA recently deployed two additional data wave buoys, one being approximately 45 kilometres offshore from the Albany wind farm at Sandpatch, where water depth is around 350 metres. The second data wave buoy is located at the CETO 6 Unit future deployment site. The data collected by these instruments helps refine the wave model and improve the accuracy of the wave conditions estimates at the site. The bathymetry data recorded through geophysical survey also helps refine the wave model developed by UWA.

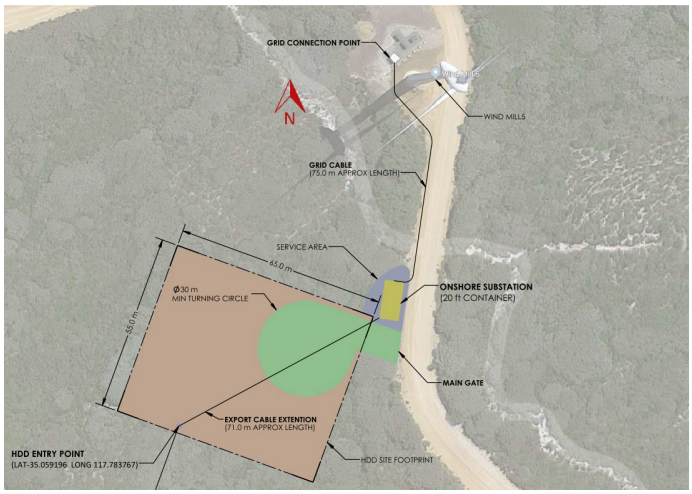
These activities and others previously disclosed such as the grid connection studies, shore crossing design, environmental surveys and permitting and approvals, has now allowed Carnegie to establish the site layout for the project. The proposed site layout includes the towing route during operation

and maintenance activities between Albany port and the offshore site, the offshore unit location, the shore crossing and cable route, the onshore substation location and the grid connection point.

Proposed AWEP towing route to common user infrastructure from Albany port



Proposed AWEP offshore and onshore site layouts



Proposed AWEP onshore site layout

With these now defined, Carnegie is able to proceed with securing the required approvals and permits for the project.

CETO 6 Development

The CETO technology for the AWEP has also advanced significantly since the last update. With the new wave data, further numerical simulations on the Pawsey supercomputer have been undertaken to update the load and motion cases. New methods to adapt industry standards to this application have been developed and implemented. A new set of numerical codes are in the process of being implemented to reduce the computational demand of the simulations. This will allow longer simulation times which improves accuracy. The tank test data continues to be vital as a benchmark to compare these new methods against.

The design for the PTO has progressed with detailed 3D modelling undertaken to define the precise position and mounting of components. Finite Element Analysis of the high stress components has confirmed the suitability of the design.

Numerical simulation and physical testing of the mooring belt has concluded the design is suitable. A manufacturing test has also been conducted to demonstrate the viability of the proposed method considering the large scale. New designs of the mooring connection system have also been received leading to cost reduction.

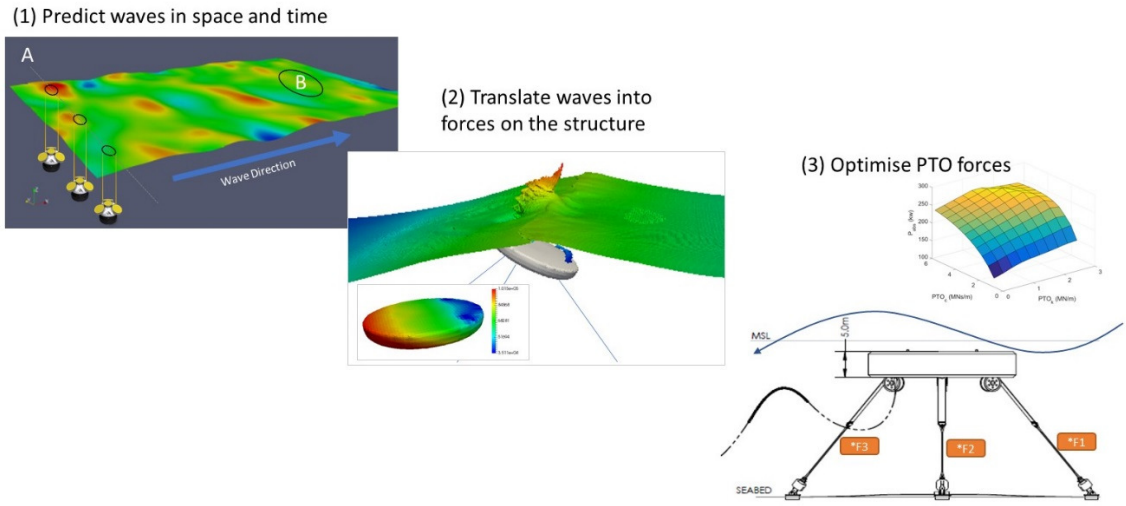
Innovations

In parallel to the AWEP, Carnegie's team commenced work on some major technological advances. These open up the potential for significant increases in the performance of CETO, through greater energy capture, more efficient conversion into electricity, higher system reliability and reduction in cost. These improvements are being enabled through advancement in both the hardware and software available as well as through the more recent ability to apply new techniques such as Machine Learning.

Machine Learning is a subset of Artificial Intelligence and has the potential to dramatically change the way CETO is designed and operated. The complexity of the ocean and the non-linear behaviour of CETO in response to waves makes it challenging to accurately and efficiently optimise and predict. The driving equations, derived from the laws of physics are often too simplistic to deal with the complexities of the real ocean. Initial work that the Carnegie team has undertaken since the beginning of this year has been very promising, showing that neural networks (artificial brains) can precisely predict the wave surface at a location some distance from the point of measurement. This technique has now been extended to use the same input to predict the waves surface into the near future.

Also underway is the development of the neural network that predicts the forces the wave imposes on the CETO buoy. After successful training, the computational speed possible will be orders of magnitude faster than the physics based approach in current use. This technique is applicable across the marine industry where vessels or submerged structures are subjected to waves.

A further application of Machine Leaning currently in the planning phase is the in the CETO controller utilising its own neural network to process this input and tune itself to extract the most energy from the waves while staying safe in extreme seas. These methods are expected to transform both the design process and the operational performance of the CETO device itself. Carnegie is in discussions with a number of suppliers and funding bodies in regards to the ongoing development and application of Machine Learning to CETO.



Application of machine learning on the development and operation of CETO

The Power Take-Off system is the part of CETO that converts the buoy motion into electricity. The Carnegie team have been working on integration of advanced electrical generators that are lighter, smaller, higher efficiency and lower cost than the hydraulic equivalent. These machines are being developed principally for wind turbine, tidal turbine and electric vehicle applications. Carnegie is engaged with a number of European suppliers, funding agencies and other wave energy developers who are actively working in this field. One example of this is “Project Neptune”, a Wave Energy Scotland Power Take-Off Stage 3 Project, of which Carnegie is a partner.

The Project Neptune project, worth £2.5m, will develop a multi-stage air cored Permanent Magnet technology that is applicable to direct drive designs of wave energy converters. The technology has a number of benefits over existing generator technologies such as: no magnetic forces closing the air gap; no cogging torque; reduced CAPEX and OPEX and high availability, all of which promise to deliver a lower cost of energy. This project builds on previous successful prototypes including a 1 MW multi-stage axial flux machine. The present project is developing twin 75 kW machines which will be used to drive against each other, based upon the motions of the CETO device derived from the Carnegie’s wave tank testing campaigns. Carnegie will be involved throughout the course of the project to ensure that the eventual solution is scalable and suitable for use within the CETO device.

The CREATE project is another Wave Energy Scotland funded project, in the Structural Materials Stage 2 call, investigating the use of alternate materials in Wave Energy Converters. The CREATE project focuses on the use of concrete in wave energy converters and aims to investigate the possibility of building the CETO buoy from concrete. This project builds upon the success of Stage 1, where significant savings were demonstrated over the conventional metal design of the CETO device. Stage 2 will look to increase the certainty of modelling the concrete buoy in more extreme conditions and will include proof of concept testing of the point load connections. Carnegie is involved in the development of load cases the buoy will be exposed to, using information based upon the recent wave tank testing undertaken by Carnegie in March 2018. This project promises to deliver savings in the cost of buoy manufacture as well as reducing the total life cycle cost of the buoy through the use of a more corrosion resistant material.

About CETO 6 and the Albany Wave Energy Project

The first deployment of the CETO 6 unit will be at Albany in Western Australia. The Albany Wave Energy Project (AWEP) is a technology development project that involves the design, manufacture and installation of a CETO 6 unit in Carnegie's existing licence area offshore from Torbay and Sandpatch in Albany. The unit will be operated for 12 months during which Carnegie will be testing the system to maximise learnings include optimising system performance, validating computational modelling results, refining installation and removal methodologies, and validating the reliability of the system.

The Project will also deliver common user infrastructure at the Albany site which Carnegie will make available for other wave energy industry developers once AWEP is complete. AWEP is supported by $15.75m from the Western Australian Government's Department of Primary Industries and Regional Development and $11.7m of undrawn funding from Carnegie's $13m CETO 6 grant from the Australian Renewable Energy Agency (ARENA).

About Carnegie Clean Energy Limited

Carnegie Clean Energy Limited is an Australian, ASX-listed (ASX: CCE) wave energy technology developer and solar/battery microgrid project developer. Carnegie is the 100% owner and developer of the CETO Wave Energy Technology intellectual property and is also 100% owner of leading Australian battery/solar microgrid Engineering Procurement and Construction (EPC) company Energy Made Clean (EMC). EMC specialises in the delivery of mixed renewable energy microgrid projects to islands and remote and fringe of grid communities. Carnegie is the only company in the world to offer a combination of wave, solar, wind, storage and desalination via microgrids which are ideally suited to islands, off grid communities and fringe of grid locations.