

Garden Island Microgrid ARENA Knowledge Sharing Report

This project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program.

The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.



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1. Summary

In August 2016, ARENA and Carnegie Clean Energy Limited (then called Carnegie Wave Energy Limited) entered into an Advancing Renewables Programme Funding Agreement to support the Garden Island Microgrid Project.

The Garden Island Microgrid Project included the design, construction and start of operations of a 2MW solar PV installation and 2MW/0.5MWh battery energy storage system on Garden Island, the location of Department of Defence's Fleet Base West/HMAS Stirling. The project includes the option for wave energy to be incorporated into the microgrid along with the desalination plant previously installed in parallel with the Perth Wave Energy Project.

The Project commenced operations in 2019 after experiencing numerous delays due to a variety of factors both internal and external to Carnegie. The Garden Island Microgrid was constructed and commissioned but then had to wait longer than scheduled for final sign offs by Western Power and Department of Defence. The system received Defence's final approval and commenced operations in August 2019. A great deal of the critical knowledge sharing activities occurred during this process of constructing, commissioning and receiving Defence and Western Power Approval to Operate.



Figure 1: Garden Island Microgrid Project

The integration of a renewable energy microgrid system behind the meter on an active Defence base had some unique technical and commercial challenges which had to be overcome throughout the project. Some of these challenges were foreseen and were in fact part of the interesting learning proposition intended to be addressed through the project, including the process of getting Western Power connection approval whilst connecting via Defence's existing connection agreement. Some of the other challenges encountered include, for instance, understanding and navigating Defence processes, systems and contractors during the design, construction, commissioning and operating phases of the project. For example, in relation to operations this includes the need to manage the system's output to meet the requirements of the base during high load and generation events, such

as when submarines are in port and when emergency diesel generators are undergoing regular test runs.

It is also worth noting that in some cases public knowledge shared has had to be limited by some unique restrictions due its location on, and electrical connection to, an active naval base HMAS Stirling. However, Carnegie has been able to share relevant knowledge gained throughout all the stages of the project from design to operations with stakeholders.

In undertaking the Knowledge Sharing Activities, Carnegie has considered the following key audiences:

- (a) ARENA, including the ARENA Executive and Board;
- (b) the Commonwealth;
- (c) renewable energy and allied services companies;
- (d) investors;
- (e) researchers;
- (f) utilities; and
- (g) the broader community

2. Activities

Carnegie has undertaken knowledge sharing activities via public releases of information, presentations and direct engagement with relevant stakeholders.

2.1. Public Announcements

Throughout the Project, Carnegie made numerous public announcements via ASX announcements, press/media releases and social media.

Carnegie uses social media such as Facebook and Twitter to reach a wide audience.



Figure 2: Examples of use of Twitter to raise awareness around the Garden Island Microgrid

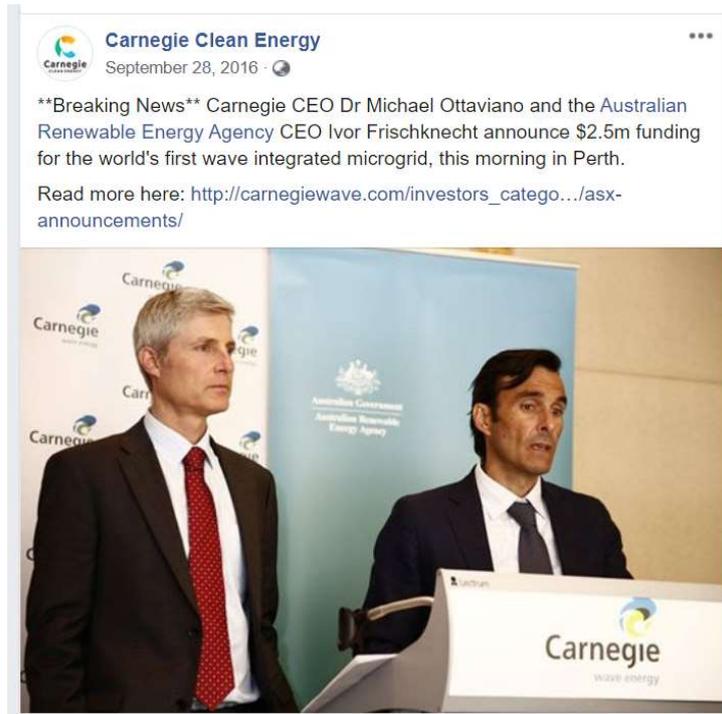


Figure 3: Example of use of Facebook to raise awareness of the Garden Island Microgrid

Carnegie also uses ASX Announcements to reach thousands of Carnegie shareholders across Australia and other media and news groups.



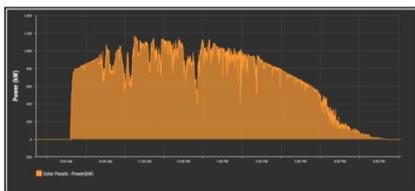
ASX Announcement

23 August 2019

Garden Island Microgrid Operational

Carnegie is pleased to announce that the Garden Island Microgrid (GIMG) has commenced operations following recent approval from the Department of Defence. With approvals in place from Department of Defence and Western Power (received in late June), Carnegie has officially powered up the system and has commenced producing clean renewable energy for HMAS Stirling, Australia's largest naval base.

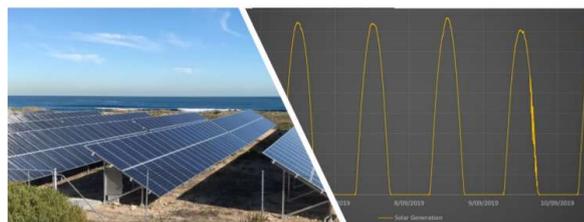
The energy being produced on Garden Island partially supports the power demand of HMAS Stirling under an electricity supply agreement between Carnegie and Department of Defence. Over the coming months, Carnegie will be working to optimise the system including ramping up capacity and system functionality.



Garden Island Microgrid on Day 1 of Operations (showing commencement of generation when the system was officially switched on)

Garden Island Microgrid

The Garden Island Microgrid has been enjoying the recent cool, sunny days and has now produced over 200 MWh of solar energy. Further to Carnegie's ASX announcement in respect to the commencement of operations at the Garden Island Microgrid (refer to the announcement dated 23 August 2019), Carnegie is pleased to announce that it has now submitted its first invoice for the sale of power to Department of Defence.



Garden Island 2 MW solar array in the spring sunshine (left) and recent smooth spring solar profiles (right)

21 North Mole Drive, North Fremantle WA 6159
 PO Box 39, North Fremantle WA 6159
 +61 8 6168 8400
www.carnegiece.com

Figure 4: Excerpts from Carnegie ASX Announcements about the Garden Island Microgrid

2.2. Presentations

Over the course of the Project, Carnegie has provided presentations which introduced the Garden Island Microgrid Project to a wide range of audiences such as:

- Australian Institute of Energy – Luncheon on Hybrid Energy Systems
- Society of Underwater Technology
- Australian Shareholders Association Investors Forum
- Carnegie Shareholders
- Asian Development Bank
- High Commissioner of India
- Primary and secondary school student groups
- University courses (such as at UWA)
- Scitech Future Earth Family Week



Figure 5: Jonathan Fiévez presenting at the Australian Institute of Energy Luncheon



Figure 6: Meeting with the High Commissioner of India introducing both CETO and microgrid projects such as Garden Island Microgrid



Figure 7: Carnegie Engineer presenting to the public at the Scitech Future Earth Family Week

The Project has also been presented at a variety of conferences and meetings over the past four years. Some of these conferences are attended every year and would have received updates on Garden Island over multiple years. The conferences include:

- Australian Energy Policy Forum
- Australian Energy Storage Conference
- All Energy (Scotland)
- WA Power and Gas Conference
- Energy in WA Conference
- Clean Energy Summit
- Disruption and the Energy Industry Conference
- African Australia Technology & Infrastructure Conference
- Seenergy Conference
- CEO Summit
- Renewable UK Wave and Tidal Conference
- Australian Energy Policy Forum



Figure 8: Carnegie (former) Director Kieran O'Brien presenting "Capitalising on the Global Opportunity for Wave Integrated Microgrids" at the 2017 Renewable UK Wave and Tidal Energy Conference

2.3. Direct Engagements

The most significant knowledge sharing activities have been undertaken via direct engagement with key stakeholders and interested parties.

2.3.1. Western Power

Western Power has been closely involved in the Garden Island Microgrid Project from its inception all the way through to issuing Approval to Operate and continuing through the operational period.

Early Design Stages

Western Power's team of engineers and technicians worked closely with Carnegie and provided network expertise and support to help integrate the microgrid with the Western Power network.

Western Power also worked with Carnegie to assess the technical challenges and opportunities of a large electricity network connected to a microgrid that has a mix of renewable sources of generation.

The engagement with Western Power was across numerous teams, but notably, Western Power elected to second an employee into Carnegie for a few months to support the project during the design phase. This was done at Western Power's cost and they had multiple staff members who applied for the secondment. The seconded employee worked closely with the Carnegie engineers and provided support with regards to the connection process and requirements but also learned a great deal about the CETO technology and supported efforts to consider how wave energy could be integrated.

Construction and Commissioning

Carnegie, EMC (the construction contractor) and Western Power worked closely together throughout the construction and commissioning phase as the team progressed through the consents, requirements and testing processes. Ultimately, working through the Technical Rules Compliance Process for a unique project such as Garden Island Microgrid was a large body of work and a significant learning experience for Western Power, Carnegie and EMC.

Operations

Western Power continues to be involved with the Garden Island Microgrid during the operational phase. The power generated by the Garden Island Microgrid supports the local network. The operation of the system also supports the grid power quality on HMAS Stirling which benefits Defence and Western Power.

2.3.2. Australian Government - Department of Defence

Carnegie has maintained deep engagement and knowledge sharing with numerous groups within the Department of Defence, including at Garden Island, in Fremantle and in Canberra during all stages of the project such as:

- Site selection process
- Design and construction reviews and approvals
- Commissioning and operations reviews and approvals

This has required Carnegie to engage closely with Defence personnel in numerous and complex groups and Directorates such as the Directorate of Estate, Environment & Energy Service Division and Directorate of Environmental Resource Management and Sustainability. These represent parts of Defence with different interests in the Project such as:

- Electrical and powerhouse personnel
- Sustainability personnel
- Asset Management personnel
- Procurement personnel
- Other site personnel

Carnegie has also needed to engage closely with Defence contractors, who have now gained a better understanding of the project, such as:

- Broadspectrum
- Doric

2.3.3. Australian Government - Other

On 1 August 2017, Carnegie welcomed the Hon. Joshua Frydenberg MP (then Minister for the Environment attending on behalf of the Prime Minister) and Ivor Frischknecht (then CEO of ARENA) to the Garden Island site for a briefing and tour of the project and the official ground breaking of the solar array.



Figure 9: Official Ground Breaking of the Solar PV Array

In June 2019, ARENA's Client Manager toured the Garden Island site, including the onshore plant building with batteries, solar array and a brief driving tour of the Defence electrical upgrade works. At that stage, Project construction and commissioning had already been completed and the Project was waiting for final Approval to Operate from Western Power and Department of Defence.



Figure 10: ARENA Client Manager touring the Garden Island Microgrid Project with Carnegie Director and Project Manager

2.3.4. Academic Community

Carnegie and UWA have had preliminary discussions about potential knowledge sharing activities such as exploring how to collaborate on the use of Machine Learning to improve the performance of GIMG. Carnegie will update ARENA on any progress on this interesting potential opportunity.

Carnegie has also been approached by several students who are interested in using Garden Island as a case study for University courses. Where possible, Carnegie supports these activities, however sometimes this is limited due to Defence restrictions and/or the student's need for confidential commercial data.

2.3.5. Consultants

Carnegie has worked with GHD on the design and operations of the Garden Island Microgrid on behalf of ARENA, the Department of Defence and Carnegie. This close engagement with GHD has enabled a significant amount of knowledge sharing about the innovative and challenging aspects of this Project. GHD now have a very good understanding of the Project and can utilise some of the lessons learnt in their engagements on other innovative microgrid projects.

2.3.6. Finance Community

Throughout the Garden Island Microgrid Project, Carnegie has engaged with multiple members of the Australian finance community and has shared knowledge about the project and explored ways to

manage the challenges of financing projects such as this. These engagements have included stakeholders such as:

- **Commercial Banks: Commonwealth Bank of Australia (CBA)** – Carnegie has worked with CBA over the past years to provide access to financing to support the Garden Island Microgrid Project. Whilst these facilities were not fully utilised, the process of getting a commercial bank to first provide financing for a wave energy integrated microgrid in 2015 resulted in a great deal of learnings for both parties. Importantly, Carnegie was able to provide enough comfort for a commercial bank to consider this type of financing, which would have previously been considered too risky for a commercial bank. This precedent and all of Carnegie’s knowledge sharing with CBA over the years will help other future wave and microgrid projects.
- **Private Equity:** Over the course of the Project, Carnegie has engaged with a number of private equity stakeholders to explore opportunities to finance the construction and/or refinance following completion.

2.3.7. Ocean Energy Industry

Carnegie has also been closely engaging with the Australian Ocean Energy Group (AOEG) which is interested in exploring ways to support the growth of the ocean energy sector in Australia.

The Manager of the AOEG cluster visited the site and spent the day with Carnegie learning about the site and the GIMG system in order to better understand all the work that has been done through the ARENA funded Perth Wave Energy Project, CETO 6 Project and Garden Island Microgrid Project. Also attending this visit was the Managing Director of Oceantera, a project developer with an interest in potential for ocean energy to be integrated into projects in South East Asia and an active supporter of AOEG.



Figure 11: Representatives from Oceantera, the Australian Ocean Energy Group and Carnegie’s CEO Jonathan Fiévez at the Garden Island Microgrid

Carnegie will continue discussions with these and other ocean energy stakeholders and aims for the Garden Island Microgrid to one day have wave energy integrated into the system. Carnegie hopes that the site can be used to support the growth of the wave energy sector in Australia.

3. Future Knowledge Sharing

Carnegie remains committed to continuing to share knowledge and lessons learned with existing and new stakeholders. Public knowledge sharing will continue via presentations, announcements and social media.

It is anticipated that some of the key knowledge sharing coming up in the next year will be associated with:

- **Upgraded Connection to Defence:**

Department of Defence has undertaken a significant electrical upgrade project to completely update the electrical system on HMAS Stirling on Garden Island. 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.

Because the Garden Island Microgrid system sits behind Defence's meter, towards the end of Defence's electrical upgrade project, the system had to be disconnected and was not able to operate whilst Defence's contractors overhauled the existing part of the powerhouse where the Garden Island Microgrid is connected. Once refurbished, the system can reconnect to the upgraded powerhouse. This reconnection process requires some testing and reprogramming, such as reprogramming the communications and protection settings. Going forwards, it is intended that the updated connection and communications should reduce the impact of Defence disruptions to system operations (there are times where the system is required to stop production for specific operational reasons on the base).

Carnegie is working with Defence, contractors and consultants on the reconnection of GIMG to Defence's upgraded electrical infrastructure. This will likely lead to new opportunities to generate and share knowledge in terms of how the system can be streamlined and optimised once connected to Defence's new, more advanced electrical system. There is a strong potential for academic and consultant engagement in these activities.

- **Future Wave Energy Integration:** Carnegie is working with ocean energy stakeholders in an effort to support the future integration of wave energy into the Garden Island Microgrid. Carnegie anticipates there being good potential for future knowledge sharing related to these activities.

Carnegie welcomes ARENA to continue to visit the site and participate in any ongoing knowledge sharing activities.

November 2020