Rottnest Island Water and Renewable Energy Nexus

Final ARENA report:

Project Results and Lessons Learnt

October 2018

Contents

Hydro Tasmania Standard			
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Rottnest Island Water and Renewable Energy Nexus **Final report: project results and lessons learnt**		Document owner:	Ray Massie
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1.0 Executive Summary

The Rottnest Island Renewable Energy Water Nexus (WREN) Project set out to develop an innovative high renewable energy penetration hybrid off-grid power system on Rottnest Island. The WREN Project also aimed to address the nexus between energy and water supply, a common dilemma in remote locations in Australia and regionally, through the use of demand side management of the water desalination plant for use as energy storage. We planned to achieve this without using significant 'enabling technologies' such as batteries and flywheels and instead utilised demand management and co-ordination of the existing system to implement high renewable penetration.

The WREN project was successful in increasing targeted levels of annual renewable contribution from 30% to 45%, and instantaneous renewable penetration of up to 95%. The project installed an additional 600 kW DC solar farm, 500 kW dynamic resistor, distribution line, diesel and feeder management system and demand side management and integrated to the existing 600 kW wind turbine and low load diesel generators. All these elements where integrated through the implementation of an advanced automated hybrid power system controller.

System Elements

Hybrid power system controller coordinates and dispatches generation and manages the enabling technologies automatically to ensure reliable power and maximum diesel fuel savings.

Diesel generation 5 x 300 kW diesel generators, and 2 x 320 kW low load diesel generators, existing.

Solar generation Installation and integration of a fixed axis 600 kW solar PV array, including 500 m underground distribution line.

Wind generation 600 kW Wind turbine, existing.

Dynamic resistor Continuously variable resistor of 500 kW capacity, converts excess renewable energy into fast-response spinning reserve, stabilising system frequency and efficiently managing diesel generation.

Demand-side management (DSM) Desalination plant reducing the energy intensity of diesel energy based desalinated water through smart control of the desalination process, representing a 145 kW load with a water storage of 14 ML. Effectively utilising water storages as a battery to store excess renewable generation.

Remote data performance management tools provide operator viewing via web and smart phone apps. Automated performance reporting, allowing real-time and remote monitoring and performance monitoring of the power system.

The challenges overcome during the project included the ability to integrate the renewable energy, both solar and wind, while maintaining power quality and system security. As the renewable contribution increases, so does the need to carefully manage the wider power system, including diesel generators, feeders and auxiliary systems to effectively integrate the variable renewable energy sources without putting the power supply at risk.

The hybrid energy control system was the key to successfully integrating renewable energy from solar and wind with the supporting enabling technology being the diesel generation, dynamic resistor and desalination plant. The control system was deployed to meet the practical challenges of implementing a high renewable contribution hybrid project in the absence of significant enabling technologies such as flywheels and batteries.

As the sophistication of power generation increases, with an increasing range of technologies deployed, it is essential that sufficient tools and training are provided to owners and operators to achieve diesel savings over the long term, including the commercial alignment of owners and operators, if they are separate companies. During the project operator training and involvement in project delivery, combined with tools such as remote view screens, training, manuals and data reporting provided the tools to monitor the power system and ensure optimum operation to maximise renewable contribution.

The WREN project proved that the storing surplus renewable energy, by converting it to desalinated water and storing in tanks is a cost effective approach to increase the utilisation of renewable energy.

2.0 Project Overview

2.1 Project summary

The primary driver for the project, as with many off-grid projects, is to reduce operational costs by displacing diesel with renewable generation. The challenge is to integrate this variable renewable energy, while maintaining power quality and system security. As the renewable contribution increases, so does the need to carefully manage the wider power system, including diesel generators, feeders and auxiliary systems to effectively integrate the variable renewable energy sources without putting supply security at risk

The project increased annual renewable contribution from 30% to 45%, with instantaneous renewable penetration of up to 95%. This was achieved via the addition of: a new hybrid control system incorporating demand management of the reverse osmosis desalination system as a form of 'energy storage', a new 600 kWp DC solar array for additional renewable power generation and a 500kW dynamic resistor for increased security of supply at high instantaneous penetration levels. The new equipment was supported by a new PLC based control system together with comprehensive documentation and operator training.

We planned to achieve this without using significant 'enabling technologies' such as batteries and flywheels and instead utilised demand management and co-ordination of the existing system to implement high renewable penetration.

The knowledge gained from this project, can be applied to many remote areas around Australia and the world that have needs for sustainable water and energy supply.

2.2 Project scope

The WREN project was undertaken to achieve the objectives set out below :

- To reduce the dependence on fossil fuel for the generation of electricity on Rottnest Island and in turn reduce the marginal costs of electricity supply. As a direct result, reduce the annual cost to Rottnest Island Authority through the reduction in electricity, gas and water usage volumes/costs.

- To demonstrate a high level of annual renewable contribution (45 %) and instantaneous 95%, into a diesel powered off-grid system without impacting the customer power supply.

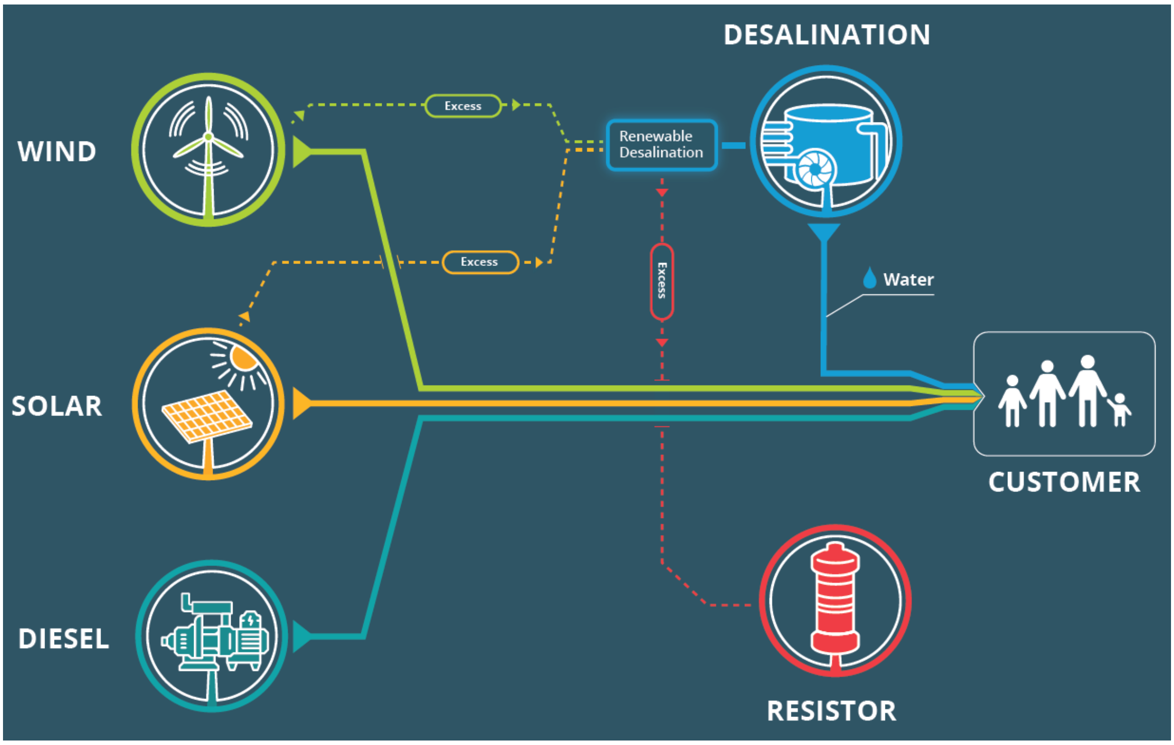
- Implement sophisticated demand side management for smart control of major water desalination loads. Reverse osmosis desalination of sea water is an energy intensive process that can be controlled to maximise the use of renewable energy delivering low emissions and low cost water. Delivering lower cost energy and water through innovative use of renewable energy is a key challenge and the results of this project have application around Australia and on a very large scale across our region.

- To demonstrate seamless integration of PV, Wind, demand side management via an advanced hybrid control system.

- Disseminate knowledge to educate and inform power station operators, utilities, power station owners, visitors and wider community on the important nexus of water and energy and ways of environmental impact through the use of renewable energy technologies.

The two major barriers we were trying to overcome were the ability to incorporate high levels of renewable energy reliably without significant enabling technology with its higher capital expense, and to demonstrate if demand side management of water desalination plant was a viable opportunity to utilise surplus renewable energy.

The knowledge being created was the development and implementation of a co-ordinated power system capable of integrating renewable energy, in a low inertia power system, development of a demand side management control module and gaining practical experience in implementing demand side management on a desalination plant. Given the strong tourism element of Rottnest Island the opportunity also existed to create greater public awareness in the use of renewable energy in modern energy supply.



Water Renewable Energy Nexus Overview, managing surplus renewable energy

2.3 Project outcomes

The planned diesel savings for the project are being realised, along with reliable operation of a high penetration renewable energy, in a low inertia system without significant new enabling technology.

The coordination of the power system, primarily by the hybrid control system and supported by the protection systems are operating correctly and have proven reliable in operation, during a range of system events.

The demand side management of the desalination plant, established that water desalination is an appropriate target for longer term (hours) energy shifting.

It is not uncommon for hybrid system operators to run systems sub-optimally, or to disable automated features due to limited understanding of system operation, poor design or faulty equipment. This can significantly reduce diesel savings over the life of the project, and reduce business case returns. One typical example is the manual scheduling by operators of an extra diesel engine to increase reserves above that required, incurring a large increase in diesel fuel costs over the project life. With high renewable contribution hybrid systems such as the Rottnest WREN, automated control is necessary due to the importance of sequencing and timing of response of the large number of system components. As response time scales are often sub-second in nature, operator intervention, such as manually setting diesel requirements or curtailing generation, is not practical.

The inability to realise project benefits can be mitigated by ensuring a high level of system operator involvement in the design and implementation of the project; as well as ensuring the operators have a thorough understanding of system operations through training programs and adequate system documentation and via sound maintenance practices.

In addition to working closely with the system operators in the design and implementation phase, ongoing support through the provision of appropriate performance monitoring tools such as real-time remote system viewing, data historian and automated performance reporting, on-line documentation are key to realising fuel savings .

The project advanced the commercial readiness of Hydro Tasmania's integrated control system and that of major contractors by building skills in the delivery of high renewable energy penetration project.

The project has a number of key learnings, refer to lessons learnt below, that will assist the industry from equipment suppliers through to project developers, owners and operators, by greater awareness of areas that can be improved to reduce the risk on future projects.

The capability and viability of the control system has also been enhanced in the areas of managing centralised diesel controllers and use of low load diesel generators, all of which are potentially attractive solutions in projects targeted at achieving diesel savings with low capital cost solutions.

The WREN project was successful in achieving its main objective of increasing targeted levels of annual renewable contribution from 30% to 45%, and instantaneous renewable penetration of up to 95%.

Total power system energy consumption and maximum demand did not increase over the period of the project period. This is driven by tourism visitation, though also it was surprising to see the combination of energy efficiency being incorporated into business as usual activities.

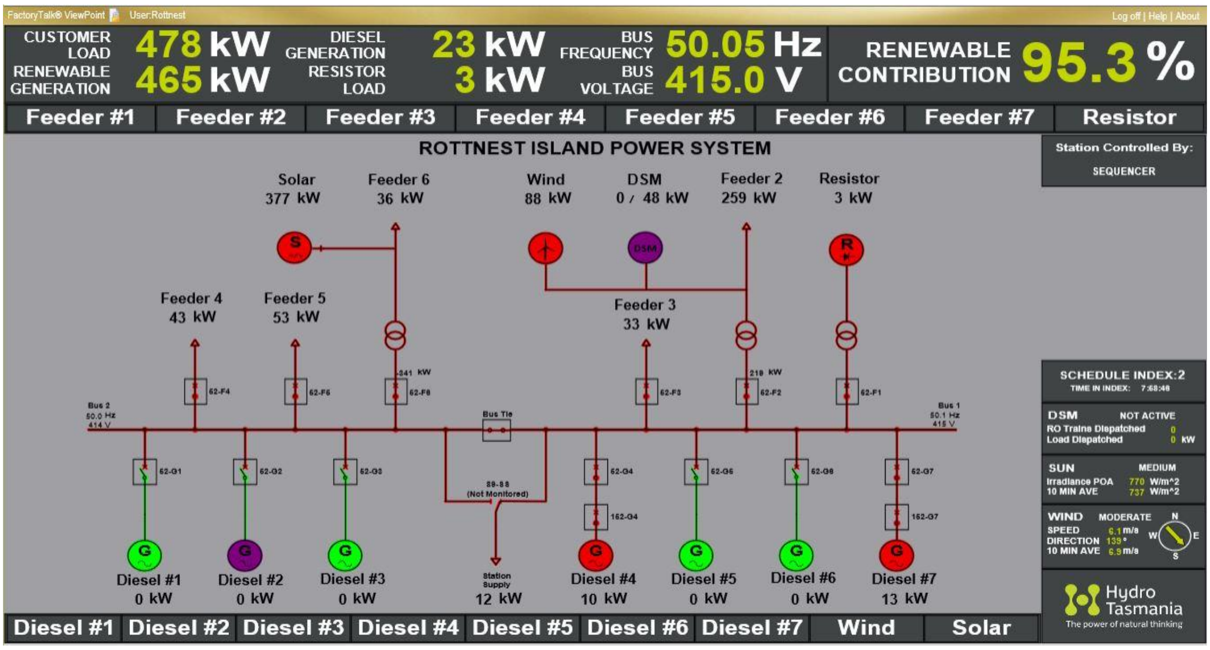
Remote Islands can have limited access to specialised skills that are required to operate and fault find increasingly integrated and sophisticated control systems from a variety of equipment manufacturers. This can result in equipment being left inoperable or at suboptimal settings for extended periods of time, impacting on the ability to achieve diesel savings.

This skill gap, highlights the need for ongoing contractual relationships between the equipment suppliers such as wind turbine manufacturers and solar inverter and controller providers as well as the system integrators. For example issues were encountered with the existing wind turbine equipment supplier being reluctant to support the legacy wind turbine in changing settings, resulting in curtailment of wind output preventing further renewable energy contribution.

The importance of a holistic design that has a focus on operations and includes the power station operators, and provides training and ongoing support to allow them to upskill and operate sophisticated power systems. Given the popularity of Rottnest Island with the Western Australia community and international tourists, achieving over half a million visitors annually, Hydro Tasmania has also developed a smart phone application to assist in engaging visitors with the water / renewable energy nexus story, shown below. The "*Rottnest Island Water and Renewable Energy project* " phone App is available for download for IOS and Android.

Rottnest Island Water and Renewable Energy Nexus, phone app

Given the contracted power system operators are employed on many operation and maintenance activities in different parts of the island, they are not always able to monitor the power system from the station itself. A remote monitoring add-on was developed as part of the control system for the operators to be able to keep watch of the power system where ever they are.



Rottnest Island, web based remote operator view screens

2.4 Demand side management (DSM)

The demand side management (DSM) module was developed and implemented within the hybrid control system. This module efficiently schedules a major island load, the water desalination plant, to utilise more renewable energy. The module provides a single user interface, within the hybrid control system, allowing operators to monitor all major generation sources and loads, assisting in more efficient operation. The DSM module takes into a wide range of power system conditions, including diesel/solar/wind generation, power reserve requirements and customer demand, in determining when to operate the desalination plant on renewable energy. The DSM module aims to store excess renewable energy, as potable water within the storage tanks and more efficiently schedule water production.

The design, coding and commissioning of the DSM module, within the hybrid control system was relatively straight forward, as the hybrid control system is designed as a module platform that can be upgraded. SCADA upgrade works (separate to this project) were required to be completed by others at the desalination plant, prior to DSM automated operation. These upgrade works took a significant amount of effort and time to complete. This is presumed to be the result of limited documentation of the existing SCADA system and the requirement for autonomous desalination plant operation.

While the control system interface was relatively straightforward, the desalination equipment being controlled required extensive work. For details on the work required please refer to the *Lessons Learnt Report: Water Desalination as Energy Storage.*

DSM of the desalination plant was proven to be an effective commercial/industrial load to increase the utilisation of renewable energy. To ensure that the desalination plant is a viable, long term source of DSM the following needs to be carefully considered:

- Ensuring alignment of ownership and operational interests. Potentially conflicting priorities such as operating the plant to minimising maintenance, or maximise water security or to reduce electricity costs need to be carefully managed to ensure cost savings are realised.

- Fast acting DSM (in the minutes or sub second) is generally not appropriate for a desalination plant, due to the increasing maintenance costs from start stopping and impact on membrane filters and the time to shutdown and restart desalination trains, for packaged water desalination plants.

- The overall utilisation of renewable energy for DSM was not fully tested due to the desalination plant having one train out of three out of service for the majority of the performance proving period. The reduced plant availability means that the remaining desalination trains have to operate more of the time in order to maintain minimum water levels, significantly reducing the opportunities for DSM.

- The desalination train being out of service, while it is not a direct part of this project, highlights the potential for equipment to be inoperable for significant periods of time in remote locations, until the appropriate resources or repair budget are available. A comprehensive condition assessment of the equipment proposed for DSM should be undertaken before confirming the project.

- Future projects in remote areas should expect extended outages as a likely occurrence, and consider this in the technical and commercial delivery of projects and put in place a significant amount of operational support.

2.5 Transferability

The use of demand side management of reverse osmosis desalination as energy storage will provide an important case study as to the value of utilising existing equipment on off-grid islands to assist in managing and integrating high levels of renewable energy.

Off-grid power systems are invariably diesel based and expensive to operate due to high fuel costs. Hydro Tasmania's experience via operation of its island systems and through development of projects such as the Rottnest WREN, indicates that communities and system operators need to be very mindful of and carefully plan the deployment of such systems, taking care to "reinforce" the system through well integrated enabling technologies to maintain reliability and stability.

The Rottnest WREN project offers lessons for other utilities or community groups interested in implementing high levels of renewable energy. In particular the project highlighted the need and value of detailed engineering planning and working closely with operators and suppliers to ensure equipment is procured and configured to suit the unique requirements of off-grid systems in the role of managing variability and supporting renewable integration.

The WREN project will also provide benefits arising from broader learnings of the essential role of power station operators in achieving diesel savings over the long term. WREN operators are being supported with the right training, and assisted with remote viewing and performance tools, providing the asset owner with confidence that the system will be operated in a manner which will achieve diesel performance targets.

Knowledge sharing above that during delivery has included site visits, white papers and publications, industry forums and data provision. In addition, due to Rottnest Island's high visitation with over 500,000 visitors annually, a range of educational resources, including a digital energy dashboard, physical signage and a phone App, were developed to increase the knowledge of school groups and the general public in sustainable energy.

The Rottnest Island Water and Renewable Energy Nexus (WREN) project, is the culmination of a series of projects over a sustained period of development, that significantly increased the use of renewable energy in an off-grid network, maintaining the quality and security of power supply, and reducing the use of diesel fuel and in turn greenhouse gas emissions.

Similar projects that utilise high renewable energy penetration in Australian remote off-grid areas include:

- Flinders Island Renewable Energy Hub, www.hybridenergysoutions.com.au
- King Island Renewable Energy Integration project, www.kireip.com.au
- Coober Pedy
- Daly River

2.6 Conclusion and next steps

The nationality electricity market is currently evolving by increasing the share of variable renewable energy. As this transition occurs the NEM will, and already has experienced events that will require greater integration and co-ordination of variable renewable energy sources using enabling technology.

The experiences from the Rottnest Island project, as well as King and Flinders Islands demonstrate that it is possible to have sustained operation of high levels of renewable energy when controlled and supported by appropriate enabling technologies. Specifically these projects demonstrate the ability for very high renewable energy contribution to be maintained without impact on power system quality or reliability. The use of enabling technology has helped improve system reliability on King and Flinders Islands at the same time as significantly reducing diesel consumption.

The projects also demonstrate the ability to have fast acting control systems to integrate wind turbines and solar farm's and control these and have in place control algorithms to handle a wide range of conditions, including the ability to ride through system events.

Demand side management has been proven to be a practical approach to assist with renewable energy utilisation and to improve system stability, proven in both a decentralised approach on the King Island smart grid and with a centralised approach as with the desalination plant at Rottnest Island.

The integration of dynamic resistors, low load diesels, diesel flywheels and battery energy storage controlled through Hydro Tasmania's proprietary control system have provided operational experience that high renewable penetration power systems are reliable, through careful integration to ensure outcomes are achieved.

The skills and capability gained within Hydro Tasmania from the WREN project will be able to be applied nationally and internationally, both for remote sites such as islands and remote communities, and also in the NEM to assist in the transition to sustainable energy. Others will be able to take the experiences from the WREN project into account, and should be able to reduce delivery risk on similar projects into the future.

Other islands, mining sites and remote communities will be able to refer to the Rottnest project outcomes, in convincing their stakeholders and setting a benchmark for integrating renewable energy into their own power systems.

3.0 Lessons Learnt

3.1 Water desalination as energy storage

3.1.1 Key learning

Storing surplus renewable energy, by converting it to desalinated water and storing in tanks is an effective approach to increase the utilisation of renewable energy.

3.1.2 Implications for future projects

The flexible scheduling of the desalination plant should ideally be planned for when the plant is designed. Understanding the planning and technical limitations of the plant will assist in the ability to control the desalination plant. For existing plants, this can be achieved by undertaking a condition assessment of the plant at the beginning of the project.

If a range of planning and technical considerations is specified and agreed upfront, this will increase the operational window of the desalination plant, improve renewable energy utilisation and minimise impacts on operational and maintenance costs. These include:

- The existing plant control system SCADA is designed to accept/reject a demand management request based on operational conditions.
- Plant is designed for repeatable start/stop sequences without impacting on maintenance.
    - Flush sequences occur after a stop/start should not limit the number of DSM operations that can occur.
- Clear understanding of any regulatory or compliance requirements of the water production system, built into the plant control system. For example minimum amount of water storage, maximum holding days, etc.
- Where multiple packaged reverse osmosis trains are utilised, these should be specified to be capable of:
    - Independent train operation to allow for graduated ramping up/down rather than on/off control
    - Similar equipment, where multiple units are used
    - Fast stop option to provide emergency under frequency load shedding
    - Designing the desalination system, to provide high power and have adequate tank sizing to provide a more flexible and wider operational band
- Soft start capability
- Agreed operational limits, maximum number of start/stop cycles per 24 hour period per membrane, that can be achieved without impacting on maintenance, such as early membrane replacement.
- System is capable of continuous, automated operation including following start/stop cycles.
- Upgrade of equipment to ensure appropriate data can be transferred including; power metering, flow rates, plant status, heat beat, etc.

- Divergent ownership and operation interests, such as operating the plant to minimising maintenance, maximise water security or to reduce electricity costs need to be aligned and carefully managed to ensure cost savings are realised.
- Detailed investigation of the plant is required prior to committing to demand side management of desalination plant as many process control or regulatory constraints can prevent the effective operation of DSM.
- Ensure the bore pumps were capable of independent operate and variable operation, this includes all auxiliary equipment such as the intakes, vales, pumps and storage. Some desalination plant may require significant capital works to upgrade physical infrastructure to allow them to have frequently interrupted operations. This is due to a variety of reasons such as back pressure, ability for partial system operation, impact of starting one train on another train and the impact on the control system.
- Desalination plants, due to their physical process control requirements, are more likely to be targets for longer term (hours) of energy shifting, rather than short term power variability. Hydro Tasmania utilised a dynamic resistor at the powerhouse to manage fast acting (<250 ms) variability and improve system security.

It is unlikely all the above conditions would be known or available in remote and small scale sites; therefore a project specific assessment would be required to determine whether DSM of a desalination plant is economically feasible. If the upgrade costs of the existing desalination plant exceed the project savings over a short number of years (~3-4 years), when compared with the projected savings, it is unlikely to proceed as a viable DSM option.

DSM is also unlikely to proceed where physical plant upgrades are required or a major augmentation of the SCADA system.

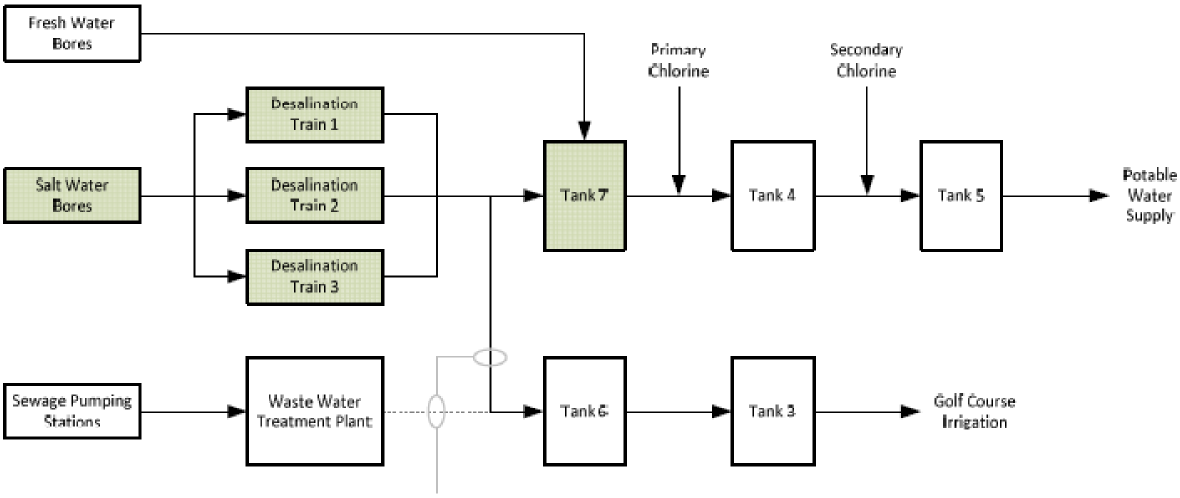
A desalination plant is more likely to be an attractive option where:

- Sufficient power (size of the plant) and energy storage (size of the tanks) is available
- Only minor SCADA modifications are required
- No or minimal physical changes are required to the plant
- Desalination plant is designed for autonomous operation with remote start/stop sequences

3.1.3 Knowledge gap

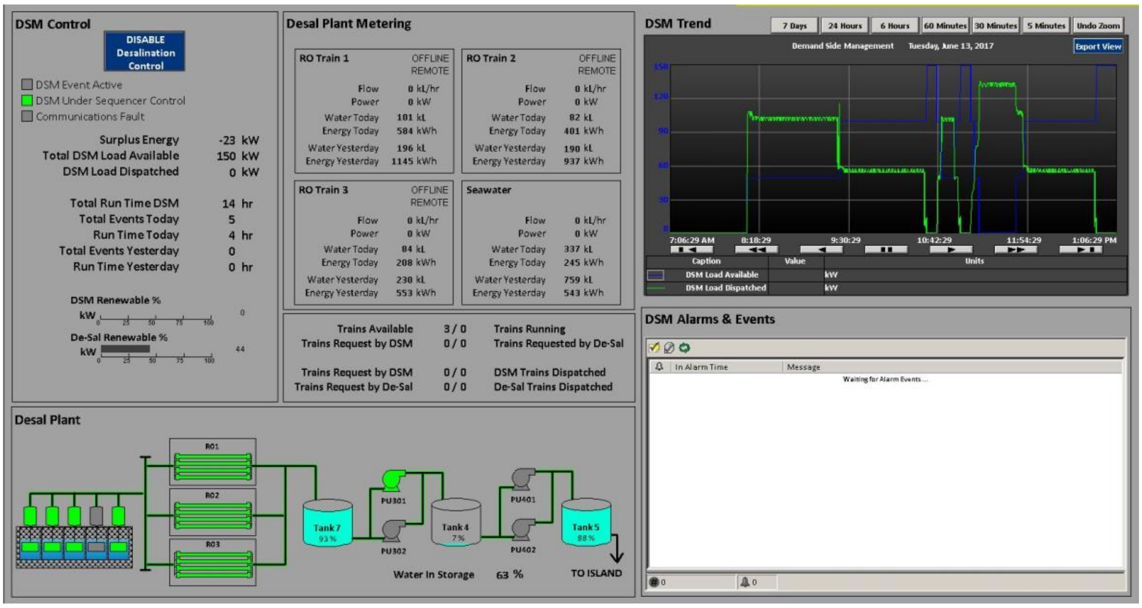
Knowledge gap is around the practical implementation experience of achieving reliable DSM of the desalination plant.

3.1.4 Supporting information



Desalination plant overview

Demand-side management, desalination plant, left, wind turbine and water storage, right



Demand Side Management HMI Overview Page, example of DSM event

3.2 Power system integration challenges in low inertia / high penetration renewable energy grids

3.2.1 Key learning

Power system co-ordination and integration is essential to the successful operation of high penetration (up to 95%) renewable energy grids with low inertia.

System stability can be maintained with careful design and minimal enabling technology, though requires a high level of planning, integration and testing to be able to ride through transient events.

All generation and monitoring, control and protection systems must be carefully designed in order not to cause a major grid disturbance in a lightly loaded system with large levels of renewable generation. This, combined with the high quantity of controllers and need for fast acting co-ordination, requires a significant level of detailed engineering in order to correctly operate under variable system conditions and contingency events. For example on Rottnest Island the control system interfaced with 7 x diesel generators, 1 x wind turbines, 20 x solar inverters, 7 x feeders, demand side management loads, dynamic resistors as well as a large number of protection devices on the network.

3.2.2 Implications for future projects

Future off-grid projects, and in the NEM as renewable energy penetration increases to higher levels, will need to ensure a greater level of co-ordination of control and protection systems between the network and generation.

The implications are that as the penetration increases, additional coordination work is required as well as enabling technology to support the increasing sophistication of the power system.

3.2.3 Knowledge gap

A knowledge gap exists between network operators, contractors and equipment suppliers in regards to the need to completely understand the device level protection and control functionality for both the individual equipment such as a solar farm, wind turbine, feeder management and also the power system as a whole.

This knowledge gap was apparent as contractors and equipment suppliers were used to designing, installing and operating equipment in larger grids, with significantly more inertia and slower control response rates.

The impact of each control and protection function in a high penetration grid has the potential to destabilise the entire grid. An example of this is a solar farm, rapidly shutting down due to an internal control function such as a warning system; this rapid shut down removes the single most significant generation source and can cause a destabilising system event. There are significant numbers of potential causes of a plant shutdown, and all of these must be known and documented, so the power system controller can manage appropriate reserve and co-ordinate the bringing online of other generation sources.

3.3 Renewable energy equipment suitability for off -grid

3.3.1 Key learning

Renewable energy and enabling equipment is primarily designed and configured for operation within large interconnected grids with significant inertia. When this equipment such as wind turbines and solar inverters are utilised in the off grid environment as an integral source of energy, significant engineering investigation and work is required with suppliers to ensure ongoing reliable operation of the power system.

An example of this is the installation of a single wind turbine that is the single largest generation source in the grid. At times internal control systems have been seen to intermittently shut down the wind turbine even when operating at full power. The shut downs could be for operational reasons such as untwisting power cables or automatic greasing of pitch motors. This disturbance has the potential to cause a system blackout in the off-grid environment, though if it occurred in in a large grid connected wind farm in the NEM a single turbine shutting down would be unnoticeable. The design of the equipment often is in accordance with evolving grid codes, but the individual detailed reasons for shutdowns are often not well documented or considered as it is unusual for wind turbines to be the key generation source.

Another example is the lack of ability in most equipment to configure a shutdown ramp rate for equipment specific controllers, and have these controlled shutdowns separate to protection based emergency shut downs which may need to occur at significantly faster ramp rates. This level of control function is not normally available in equipment as it is not necessary in large scale grid connected situations, but would be extremely useful in a small scale off-grid project.

Detailed performance based specifications were developed as part of the procurement process, including details on communications and power output response times required. Extensive commissioning and testing occurred to observe equipment behaviour over a wide range of operating conditions.

Numerous clarifications were required with OEM equipment manufacturers to gather further detail on equipment settings and local control system responses. In the case of the pre-existing wind turbine this was not completely resolved as there was reluctance to investigate on a solution for a single turbine installed around a decade previous.

3.3.2 Implications for future projects

Future projects will need to ensure specifications are clear that all operational shutdowns are configurable or clearly documented. Difficulty in accessing the equipment designer engineers especially when they are located overseas impacts on the ability to quickly resolve equipment issues.

3.3.3 Knowledge gap

The knowledge gap in the market is between equipment suppliers, contractors and power system operators in understanding in detail the application in a high penetration system. This knowledge gap extends to the design and documentation of the equipment, through to the contractors and designers specifying, installing and configuring control system settings.

3.4 Solar Industry Capability in smaller scale isolated systems

3.4.1 Key learning

At the time of this project solar PV contracting was still a growing industry and where the solar PV farm differs from a standard large scale grid connected system there was limited or developing capability. The WREN solar farm had particular control requirements combined with being implemented at a small scale (600 kW DC) in a remote area. Learnings from the design and construction of the solar farm array included:

- Where a solar farm requires fast acting set point control to maintain system stability, there may be advantages with using a centralised inverter. Commonly available industry Solar PV controllers that aggregate string inverters to a central point, have difficulties in robustly providing the supervisory control within the required timeframes (sub second).
- Limitations with the communications network topologies, (daisy chain) and the subsequent loss of inverters downstream of a point of failure should be considered when selecting between central or decentralised inverters.
- Expectations of quality and timely solar PV project delivery were impacted largely due to over-commitment on multiple projects by the solar subcontractor. Project delivery of the solar farm, may have suffered from subcontractors moving up in scale from smaller 'standard' systems with relatively repeatable design, of solar PV systems without the mature delivery approaches that may be more common on larger scale tier 1 firms. This was shown across the solar farm from equipment selection, design to the overall delivery experience.
- The size of solar farm at 600 kW DC, is challenging in that it was too small to attract interest of the larger more experienced contractors, though complex enough to be challenging to deliver for less experienced contractors.
- Foundations are a major source of a solar farm capital cost and though upfront geotechnical reports were provided at the time of tendering, the subcontractor did not fully consider the impact and subsequently took numerous attempts to achieve a suitable design withcost implications due to the high cost of concrete in remote areas.
- There was evidence of a shortage of qualified and experienced PV contractor personnel in a busy and rapidly expanding market. This has been seen on other projects as well.

3.4.2 Implications for future projects

In situations where the solar farm and control of the solar farm is critical to the power system, such as in high penetration off-grid projects, developers should expect that they will need detailed engineering input into the specification, design and commissioning, even when using EPC contractors and pay close attention to specific contractor experience.

3.4.3 Knowledge gap

Contractors and equipment suppliers will need to evolve to deliver solar farms at smaller scale, and with increasingly sophisticated supervisory and control systems. These control systems and configuration of these will need to provide robust, fast acting response and configurable fault ride through capability for critical applications such as high penetration renewable energy systems.

4.0 Summary of knowledge sharing

A number of activities have been undertaken to increase awareness of the project and share knowledge:

- Hydro Tasmania presented at an international ecotourism conference on Rottnest Island, attended by managers of operations on off-grid remote islands, during the week of 16/11/2015. Hydro Tasmania provided insights into renewable energy and energy efficiency for islands.
- Hydro Tasmania presented at the Australia Remote Area Power Conference in Melbourne in March, 2016, making specific reference to the WREN project and the core demonstration elements.
- Hydro Tasmania held information sessions with the Rottnest Island community on island on the 2nd June 2016, with over 45 people in attendance. This was the second such community engagement session and covered talks and engagement with RIA, Programmed Facilities Management (Rottnest Island main contractor) staff, island community, business and the Rottnest Volunteer Guide Association.
- RIA have provided updates through their website, http://www.rottnestisland.com/the-island/about-the-island/sustainability
- Temporary solar signage was installed during construction to engage with the community.
- A project fact sheet has been provided to operators of historic railway that passes the solar farm, RIA staff, at the visitor centre, ferry company and Rottnest Island business community (RIBC).
- A media activity occurred including;
    - Media release, dated 29/11/2016 - Rottnest Island facebook and tweet.
    - Media led report, channel 7, dated 7/11/2016
- Other utilities operating hybrid projects including Horizon and Synergy have visited Rottnest Island.
- RIA has continued informal liaison with RIBC and Rottnest volunteer association.
- Hydro Tasmania presented at the Australia Clean Energy Summit in Sydney in, 2017, making specific reference to the WREN project and the core demonstration elements along with other ARENA projects.
- Hydro Tasmania and RIA are attending the World Renewable Energy Congress conference in Perth in February 2017. A technical tour of the WREN Rottnest Island project is incorporated into the conference program.

Figure 7 – Hydro Tasmania's David Brown presenting to stakeholder on Rottnest Island

There has been a significant degree of informal knowledge sharing between Hydro Tasmania and RIA / PFM through design review sessions and risk assessments of various works packages.

Engagement with industry contractors has also occurred, through outing methods for hybrid renewable energy, including distribution contractors, solar PV contractors and diesel and station control system providers.

In addition a range of website updates, newspaper articles, tweets and facebook updates have been provided by RIA on the progress of the project. Two electric vehicles are used by RIA staff and project team members, with signage raising awareness of the project being delivered by Hydro Tasmania, Rottnest Island Authority and the support of ARENA.

Hydro Tasmania has shared project specific data with a number of universities and the Rottnest Island WREN project has been used as a case study for project management and renewable project design case studies.

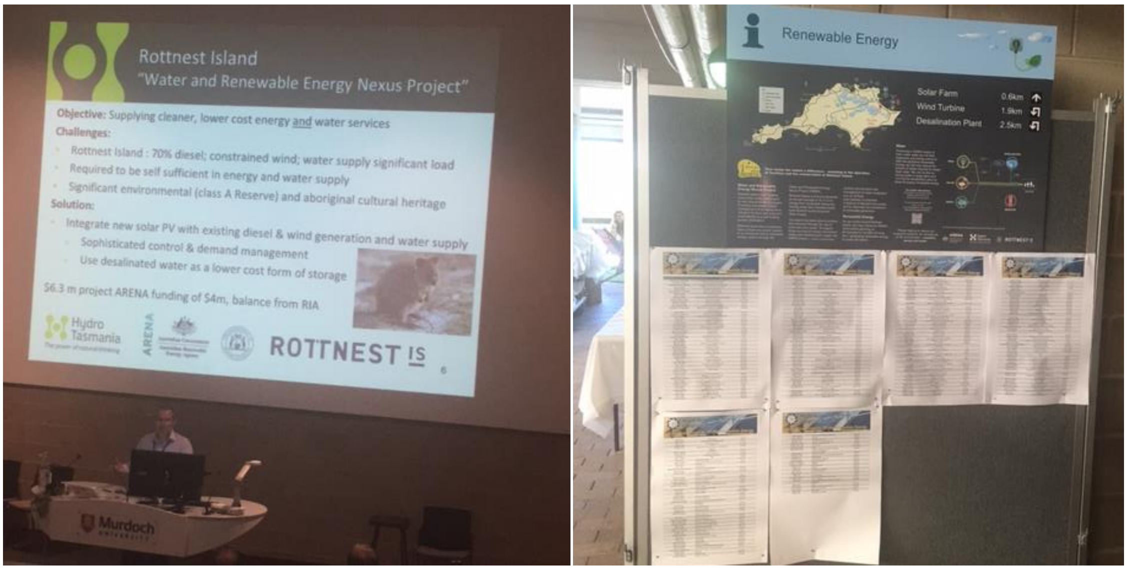
Figure 8 – Water and Renewable Energy Nexus project signage on a Nissan Leaf electric vehicle.

World Renewable Energy Congress, 6th February 2017

Hydro Tasmania presented at the World Renewable Energy Congress (WREC) on the WREN project, this included attendance by RIA, academics and industry participants. In addition a half day project site tour occurred on 9th February.

Hydro Tasmania published a conference paper for this event and wider publication.

Hydro Tasmania, *Rottnest Island Water Renewable Energy Nexus Project : Practical integration challenges for hybrid renewable energy power systems,* World Renewable Energy Congress, 2017



Hydro Tasmania's presenting at the World Renewable Energy Conference, Fremantle

- The RIA hosted a Singaporean visit to site during June 2017.
- Managers from Synergy visited Rottnest Island to understand the project and learn for their own hybrid energy sites.
- Project signs have been installed on Rottnest Island.

Example of WREN renewable energy signage around the island, at the solar farm, wind turbine, desalination plant and visitor area's.

Rottnest Project Opening and Phone App Launch- 16th November 2017.

Island Power System Connect conference

Hydro Tasmania, organised and delivered an island power system connect conference on Rottnest island, that included a range of national and international guests from within industry facing similar renewable energy and water integration challenges. As part of this event Rottnest WREN project site visits occurred giving others in the industry a chance to ask questions and apply WREN project learnings to their own projects in the future.

Elements of the Rottnest Island project along with other ARENA supported project such as King & Flinders Island were most recently presented at the October 2018 IPS Connect conference to international delegates in Maui, Hawaii.

4.1 Industry Publications

Summary article

http://www.esdnews.com.au/diesel-to-de-sal-on-rottnest-island/

Full article

Energy Source and Distribution, Nov-Dec 2017

http://www.esdnews.com.au/magazine/

http://www.calameo.com/read/000373495645e442e18cc

A range of media Releases and Magazine Articles in industry magazines and online occurred during November.

https://www.hydro.com.au/about-us/news/2015-11/diesel-%E2%80%98de-sal%E2%80%99-rottnest-island-creating-power-and-drinking-water-lower-costs-https://www.hydro.com.au/about-us/news/2017-09/renewable-rottnest

https://www.hydro.com.au/about-us/news/2017-11/tasmanian-tech-drives-renewable-rottnest

4.2 Rottnest Project White Paper

World Renewable Energy Congress, Rottnest Island Water Renewable Energy Nexus Project: Practical integration challenges for hybrid renewable energy power systems.

Available on the ARENA website.

4.3 WREN Project Phone App

Completed, refer above for details. Available for Android and IoS.