



Report to Shareholders

Quarter Ended 31 December 2020

BOARD OF DIRECTORS & CEO

Non-Exec Chairman - Terry Stinson

Non-Exec Director - Grant Mooney

Non-Exec Director - Michael Fitzpatrick

Non-Exec Director - Anthony Shields

Chief Exec Officer - Jonathan Fievez

CONTACT DETAILS

www.carnegiece.com

enquiries@carnegiece.com

21 North Mole Drive

North Fremantle WA 6159

+61 8 6168 8400

PO Box 39

North Fremantle WA 6159

QUARTER HIGHLIGHTS

- \$1.6m Mooring Tensioner project led by Carnegie awarded funding by Blue Economy Cooperative Research Centre and formally commences with project partner
- Hewlett Packard Enterprise Company (HPE) and Carnegie sign Collaboration Agreement to develop reinforcement learning based controller for CETO and commence work
- Microsoft awards Carnegie with an AI for Earth grant providing computational resources and support for a project to enhance Carnegie's Wave Predictor
- Oceantera, a South East Asian project developer, and Carnegie sign Collaboration Agreement to explore potential projects in SE Asia and share knowledge and expertise
- Hydrogen opportunities explored and further knowledge developed through ongoing internal investigations and via industry relationships
- Garden Island Microgrid resumes operation following temporary disconnection required for Department of Defence's own electrical upgrades
- European Commission releases new EU Strategy on Offshore Renewable Energy supporting a vision of at least 1000 MW of ocean energy by 2030 and 60 GW by 2050

CETO DEVELOPMENT

During the quarter, the team progressed the previously identified CETO innovation activities around the advanced controller, power take-off system, hydrodynamics and system architecture. Some of these activities can be treated initially as standalone developments, however in reality all the innovations are interlinked in terms of how the system is configured and operates. Therefore, the team works through design iterations that explore how the requirements/inputs/outputs of interlinked sub-systems and configurations impact the rest of the system and, ultimately, the cost of energy.

The work completed to date has demonstrated cost and performance improvements from previous CETO designs. It has also identified some more potential gains that could be made with a further round of system design iteration. While the team could lock the system architecture now, there is a clear and compelling opportunity to extend the current work into the current quarter to enable further cost of energy reductions.

Performance and cost improvements made by design optimisation at this stage of the technology roadmap are lower cost to achieve and have significant beneficial impacts on the commercial pathway for CETO. Not only does this directly reduce the cost for the next CETO projects it also reduces the required investment and risks along the long-term commercial pathway. As such, at the end of the quarter Carnegie committed to continuing design activities into the current quarter to enable the team to pursue these compelling opportunities.

Hydrogen opportunities were investigated during the quarter and continue with growing interest in the space from industry and government. The synergies between wave energy and hydrogen production strengthen the case and Carnegie has been particularly focussed on opportunities that encompass existing target markets such as islands, remote areas and marine energy consumers including fish farming. In parallel, enabling technologies are being developed by a variety of companies that are complementary to Carnegie's activities. For example, electrolyzers, the devices that produce hydrogen from water and electricity, are being developed that can use seawater as their hydrogen source rather than fresh water.

Hydrogen is most likely to play a role as long/medium term storage or as a fuel source for vessels and generators. Carnegie's role in the Blue Economy CRC is providing good insight into the topic of hydrogen in the marine space and opportunities will continue to be identified.

Some of the recent highlights this quarter include:

- Awarded Blue Economy CRC funding for Carnegie-led \$1.6m Mooring Tensioner project and commenced the project with partners including Advanced Composite Structures Australia, University of Queensland and Australian Ocean Energy Group.

- Advanced Carnegie’s Intelligent Control products including the Wave Predictor, Wave Solver and Wave Controller along with progressing parallel controller developments. Advanced control provides significant opportunities for LCOE reduction and continues to be a key area of focus.
- Selected to receive a Microsoft AI for Earth grant to support enhancement of Carnegie’s Wave Predictor and commenced the work with a specialist new recruit.
- Progressed development of the power take off system via engagement with generator suppliers, local engineering firms and collaboration with other international wave energy developers. This has included exploring opportunities to reduce the cost of the system by reducing extreme states requirements which contribute very little power but have large impacts on the system cost.
- Refined Carnegie’s techno-economic modelling tool to support further definition of the CETO architecture.
- Undertaken scale studies to optimise the CETO unit size with respect to LCOE.
- Engaged internal expert consultant to support the identification and protection of new intellectual property.

Carnegie continues to see growing vision and support for offshore renewables around the world as demonstrated by actions such as the European Commission publishing a dedicated EU strategy on offshore renewable energy in November 2020 (*An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future*). The EU’s strategy supports an objective of achieving at least 1 GW of ocean energy by 2030 and 60 GW of ocean energy by 2050. It also proposes a strategy to make offshore renewable energy a core component of Europe’s energy system by 2050.

In the US, the new President has significantly elevated the issue of climate change with renewed commitment to the Paris Agreement. Carnegie sees this as highly positive and expects support measures for marine renewables to increase as a result.

CETO Collaborations

Carnegie continues to maintain and develop close collaborations with industry and research partners such as local engineering firms, specialised international suppliers and engineering groups, other wave energy developers, University research groups, the Australian Ocean Energy Group and collaborative research and industry groups.

Several key collaborative projects and relationships are underway including with Hewlett Packard Enterprise (HPE), Microsoft, Blue Economy Cooperative Research Centre and Oceantera as described in more detail below.

Hewlett Packard Enterprise (HPE)

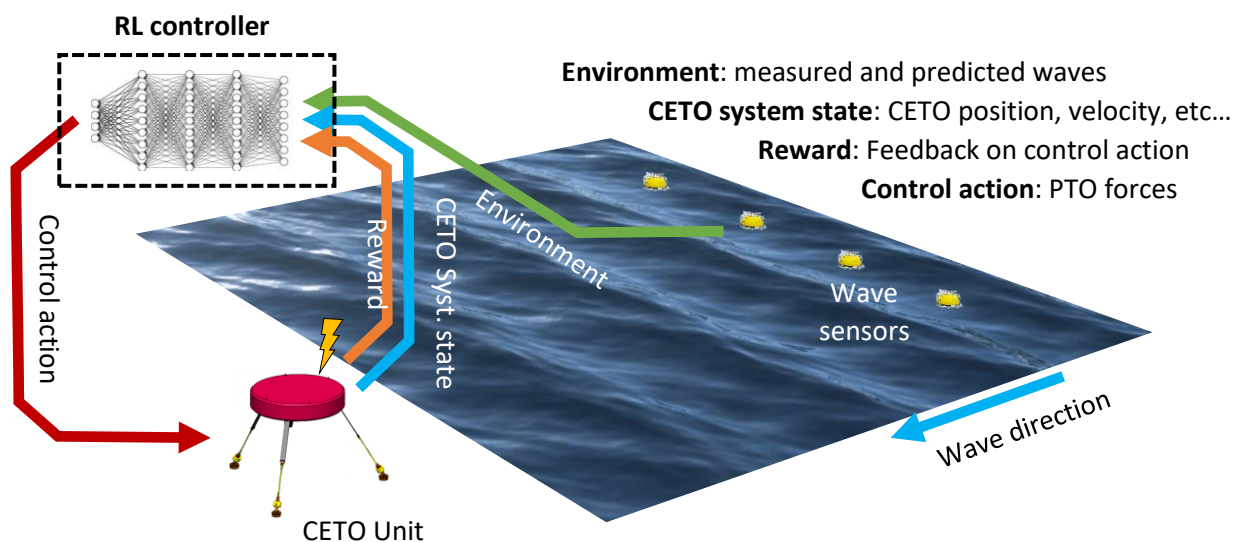
During the quarter, Carnegie signed a new Collaboration Agreement with Hewlett Packard Enterprise Company (HPE) in which the parties work collaboratively on a project to develop a reinforcement learning based controller for the CETO wave energy technology. The work will extend the artificial intelligence development already underway at Carnegie.

Hewlett Packard Labs are contributing their reinforcement learning (RL) expertise and computational resources to the project, working alongside Carnegie’s team, which is already developing an intelligent controller for the CETO technology. The RL based controller development in this project is occurring in parallel with, and enhancing, the Carnegie team’s ongoing work on a machine learning (ML) based intelligent controller.

Reinforcement learning is an area of artificial intelligence in which a machine learning model is built with the ability to self-learn. While the intelligent controller currently under development has to optimise the device’s response for every wave (using ML models within the optimisation), the RL controller has the ability to directly learn and apply the optimum response to predicted waves, during operation. The RL controller, which comes pre-loaded with a simple control scheme, tries alternative schemes, and using the concept of reward can identify control actions that deliver better outcomes.

What this means for wave energy is that an RL based controller can move beyond optimising CETO’s response using an ML model of the system trained on simulated data. An RL based controller can actively adjust, experiment, learn and optimise by utilising what actually happens during operations.

This project is underway with good progress so far.



Reinforcement Learning control applied to CETO. The RL controller uses input from the environment (predicted waves), the state of the CETO system (how it responds to the environment), and rewards from previous actions, to determine how to optimally control the system

Microsoft’s AI for Earth Program

In late October, Carnegie was selected to receive a Microsoft AI for Earth grant to support a project that uses artificial intelligence (AI) to enhance the capabilities of Carnegie’s Wave Predictor and broadens its potential applications. Carnegie’s project was chosen through a competitive global selection process. Carnegie’s AI for Earth grant provides Carnegie with a sponsored Microsoft Azure account and credits for Azure compute consumption up to \$15,000 USD to be used within one year. As part of this project, the team is accessing Microsoft Azure’s Tesla V100 GPU data science virtual machines, high performance storage, as well as higher-level services, such as Azure Machine Learning, which includes powerful AI software tools such as AutoML. The hardware does the work to crunch the numbers and the software tools help to tune the neural networks, models and features making them run much more efficiently. Work on this project is underway with the support of a new Carnegie team member who has recently completed a PhD on data science specialised in ML techniques.

Blue Economy CRC Mooring Tensioner Project

The Blue Economy Cooperative Research Centre (BE CRC) awarded \$850,000 of grant funding to support the Mooring Tensioner for Wave Energy Converters (MoTWEC) Project, a \$1.6 million project led by Carnegie with partners Advanced Composite Structures Australia (ACS-A), University of Queensland (UQ) and ClimateKIC representing the Australian Ocean Energy Group (AOEG). This Project fits in with Carnegie’s other ongoing digital development work and is focused on developing a novel Mooring Tensioner, a key component that will support the use of rotary power take-off systems and associated cost reductions for wave energy converters. The project has completed its first quarter of activities and is benefiting from close collaboration between the project partners.

Oceantera Collaboration

In November, Carnegie signed a Memorandum of Understanding with Oceantera, a project development company focused on delivering clean, affordable and reliable energy to remote and island communities in South East Asia. Through this collaboration the parties are sharing knowledge and exploring opportunities for future CETO projects. Initial discussions have provided insight into Oceantera’s detailed market knowledge of opportunities in the Philippines and investigated prospects to further strengthen the collaboration’s opportunities in South East Asia.

GARDEN ISLAND MICROGRID

At the start of the quarter, the Garden Island Microgrid remained disconnected due to Department of Defence’s base-wide electrical system upgrade on HMAS Stirling. The electrical upgrade is part of the larger 3A base redevelopment, with more than \$350m being spent on the island by the Department of Defence.

During the quarter, Carnegie’s contractors were onsite finalising the reconnection works to the upgraded Defence electrical system and the system was reconnected in December 2020.

Carnegie secured Defence’s formal consent to resume normal operations in January 2021.

CORPORATE ACTIVITIES

Carnegie held its Annual General Meeting on Wednesday 25 November. All resolutions were passed by poll. The Chairman’s address and Company Presentation can be found on the ASX and Carnegie’s new website.



Financial Notes

At the end of the Quarter, the Company had approximately \$3.7 million in cash reserves.

Note 6 to Appendix 4C:

Payments to related parties of the entity and their associates were made during the quarter. In total, approximately \$61,000 was paid to Directors and associates for salaries, superannuation and contracted services.