

ASX Announcement

27 February 2018

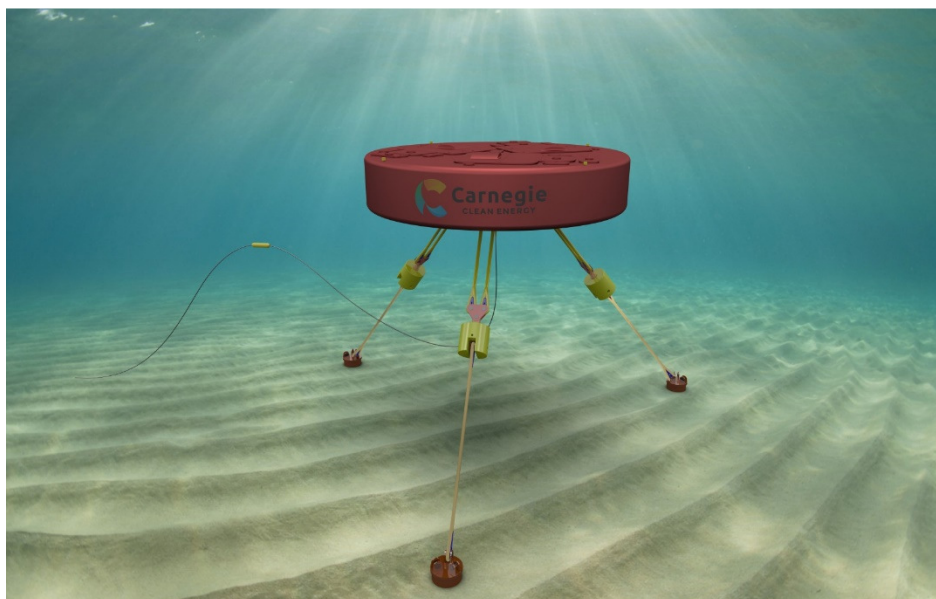
CETO Wave Energy Update

- Albany Wave Energy Project site specific design and development advances
- CETO 6 design, development and testing progress
- Significant European and UK collaboration, research and supply agreements to support delivery of Albany and future wave projects

Carnegie Clean Energy Limited (ASX:CCE) is pleased to provide an update on the latest developments on its CETO 6 design and its Albany Wave Energy Project, as well as new and ongoing collaboration relationships with several key UK-based partners and suppliers.

As announced in November, CETO 6 builds on Carnegie's decade long development of CETO, and over the past two years, incorporates internal and external collaboration efforts as well as significant time and resource investment to deliver a step change in performance. The CETO 6 design builds on intellectual property first lodged by Carnegie in 2013 incorporating on-board power generation and multiple moorings and power take off (PTO) modules.

The first deployment of the CETO 6 unit will be at Albany in Western Australia. The Albany Wave Energy Project (AWEP) involves the design, manufacture and install of a CETO 6 unit in Carnegie's existing licence area offshore from Torbay and Sandpatch in Albany during the 2019/2020 summer weather window. 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).



CETO 6 unit incorporating multiple moorings and on-board generation

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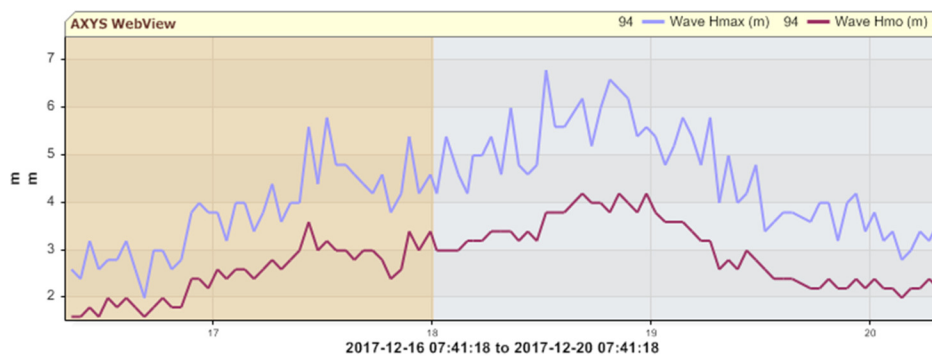
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The past months have seen design progress on the core CETO 6 technology as well as the site-specific design and development for the Albany Wave Energy Project.

Site Development Activities

Recent site development activities include completion of a metocean modelling study, deployment of an acoustic wave and current meter, ongoing monitoring of the previously deployed wave buoy, local site investigations, studies and surveys and ongoing stakeholder engagement.

The detailed measurement of the wave resource at the offshore site has been occurring for over two months from the installation of Carnegie’s wave buoy at a site approximately 1.5 kilometres offshore from the existing Albany wind farm. The data buoy is deployed in 30 meters of water depth and is measuring wave height, period and energy spectra and is transmitting this data to Carnegie’s CETO team. Wave data gathered at the deployment site feeds into the CETO 6 unit design and also supports the development of the Project’s installation, operations and maintenance design and planning. A significant wave event was recorded in December when the Hmax (maximum wave height) reached 6.8 m.



Significant wave event captured by Carnegie’s Wave Buoy in December

In addition, the University of Western Australia (UWA) completed a Metocean modelling study for the Project and deployed an acoustic wave and current meter (AWAC). These activities were done through the Wave Energy Research Centre (WERC) which was established in association with Carnegie’s AWEF. These activities help characterise the yearly wave conditions and extreme events that could be experienced at the offshore site. This detailed knowledge of the nearshore wave field feeds into many aspects of the Project design and delivery including management of extreme loads and identifying safe working conditions. Through WERC, the University of Western Australia will also soon deploy two additional wave buoys at strategic locations which will help calibration of the Metocean modelling work.



Deployment of the UWA AWAC in December

Carnegie and its contractors have also been undertaking environmental site inspections and appraisals, grid connection studies and site surveys which will continue as part of the Project's approvals, permitting and consultation processes. Upcoming activities on site include geophysical and geotechnical surveys which will help further characterise the deployment site. Good progress has also been made on the cable design, including installation and route options for the cable installation at the AWEF site.



Onshore Site Inspections and Surveys in Albany

Consultation with specific project stakeholders and engagement with the local supply chain has commenced and local community consultation activities will be undertaken over the next few months.

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Carnegie will be exhibiting at the Great Southern Sustainable Living Fair & Expo in Albany in March and will also be holding several additional engineering and local supplier events.

CETO 6 Design Activities

The CETO 6 design packages for the Albany Wave Energy Project are progressing, along with the ongoing CETO research and development, which includes developing tools and methods to support AWEP as well as undertaking collaborative R&D activities that will feed into future commercial CETO Projects.

The CETO design team has been progressing the CETO Unit architecture design including modelling to establish the optimum physical implementation of the Power Take Off (PTO) inside the Buoyant Actuator to maximise power and facilitate construction for AWEP. Testing campaigns to validate preferred PTO designs are currently under development.

Further design and analysis of the CETO Unit performance has been undertaken across the range of expected sea states at the Albany site to achieve the best Buoyant Actuator (BA) geometry for power production, load optimisation and manufacturing, local logistics and operating costs. This is now incorporating the specific data for the site from the metocean study.

The optimised Buoyant Actuator (BA) geometry will now proceed to wave tank testing at the University of Plymouth in South West England. A tank testing campaign at 1/20th scale will commence in the coming weeks that will test the preferred geometry and power take off design for CETO 6 and the validation of the computational work undertaken for the Albany as well as at Wave Hub, in Cornwall, UK. Carnegie has signed an MOU with the University of Plymouth to collaborate on the development of CETO wave energy projects at Wave Hub in Cornwall by utilising numerical and tank testing methods and analysis. Successful delivery of AWEP will allow Carnegie to proceed towards delivery of a CETO array project at the Wave Hub site.

Carnegie has completed further Computational Fluid Dynamics (CFD) numerical simulations for estimation of the power, loads and motions of CETO 6 at Albany. This work supports the load and motions case that will feed into final design specifications for components such as the foundations. Geotechnical and foundation development activities are also being progressed in the UK via a newly signed MOU with James Fisher Marine Services Ltd. This collaboration is focused on low cost foundation design, subsea connectors, components and tooling, array planning, operation, installation and maintenance requirements for wave energy projects at Wave Hub.

A wave to wire model of the CETO 6 technology at Albany is also being developed using Mathworks products. Virtual prototyping such as this reduces risk and fosters innovation because it allows the rapid testing of novel ideas and cost-effective understanding the dynamic behaviour of specific components.

In addition, a design load calibration methodology is also under development. There is currently no wave energy converter (WEC) design standard the industry can directly rely on to define a relevant safety factor. The method developed is a statistical approach based on extreme value analysis to define the relevant design load. This aims at ensuring the design load considered delivers the

appropriate level of safety without being overly conservative and therefore adding unnecessary cost. This work is being developed in collaboration with UWA via the Wave Energy Research Centre (WERC).

Further work has been performed to develop a system level Failure Mode and Effect Analysis (FMEA) building on best system engineering practice for AWEP. This ensures early identification of potential failures and triggers the implementation of relevant mitigations actions.

With the immediate focus for delivery of the first CETO 6 prototype shifting from Wave Hub in Cornwall to Albany in Western Australia, Carnegie and Wave Hub Limited signed a Memorandum of Understanding (MOU) to capture Carnegie's work delivered to date at Wave Hub and to progress development for a CETO array following the Albany Project. The collaboration activities will focus specifically on site development, array planning, operational and maintenance requirements for wave energy devices and arrays.

CETO R&D Projects

Carnegie is actively engaged in a diverse portfolio of collaborative research and development projects with Australian and International partners.

Internationally, Carnegie is a project partner in many of the Scottish Government's dedicated wave research agency, Wave Energy Scotland (WES), research and development (R&D) projects. Carnegie is a partner in WES's Structural Material and Manufacturing Processes Stage 1 RotoHybrid and RePOWER Projects; these projects have been developing alternative approaches to the manufacture of the Buoyant Actuator involving roto-moulded and composite components. Carnegie has also been working as a sub-contractor to ARUP Consulting Engineers for the CREATE project, investigating the use of concrete in the manufacturing of the Buoyant Actuator.

Carnegie is also a partner in two WES Stage 3 Power Take Off (PTO) development projects, the £2.5m Project Neptune led by the University of Edinburgh and the £2.5m Project Emerge led by UMBRA GROUP S.P.A. Carnegie is also engaging as an industry stakeholder in the WES funded landscaping work currently being undertaken in the fields of mooring and foundations, and electrical cabling and connectors.

In Australia, Carnegie has become a partner on the \$4m Australia Research Council (ARC) Linkage project awarded to BioPower Systems. The project aims to develop a common input PTO system, capable of accepting inputs from multiple different sources, including differing wave energy conversion technologies. Carnegie will apply knowledge and experience gained from developing PTO technologies for wave energy converters over the last decade.

Carnegie and the University of Western Australia (UWA) continue to build on its ongoing collaborative relationship through the development of the new Wave Energy Research Centre and work on existing and new funded R&D projects. Carnegie and UWA were successful in applying for funding under the European MARINET program, being awarded funding for 15 days of tank testing at the COAST facility at Plymouth University in March 2018. UWA and Carnegie will be investigating the response of wave energy converters in extreme conditions as well as methods for determining the design wave of the CETO device. Work also continues under the ARC Linkage grant between the University of Western Australia and Carnegie on foundation design for extreme events and the ARENA funded R2 project,

developing cost optimisation techniques for wave energy converter design. UWA have been developing numerical modelling tools around the interaction between wave energy converters in arrays. Work is now underway in developing secondary mooring connection solutions, aiming to build upon the results of the tank testing campaign in March.

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.

About Department of Primary Industries and Regional Development

The Department of Primary Industries and Regional Development (DPIRD) is committed to building vibrant regions with strong economies through jobs growth, economic growth and capable people. The Department is responsible for the effective planning, coordination and delivery of the State Government's regional development agenda. This includes the management of the Royalties for Regions investment program and maintaining effective relationships with key partners across government, industry and the community. The Western Australian State Government, via DPIRD, is investing \$15.75 million in grant funding into the Albany Wave Energy Project and a further \$3.75m into the Wave Energy Research Centre via the University of Western Australia.

About ARENA

ARENA was established by the Australian Government to make renewable energy technologies more affordable and increase the supply of renewable energy in Australia. Through the provision of funding coupled with deep commercial and technical expertise, ARENA provides the support needed to accelerate the development of promising new solutions towards commercialisation. ARENA invests in renewable energy projects across the innovation chain and is committed to sharing knowledge and lessons learned from its portfolio of projects and information about renewable energy. ARENA always looks for at least matched funding from the projects it supports and to date has committed \$1.1 billion in funding to more than 270 projects. For more information, visit www.arena.gov.au. ARENA has approved the transfer of \$11.7m of undrawn grant funds from Carnegie's \$13m CETO 6 Project funding from Garden Island to Albany.

For more information:

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