Australian Government
Australian Renewable Energy Agency

ARENA

ARENA Submission to the Economics and Industry Standing Committee Inquiry into microgrids in Western Australia

This submission seeks to provide the Committee with information and insights attained through ARENA's ongoing portfolio of investments. The submission focuses on the potential for microgrids and associated technologies to contribute to the provision of affordable, secure, reliable and sustainable energy supply, in both metropolitan and regional WA.

About ARENA

ARENA was established to make renewable energy solutions more affordable and increase the supply of renewable energy in Australia.

ARENA provides financial assistance to support innovation and commercialisation of renewable energy and enabling technologies. This assistance is designed to accelerate the commercialisation of these technologies by helping to overcome technical and commercial barriers. A key part of ARENA's role is to collect, store and disseminate knowledge gained from the projects and activities it supports for use by the wider industry and Australia's energy market institutions.

As of March 2018, ARENA has committed $81.7 million in funding to 19 projects in WA with a total project value of around $229.8 million. ARENA is also working with a number of WA-based proponents to development future funding opportunities. Projects to date have included a focus on off-grid and fringe of grid demonstration projects and utility-scale solar, wave and bio-energy projects. A list of projects based in WA is provided at Appendix A.

Summary

Australia's electricity sector is undergoing a profound transformation, driven by technology and commercial innovation and changing consumer preferences. At the centre of this change is the emergence of low cost grid-scale and distributed renewable energy technologies.

This submission makes the following key points:

- Variable renewable energy (VRE) technologies, such as solar photovoltaics and wind power, are the lowest cost forms of new electricity generation and are likely to substantially increase their share in WA's generation mix over the next decade.
- Renewable energy generators can have different performance characteristics to traditional thermal electricity generators and ARENA is engaged in a number of projects which are exploring how future power systems can best incorporate high penetrations of renewable energy technology while delivering affordable and reliable energy services to consumers.

- Distributed energy resources, such as demand response and battery storage, can complement VRE generation by helping to keep supply and demand in balance, contributing to power system reliability and security.
- Dispatchable and baseload renewable energy generators, including solar thermal power and wave energy generation, have some potential in WA, including in on-grid and remote area power supply and in thermal processing in the resources sector.
- Renewable energy resources and microgrids can help offset the need for large-scale distribution network capital investment and operating costs, thereby reducing costs for industrial, commercial and household consumers, especially in remote area and fringe of grid situations. For example, the Garden Island Microgrid Project plans to be the world's first wave energy integrated microgrid and will produce both power and desalinated water.
- Reform of energy and ancillary services markets and supporting regulatory frameworks are being progressed in the National Electricity Market to ensure generators and consumers are provided appropriate incentives to offer power quality services to support the system at the right time and in the right location.
- ARENA can help WA industry get practical experience 'ahead of the curve' by funding demonstration (proof-of-concept) projects. These projects can also inform policy design.

Standalone power system and fringe-of-grid projects

The energy sector has observed rapid cost reductions in distributed energy technologies in recent years, including in battery storage and solar PV. In some 'standalone power system' and 'fringe of grid' situations, this is making microgrid solutions more cost-effective and reliable compared to traditional grid-supplied electricity services. Demonstrating the potential for microgrid solutions has been a major focus for ARENA. Horizon Power in WA has been a pioneer in this area, working with ARENA on a number of proof of concept demonstration projects.

In 2013, ARENA launched the RAR (remote and regional) Program with the intention to bring renewable energy to energy users in Australia's remote and regional areas while reducing reliance on high cost diesel generation. Under RAR, 14 active projects have a total value of $323 million and will add 78.32 MW to off-grid renewable capacity. The location of these projects are provided in the Figure 1 (below), alongside Solar Energy Transformation (SETup) projects in the Northern Territory that have a total value of $59 million.

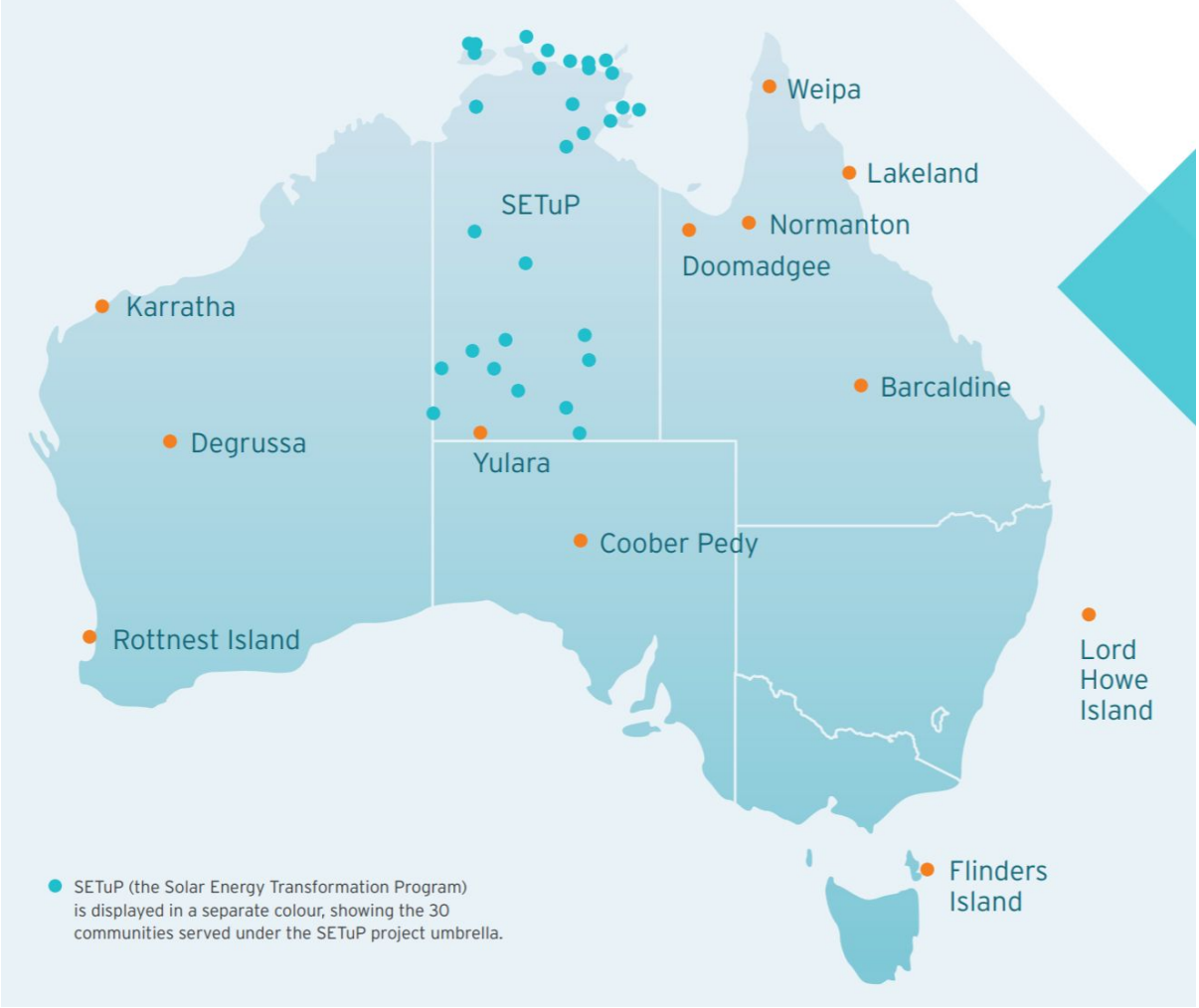
Each RAR project has contributed to industry experience about how renewable energy resources can provide effective alternatives to traditional centralised power generation and transmission approaches.

The portfolio includes a wide range of technology mixes. This, and the different locations and particular circumstances for each project, affect the proportion of renewables being added into the system. This all affects costs, and the timeline of delivery of these projects as well as the the types of technical outcomes achieved. An evaluation of ARENA's offgrid programs, focussing on technology and commercial lessons learned, has recently been published[1] and may be of interest to the

[1] Herteleer et al (2018), *Identifying risks, costs, and lessons from ARENA-funded off-grid renewable energy projects in regional Australia*: https://onlinelibrary.wiley.com/doi/full/10.1002/pip.3004

Committee. More information on the RAR program is also available on the ARENA website (www.arena.gov.au) as well as case studies and reports associated with each project.

Figure 1: Map of active RAR and SETup projects



Summary of active RAR projects in WA:

- The **Karratha Airport** project involves the design, construction, commissioning and operation of a 1 MW solar photovoltaic facility with cloud predictive technology (CPT). Including CPT will reduce the level of energy storage required whilst maintaining the performance standard specified by Horizon Power. Successful demonstration of solar with CPT has the potential to accelerate solar PV deployment in the North West Interconnected System (NWIS) and in broader markets. The City of Karratha is expected to achieve significant savings in electricity expenditure over the 21 year PPA term while hedging against uncertainty in future electricity prices.
- The **Rottnest Island** project will combine innovative use of renewable energy and smart controls to help reduce the amount of diesel fuel needed to generate power and produce clean drinking water. This project includes the addition of solar PV to the existing wind generation, integrated through advanced controls incorporating automated demand side scheduling of desalination as a form of energy storage, and deployment of energy efficiency measures. It is expected to reduce diesel fuel used for power generation by 45%. An energy

technology centre will allow visitors to learn about the project and sustainability more broadly with a focus on the role of energy efficiency and renewable energy, the importance of flexibility in the power system and the water energy nexus.

- The **Degrussa** project consists of a 10.6 MW solar photovoltaic power plant with storage at the DeGrussa Copper Mine. Commissioned in June 2016, solar power now provides the majority of the mine's daytime electricity requirements. The project aims to increase knowledge and confidence in the use of renewable energy to power off-grid mine sites as it is one of the highest penetration hybrid projects in the world. Single axis solar trackers and lithium ion battery storage allow more renewables to be used and will offset approximately 5 million litres of diesel fuel per annum.

Virtual Power Plants and on-grid microgrids

In addition to demonstrating the potential for large-scale renewable energy generation in offgrid and fringe of grid locations, ARENA is funding a range of projects which are demonstrating how Distributed Energy Resources (DER) can be orchestrated to contribute to power system reliability and security while providing a cost-effective alternative to network upgrades.

These types of orchestrated DER solutions are often referred to as Virtual Power Plants (VPPs), so known because they allow many hundreds or thousands of small-scale assets, typically located at individual customer premises, to deliver energy and other power quality services traditionally provided by power stations. VPPs are leveraging growing consumer interest in solar and battery storage and 'demand response' (DR) - where appliances can be remotely controlled to reduce their electricity use, such as switching off energy-hungry air-conditioners or pool pumps for short periods of time during peak pricing events.

Compared to large-scale generation resources, VPPs have the advantage of being able to address local network issues (such as thermal or voltage issues) as well as supply constraints in the broader market. Trials are also being developed to demonstrate how VPPs, can dispatch energy, within milliseconds, to provide power system security (frequency control) services. The opportunity to utilise DER to support system security is a key focus for the Australian Energy Market Commission through its current Frequency Control Frameworks Review.[2]

VPP and DR trials are providing useful industry experience around recruiting customers and rewarding them for the services they provide the power system. ARENA is also working to share the outcomes of these trials into energy market reform processes. ARENA sees VPP discussions evolving rapidly and many alternative technology, commercial and regulatory models are being explored and debated.

In particular, VPPs can provide services to networks that would otherwise be provided by network-owner assets. This has implications for the regulatory frameworks for network pricing (incentives for CAPEX vs. OPEX expenditure) as well as ring-fencing of network activities to support competitive neutrality in service delivery as well as consumer information and protections.

VPPs can deliver the most value for customers when they are able to trade multiple services from a DER to multiple customers including networks, retailers and system operators. This can involve

[2] https://www.aemc.gov.au/markets-reviews-advice/frequency-control-frameworks-review

complex commercial trade-offs and an overall increase in system complexity. A key focus for ARENA's VPP and related projects is how markets could evolve to help manage this complexity, delivering maximum value for consumers while providing appropriate levels of predictability and control to network and market operators.

One such trial, supported by ARENA, is being run by Synergy and Lend Lease at **Alkimos Beach** in WA. It will:

- design, manufacture and install a fully contained lithium ion energy storage system of approximately 250 kW peak / 1.1 MWh;
- install an Energy Smart Home Package in at least 100 homes; and
- develop and test at least three new electricity retail products.

While not strictly a VPP, the new energy retail model will demonstrate how critical integration (enabling) technologies can be commercially supported by innovative products and services to unlock additional value from rooftop solar PV for consumers, land developers, electricity retailers and network operators.

The trial also aims to address potential caps on PV hosting capacity on local electricity network by network operators in WA. The trial will demonstrate how to integrate, operate and manage enabling technologies with high levels of solar PV in an Australian metropolitan suburb.

Curtin University is leading a further trial at **White Gum Valley** in Perth, in partnership with LandCorp, Electricity Networks Corporation, the CRC for Low Carbon Living Ltd, the City of Fremantle and Balance Utility Solutions. This trial will develop governance models to allow shared solar photovoltaics (PV), battery and monitoring systems to be used in medium density apartments. The governance models will be tested at 50 units. The proponents aim to provide scalable and generalisable models for shared ownership of solar and storage in medium density developments, enabling greater solar PV and storage to be adopted across apartment housing in WA and across other parts of Australia.

ARENA is able to work with West Australian industry to learn from the large number of trials already conducted and currently under development in Australia.

Dispatchable renewable energy study

As the proportion of VRE in the grid increases, various approaches will be able to contribute to reliability. These could include resource diversity (geographic diversity, energy source diversity and greater demand side participation), improved forecasting and greater use of storage to deliver services including energy over various timeframes and power for frequency control. Techniques can also be applied to VRE generators to increase their firmness and flexibility for example, by using inverter controls to constrain power output.

ARENA has commissioned a quantitative comparison of alternative dispatchable renewable electricity options to explore the contributions to reliability in a high penetration renewables grid.[3] The results of this analysis are encouraging and indicate that even with currently available

[3] ITP Renewables, *Comparison of Dispatchable Renewable Electricity Generation Options, Preliminary Findings*, December 2017 - publication forthcoming

technology and current costs, dispatchable renewable energy is perhaps cheaper and easier to achieve than previously considered.

In the LCOE range of around $100 to $150/MWh, this study indicates that a range of storage technologies, combined with renewable generation, can compete to provide firming and peaking capacity with a range of 30 minutes to over 40 hours storage. Under higher utilisation scenarios, dispatchable renewables can compare favourably with the current costs for peaking generation in the market. These estimates reflect technology costs in 2017, and can be expected to reduce over time with RD&D, global experience and manufacturing scale. Other studies, supported by ARENA, have forecast the cost for an electricity system powered by PV and/or wind with pumped hydro at $75-82/MWh.[4]

A relatively low marginal cost is associated with extending storage to provide low-utilisation long-term energy reserves, which could cover occasional periods of low renewable resource availability.

A variety of these technologies are (or can be) synchronous (contributing to system security), including biomass, concentrating solar thermal and hydro generation, while others can deliver sub-second frequency and voltage support services.

The dispatchable renewables study also indicates that VRE generation will remain lower in cost than dispatchable options and, as such, we expect it is likely to increase its share of the generation mix into the future. This should keep average wholesale electricity costs to electricity consumers below the levelised cost of dispatchable renewable energy generation.

This analysis suggests that if power system services are appropriately valued, and with a supportive and predictable policy environment, we may see a competitive deployment of significant quantities of energy storage in wholesale markets in response to identified market opportunities.

WA is leading in wave and tidal energy

Wave and tidal energy have the potential to complement VRE generation, reducing the need for energy storage or other forms of flexible capacity. While wave energy is variable, it is more predictable than wind energy and is often available reasonably close to coastal population centres. Tidal energy can provide baseload power, however the best resources are typically located far from the main demand centres.

WA has some of the world's best wave resources along its south-west and southern coasts and a world class tidal resource located in King Sound in the north of the state. ARENA has played a major role in developing the wave sector in WA, for example supporting the demonstration of Carnegie Clean Energy's CETO5 device, one of the first successful demonstrations of a wave energy array in the world. This produced over 14,000 hours of operating data and helped inform the design of Carnegie's CETO6 device, which ARENA is now supporting (together with the WAn government) it to demonstrate in Albany.

ARENA is supporting the **Garden Island Microgrid Project** which plans to be the world's first wave energy integrated microgrid and will produce both power and desalinated water. The Project will

[4] A. Blakers, B. Lu, M. Stocks, (2017) *100% Renewable Electricity in Australia*, Energy vol 133. p.471-82

involve the construction and integration of 2MW of photovoltaic solar capacity, a 2MW/0.5MWh battery storage system and a control system with the option to connect wave energy generation technology. Together this will form a microgrid designed to operate either independently or in conjunction with the Western Australian electricity network, seamlessly switching between the two through a control system. The project will help accelerate the commercialisation of wave energy technology by demonstrating the technology as a renewable energy and water solution in an island/off-grid-ready microgrid setting.

ARENA has funded resource characterisation exercises such as the Australian Wave Energy Atlas and is supporting work on how to optimise wave arrays to maximise output. We note the WA Government's commitment to a Centre of Ocean Renewable Energy excellence and are actively engaged with this through our grant recipients in WA, Carnegie and the University of WA.

Solar thermal potential in WA

ARENA is involved in a number of projects which are exploring the potential for concentrated solar thermal (CST) power generation including in WA. This is relevant to off-grid and fringe-of-grid network development as well as thermal processing in WA's resources sector.

In 2014, ARENA funded a feasibility study into the construction of a 20 MWe solar thermal power station in Perenjori, WA, integrated into the north-eastern fringe of WA's South Western Interconnected System (SWIS). The project location near Perenjori in WA's mid-west region was selected as a valuable case study because:

- the site has a world class solar irradiation resource;
- fringe-of-grid connection will provide significant network benefits;
- proposed off-take arrangements include a combination of an electricity retailer and potentially a large iron ore mining operation with suitable load requirements;
- strong demand for peak and especially shoulder generation; and
- excellent prospects for further roll-out of solar thermal power generation with storage in end of grid and off-grid applications, with an emphasis on powering the mining sector.

The study concluded that a 20 MWe solar thermal plant, with 7 hours of storage, would provide about 94 GWh of electricity each year at an estimated 2015 cost of $320 per MWh. This high cost reflected the fact that it was a smaller system and a first of its kind for the proponent. If a larger system (i.e. 100 MWe) was deployed, the estimated 2015 cost was $177 per MWh. A recent Request for Information (RFI) on CST indicated a 2017 price of between $122 and $154 per MWh for a 100 MWe CST system.

ARENA is currently undertaking two solar thermal activities of relevance to the Committee's Inquiry. The first is the preparation of a CST Roadmap, which will include consideration of CST microgrid applications. This roadmap is expected to be finalised in mid 2018.

The second activity is a roadmap for minerals and metal processing. This roadmap will examine the use of renewable energy, including CST, to improve energy outcomes for mineral and metals processing within Australia. This roadmap is expected to be finalised by September 2018.

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Appendix A - ARENA funded projects in WA

Proponent	Project title	Total project value
Regional Power Corporation	Horizon Power Business Model Pilot Project - Phase 1 (Highgarden)	$7,087,296
WorleyParsons Services Pty Ltd	Tidal Turbine Reef Feasibility Study	$620,000
The University of WA	From single to multiple wave energy converters: Cost reduction through location and configuration optimisation	$3,609,340
Curtin University	White Gum Valley: Increasing the uptake of solar PV, using energy storage, monitoring and grid-connected microgrids within strata	$2,590,375
APT Pipelines Limited	Emu Downs Solar Farm Project	$47,200,000
Bombora Wave Power Pty. Ltd.	Cost of Energy Study for the Bombora Wave Energy Converter system	$420,573
Carnegie Clean Energy Limited	Garden Island Microgrid Project: Development and demonstration of the integration of CETO6 wave energy technology with solar PV, energy storage system and a desalination plant	$7,498,712
Electricity Generation and Retail Corporation	Alkimos Beach Energy Storage Project	$6,712,300
Degrussa Solar Project Pty Ltd	DeGrussa 10.56MW Off-Grid Solar PV/Storage Project	$39,477,750
Karratha Solar Power No 1 Pty Ltd	Karratha Airport Solar Project	$6,823,741
Carnegie Wave Energy Limited	The CETO 6 Project	$33,000,000
Abengoa Solar Power Australia Pty Ltd	Perenjori Dispatchable Solar Thermal Power Project	$824,789
C2K Pty Ltd	Development of an off-grid renewable energy island solution to reduce diesel dependency using mine dewatering	$400,000
Renergi Pty Ltd	A Low Emission Biofuel Technology	$13,491,182
Hydro Tasmania	Rottnest Island: Addressing the Energy and Water Nexus	$6,096,391
Murdoch University	2-S013: Murdoch, Tobias Prosin, Development of a state of the art solid particle receiver CST system, optimised for commercialisation in the Australian market	$120,000
Renergi Pty Ltd	An Advanced Biomass Gasification Technology	$7,325,842
Carnegie Wave Energy Limited	The Perth Wave Energy Project (PWEP)	$39,870,905
Curtin University	Transport fuels from mallee biomass by pyrolysis bio-refinery	$6,664,355
Total		*$229,833,551*