Project Final Report
Lessons Learnt During **Trial Deployment**

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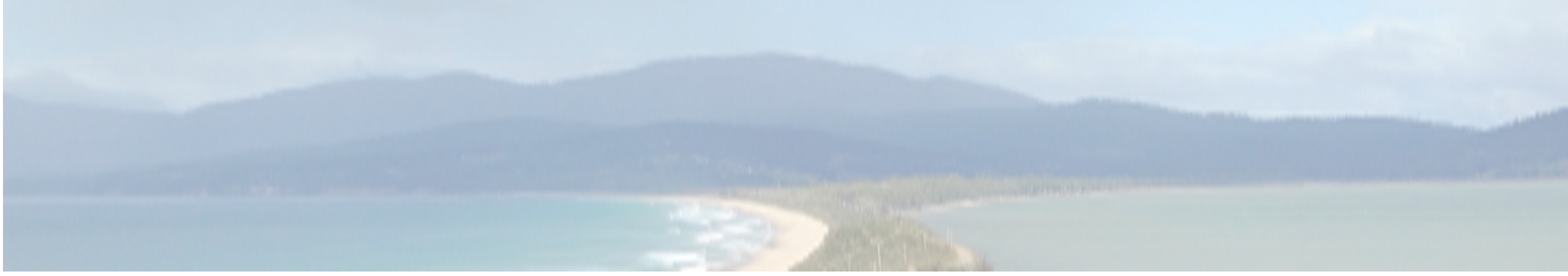
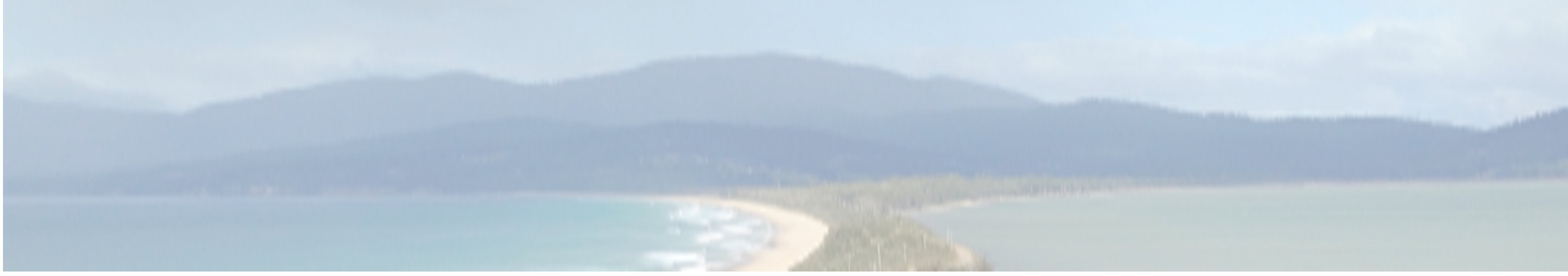
April 2019

http://brunybatterytrial.org

CONSORT: “Consumer Energy Systems Providing Cost-Effective Grid Support” is a collaboration between The Australian National University, The University of Sydney, University of Tasmania, Reposit Power and TasNetworks. The Australian Government, through the Australian Renewable Energy Agency, is providing $2.9m towards the $8m trial under its Research and Development Program.





Executive Summary

The CONSORT Bruny Island Battery Trial has demonstrated how customer-owned distributed energy storage can deliver significant value to the network. The 34 participating batteries were orchestrated to reduce the amount of diesel generation that was required to manage an existing constraint in the cable supplying Bruny Island. The batteries and orchestration system combined to deliver a 33% reduction in the amount of diesel generation in 2018.

The project delivered four key deliverables:

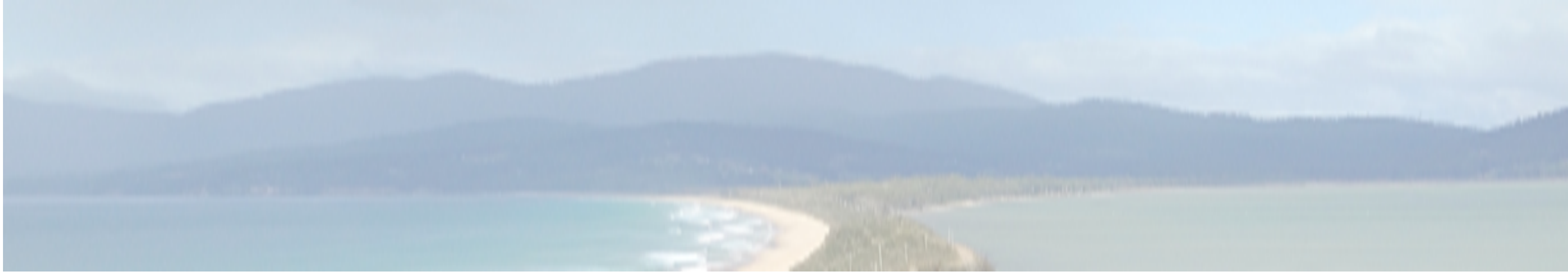
- 34 households with solar/battery systems equipped with Reposit Power battery controllers totalling 127.8kW/333 kWh;
- An advanced battery orchestration algorithm, Network Aware Coordination (NAC), developed by the Australian National University (ANU);
- A means of pricing network services that reflects the value they provide the network developed by The University of Sydney (USyd); and
- A map of the customer experience and insight into how future demand response and orchestration programs by the University of Tasmania.

This report summarizes the deployment of NAC and reward structures. It distils the key learnings that are relevant for a large-scale application of this type of technology elsewhere in Tasmania and Australia.

The key outcome of the trial was that orchestrated customer sited DER successfully managed a network constraint; the batteries and orchestration algorithm were able to deliver a 33% reduction in diesel and completely avoid all diesel generation on one occasion (see Network Aware Coordination final report [1]). The community remained engaged throughout the whole trial and continue to provide valuable insight (see Social Science final report [2]). A new Shapley value based means of pricing network services was demonstrated (see Reward Structures final report [3]). The use of batteries at peak times delivered a 33% diesel saving. Half of which was attributable to the NAC battery orchestration algorithm, the other half being from optimising the customers own consumption.

There were many learnings generated at all stages of this trial the key learnings were:

- Asset and operational data is often poor quality which can affect the ability of orchestration platforms to work effectively;
- For customers to become a key providers of network services they should be engaged early and often. It is important to provide real-time relevant feedback;
- Customers and installers are often ill-informed about the benefits of grid participation which can limit uptake of these technologies. It would be beneficial for a trusted party to step into an “informing” role to assist uptake; and
- Short term load forecasting of small blocks of load is important and difficult to get right, but required for orchestration to work effectively.



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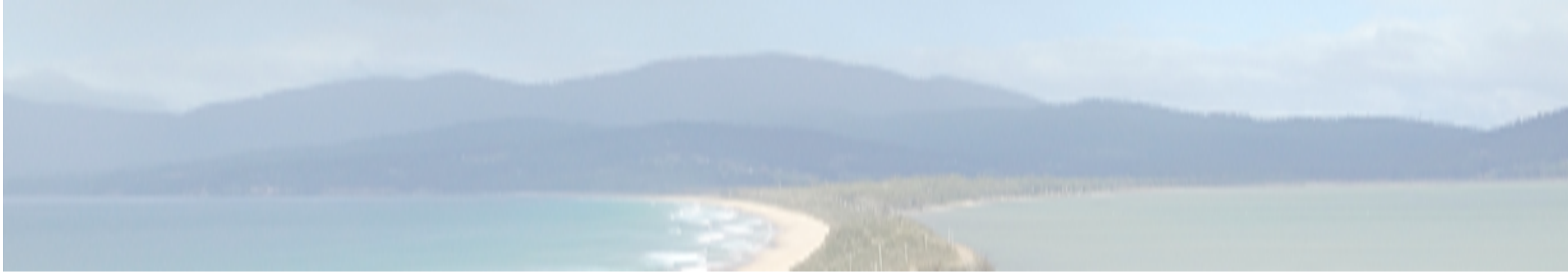
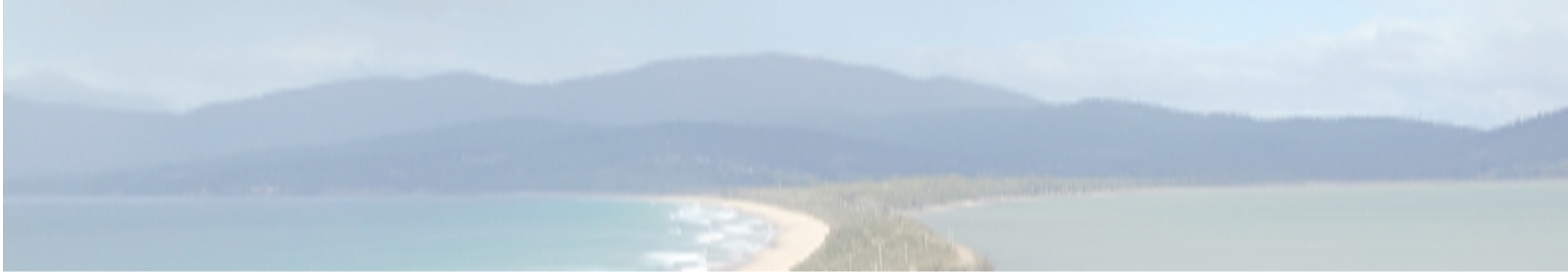




Introduction

This report discusses an overview of the approach taken in designing the project, customer engagement, battery installation, rollout of the Network Aware Coordination (NAC) and reward structures during the CONSORT trial. The report describes:

- The process used;
- Lessons learned during the process; and
- Learnings for future deployments.

More detail on the technical design and outcomes of algorithms themselves can be found in the relevant milestone reports specific to the research package:

- Network Aware Coordination final report [1];
- Reward Structures final report [3]; and
- Social Science final report [2].

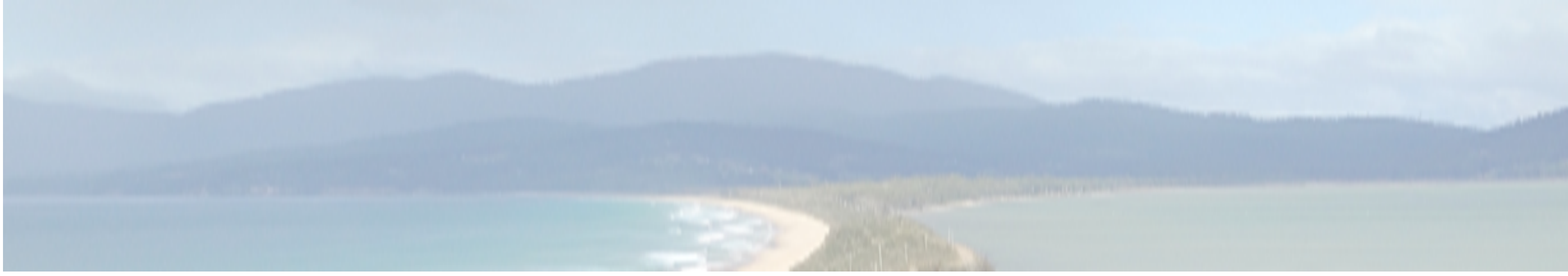
Customers are installing batteries in their home an an accelerating rate. These batteries are a promising reserve of network services. These services (such as peak load reduction and voltage control) can increase the value of these batteries significantly but require the appropriate algorithms, pricing structure, and customer acceptance to be realised.

The CONSORT Bruny Island Battery trial was a customer sited battery trial designed to test the value of these grid services. It installed 34 solar/battery systems equipped with Reposit Power (Reposit) optimising controllers and orchestrated them to manage an existing network issue on Bruny Island. The project was an ARENA funded trial and was primarily a research project, including computer science, engineering, economics, and social science research elements.
The specifics of the trial were:

- Total trial budget: **$7.9m**
- ARENA Grant: **$2.9m**
- Trial period: **April 2016 - March 2019**
- Trial partners: **The Australian National University (ANU), The University of Sydney (USyd), University of Tasmania (UTAS), TasNetworks, and Reposit Power**
- Battery capacity installed: **127.8kW/333 kWh over 34 installations**

Customer engagement trial design

This trial was designed to test a model for the future. We expect that the in the long term, battery installations will be primarily driven by customer side drivers, such as a desire to maximise their solar self consumption and save on their retail bill. As such, batteries will



start “appearing” on the network (in the eyes of a DNSP) in an ad hoc manner. A portion of these batteries will appear in constrained areas of network, providing a resource the DNSP can use to support the network during peak periods or manage voltage constraints. These batteries will feature a range of capacity and demand sizes, inverter size and settings, solar size and native tariff responses. The CONSORT trial design aimed to mimic this future as far as practically possible.
In addition, the project was designed in a fashion that allowed the use of network support to continue post trial with as little effort as possible.

Trial implementation and customer interface

To meet this design intent, the trial implementation was carefully designed to replicate the process customers would use to install a battery capable of providing grid services outside of a trial setting as much as possible. This was achieved through providing the maximum degree of choice to each customer and ensuring customer contributed financially. The factors customers could choose were:

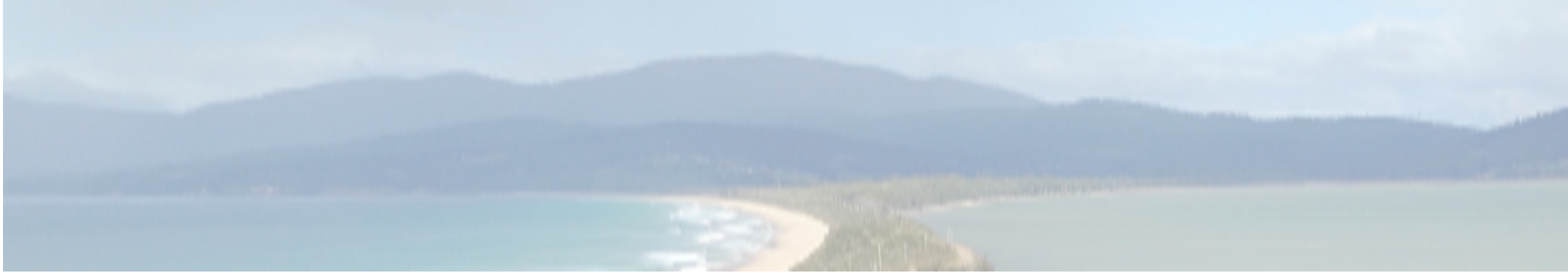
- The Installer (from a pre-qualified panel of 6)
- Battery
- Inverter
- Solar size
- Retail Tariff rate
- Back-up circuits

A key step in the process was to allow customers to choose their own installer and work through them to design and install the system. This inclusion has been key in understanding the critical role installers perform in the new energy future. The social science findings discuss the role of the installer in greater detail.

The degree of choice intentionally created ownership of the systems. In addition, the customers paid a minimum of $2000 out of pocket towards their system. Customers had to pay more for additional features at their own cost.

Another factor exercised in testing the future was through selecting trial participants in a random process rather than looking for specific geographic locations. This was especially important in regards to the research on Reward Structures, as the relative location of batteries changes their electrical value in solving network problems.

Even though a there was a large battery subsidy the trial still paid customers for services they provided the network. This was important as we wanted customers to feel ownership, and place the same requirements on the network usage of the systems as if they had paid the full installation cost.



Through observing this process we have obtained valuable learnings about the customer experience and likely issues the industry would face as this technology is scaled.

More detail on the process and how it worked can be found in the original documentation provided to customers:

- Trial fact sheet
- Participation application fact sheet
- Participant information sheet
- Presentation from customer forums
- Frequently asked questions
- Application form

Additionally the documentation provided to installers provides details on the technical requirements of the trial

- Subsidy process and checklist
- Technical specification and subsidy design
- Hazard and Operability study report

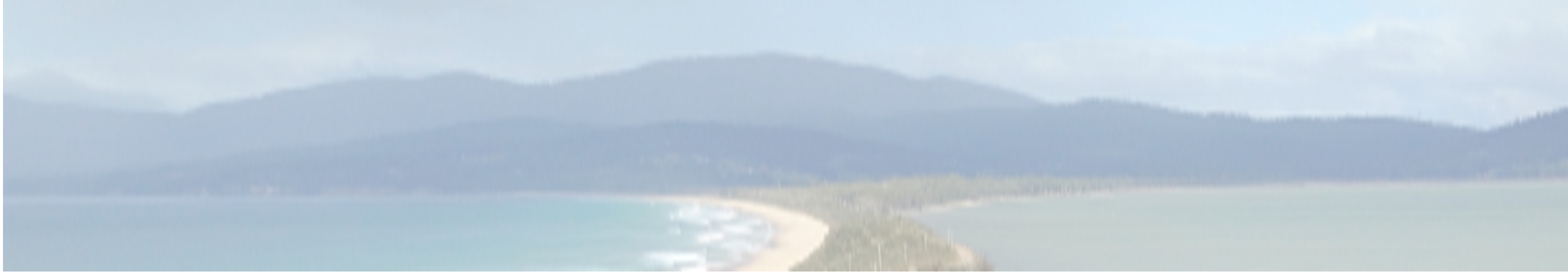
Implementing the trial in this way, while initially more complex, provided many learnings that are important for the industry as a whole. Many of these are covered in the Social Science final report [2], but important ones are repeated in this report.

Research

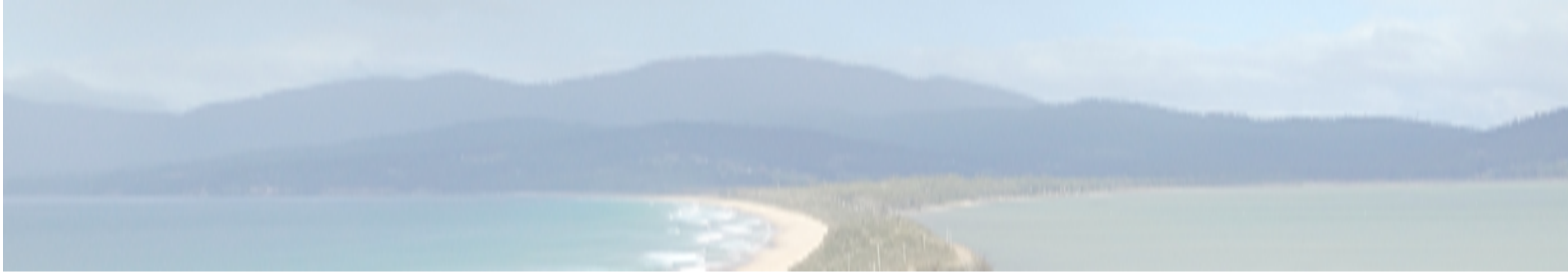
This project was primarily a research project. There were three research packages within the trial:

- The Australian National University (ANU) computer science and engineering research team developed the Network Aware Coordination (NAC) battery orchestration algorithm;
- The University of Sydney (USyd) developed innovative new pricing methodologies to rewarding customers for their grid participation; and
- University of Tasmania (UTAS) undertook research to investigate customers emotions, thoughts, and reactions to grid participation and the technology installed in their homes as part of the trial.

The NAC algorithm designed by the ANU is a means to coordinate distributed energy resources (DER) in a way that respects network constraints and minimises the total cost to both the network provider and the DER owners (participating households). See the Network Aware Coordination final report [1] for more details on this work package.
For customers to accept their batteries being orchestrated by the NAC algorithm they must be fairly rewarded for the services they provide. The reward structures research undertaken by USyd investigated a Shapely values as a means to generate a value-reflective pricing signal for grid services form customer batteries. See the Reward Structures final report [3] for more details on this work package.
Using customer-sited batteries to manage network issues requires customer acceptance of the technology. The social science research undertaken by UTAS investigated customer

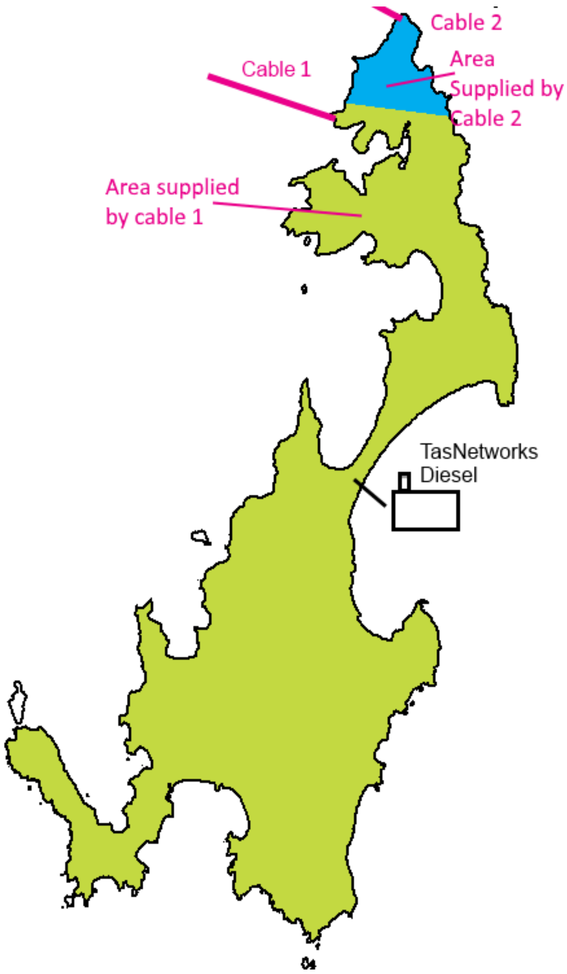


thoughts, feelings, and behaviour to the technology in their home and grid interaction. This was performed using a series of interviews, focus groups, and energy diaries with all 34 customers. See the Social Science final report [2] for more details on this work package.

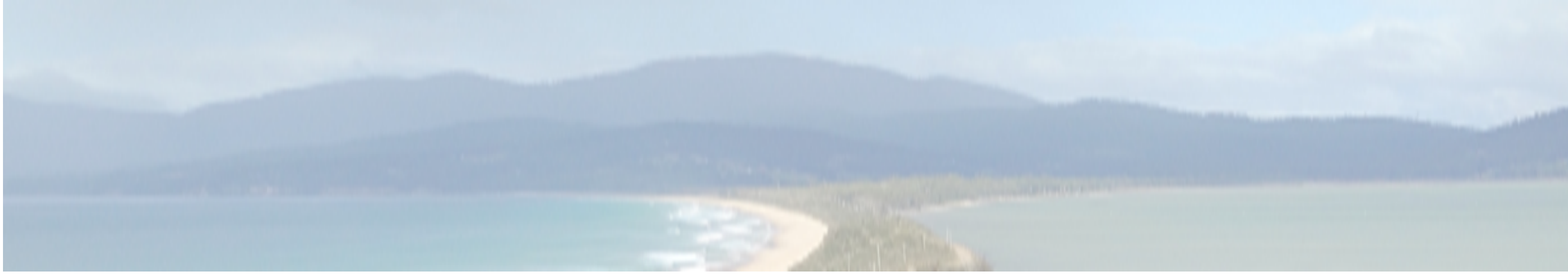


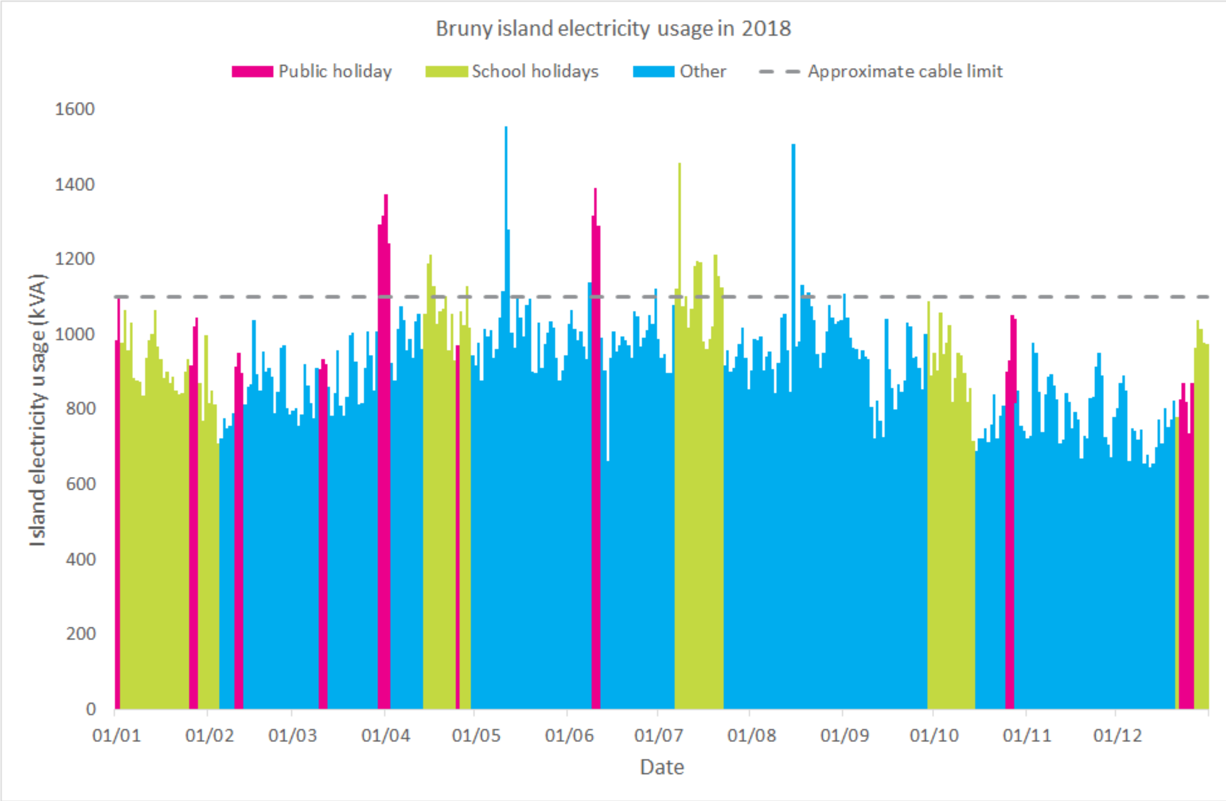
Bruny Island electricity network

The key network purpose for the trial was to manage an existing issue with the network supplying Bruny Island. Bruny Island is supplied via two cables. The southernmost of the two cables can reach its capacity at peak times centred around holiday periods, approximately 21 events per year. Historically this issue was managed using a diesel generator. The aim of the project was to use energy from customer batteries over the diesel generator. A map of Bruny Island with the cable location is shown below:

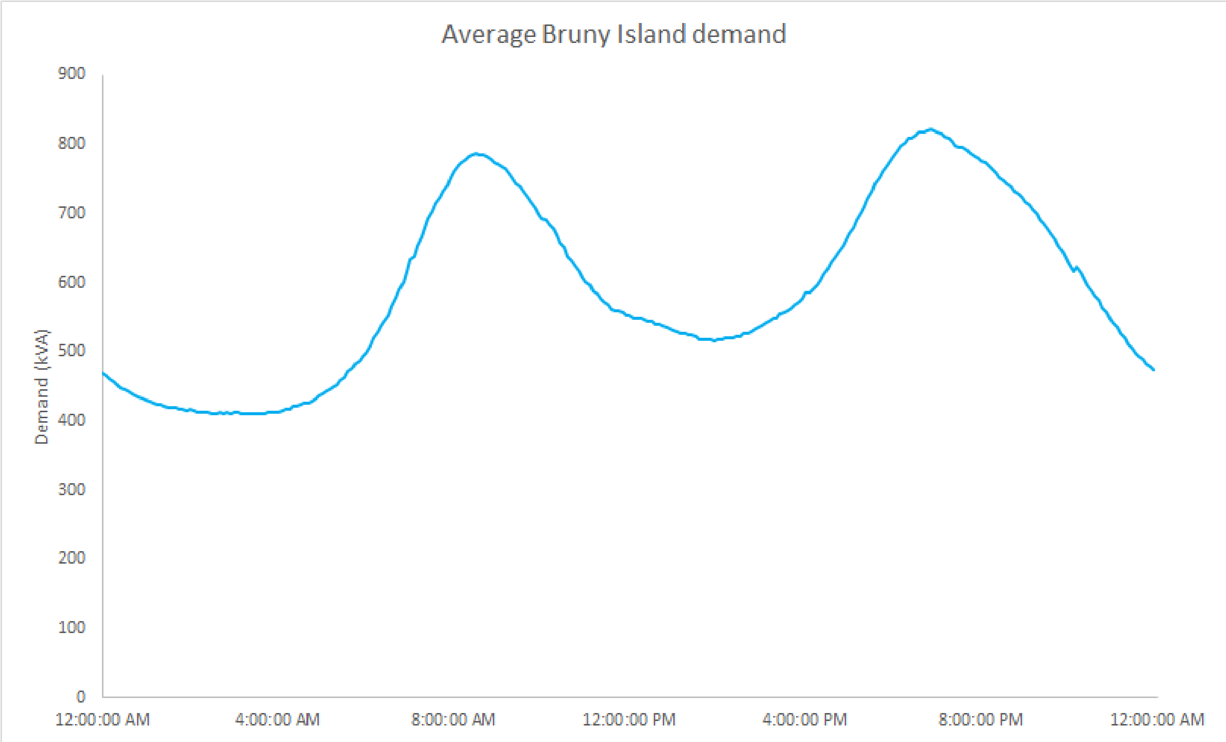


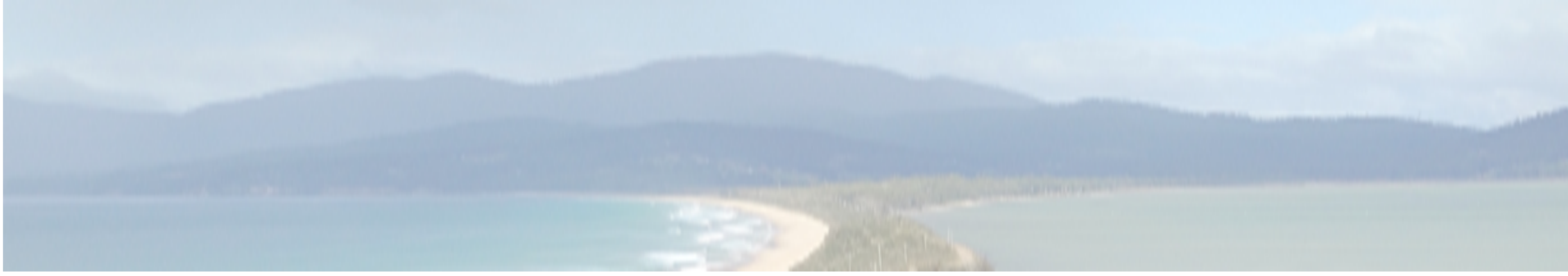
The peaks on Bruny Island are driven by temperature (colder weather drives a heating load) and population influx (an increase in number of heaters being used). Historically the largest peaks are Easter and the Queens Birthday long weekend in June. Other peaks occur in school holidays in winter. The Bruny Island peak loads for 2018 are shown below:





Bruny Island generally experiences two peaks in a day - one in the morning around 8:30 AM and one in the evening around 8:00 PM. The average daily load curve is shown below:



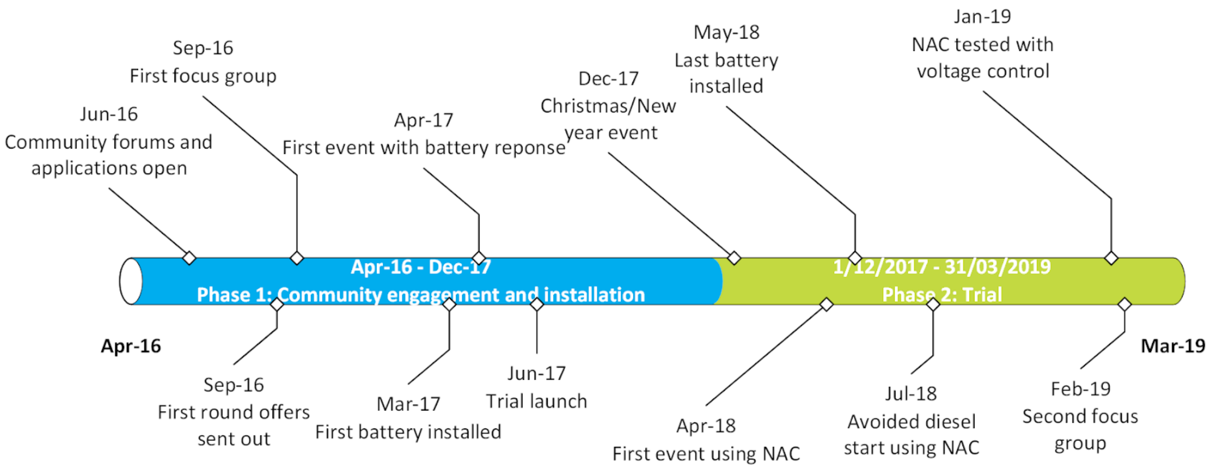


Trial Program

The trial was split into two phases:

- Phase 1 was community engagement and installation of solar/battery systems; and
- Phase 2 was the trial where NAC and reward structures were tested.

An overall timeline of the trial is below:



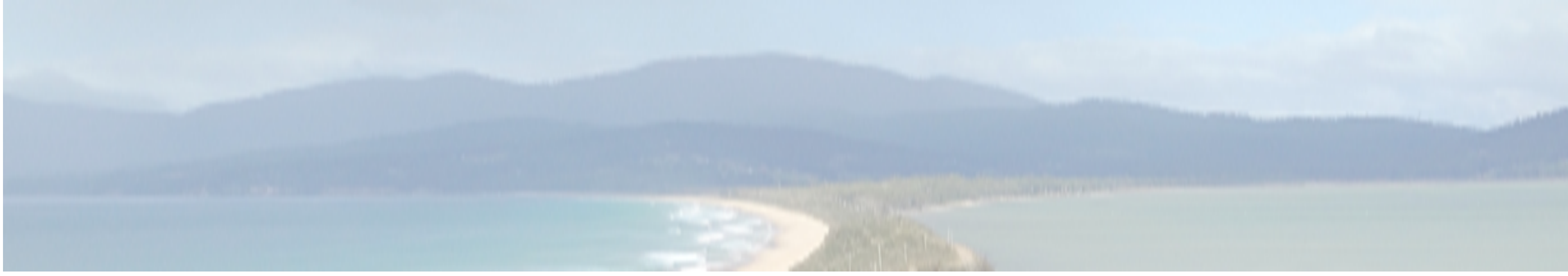
Phase 1: Community engagement and installation

This phase was where the community were initially informed of the trial and participants were selected. It was also where the bulk of the batteries were installed. It's key outcomes were:

- Developing the design of the trial;
- Determining the customer proposition for participation;
- Selecting installers to participate;
- Selecting customers to participate;
- Installing batteries; and
- First two social science interviews (pre and post installation) and first focus groups.

This phase concluded in December 2017.
The key events in this phase were:

Date	Details
06/2016	Focus groups with community members to refine trial design
07/2016	Community forums in Hobart and on Bruny Island to formally introduce community to project.
06/2016	Trial design finalised and released to public



06/2016	Applications open
08/2016	Applications close
08/2016	Installers selected
08/2016	HAZOPS safety workshop with installers
09/2016	Round 1 offers sent to selected participants
09/2016	Information night and first UTAS focus groups
12/2016	Round 2 offers sent to selected participants
03/2017	First battery installed
04/2017	First event with battery response (Easter and ANZAC day, 3 batteries) (fixed dispatch; fixed payment type)
06/2017	Trial launch

Apart from the social science activities most of the research activities at this stage were in development. Nevertheless there were several significant learnings generated during this time, in particular around the customer interface, install process, and installer relationships. In particular:

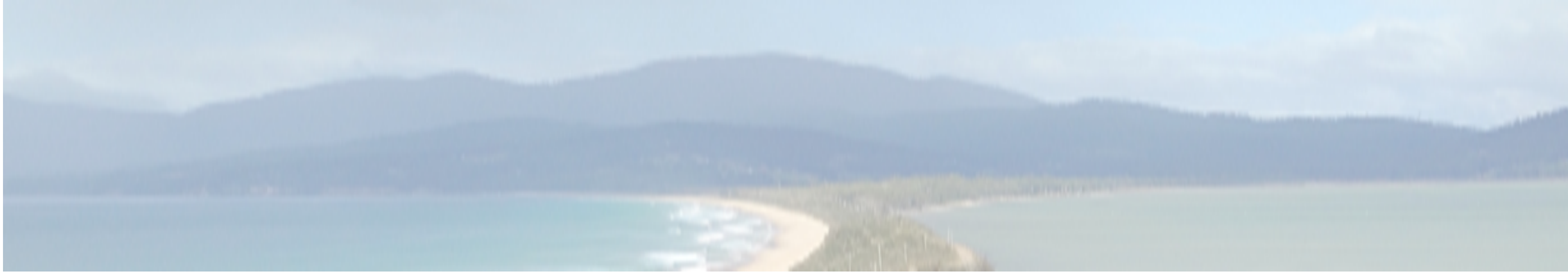
- Installers were found to be key intermediaries in the installation process but generally lacked the knowledge to adequately educate the customer;
- Customers found the advice and guidance provided by TasNetworks and UTAS helpful and useful to navigate the install and operation process but outside the trial this service is missing; and
- Most installations had defects that needed to be rectified before the installation could connect.

The first battery event occured in this time, easter 2017. In this event there were three batteries commissioned therefore there were no significant network impacts. It did, however validate the “fixed dispatch” methodology. In this methodology:

- The battery discharges based on time schedule; and
- Customers are paid a fixed $1/kWh for energy the battery discharges.

Phase 2: Trial

This was the part of the trial where the NAC and Reward Structures research trials were undertaken.



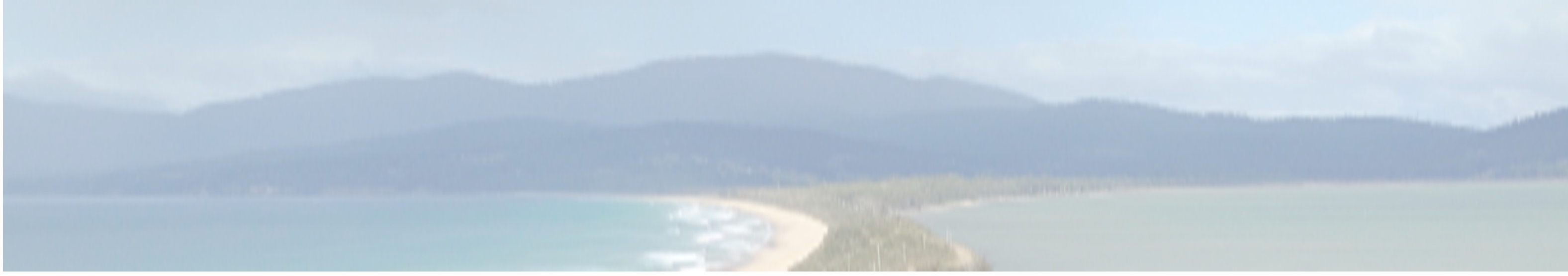
The trials were combinations of the different dispatch method and payment types. The table below defines and explains each of the methods and types:

Dispatch method	Payment type
Fixed ● Dispatch based on simple timer (e.g. “discharge between time X and Y”) ● Dispatch manually scheduled ahead of event ● No load forecasting/automation	Fixed ● Customers paid $1/kWh for energy discharged into the grid ● Customers notified post-event of amount of payment
NAC ● Battery dispatch using Network Aware coordination algorithm ● Dispatch automatic ● Load forecasting algorithm	Energy Reserve ● Customers paid variable amount related to their utility in resolving the network problem ● Customers notified before the event of amount of payment (reserve)
	Energy Usage ● Customers paid variable amount related to their utility in resolving the network problem ● Customers notified after the event of amount of payment

Phase 2 began in December 2017 with a series of battery dispatches over Christmas and New Year using a fixed dispatch methodology. The key outcomes of this phase were:

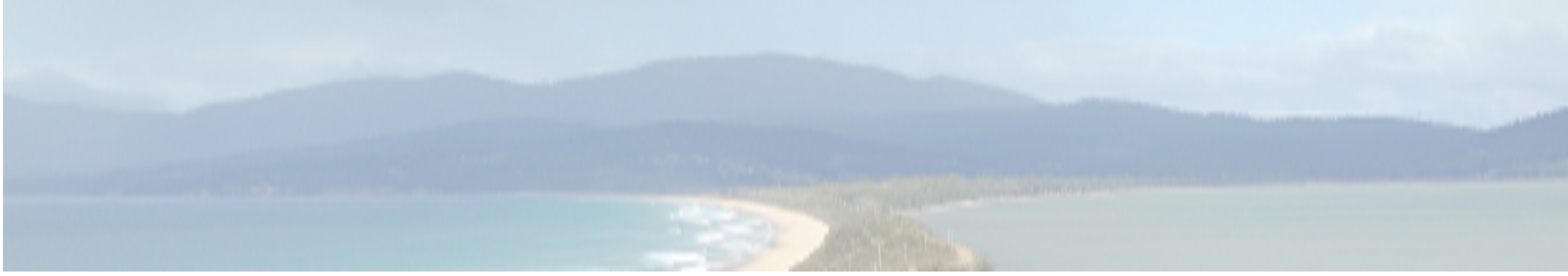
- Validation of Reposit “fixed dispatch” system performance;
- Trial of NAC;
- Trial of two payment types (“Energy reserve” and “Energy usage”); and
- Third social science interview, second focus group, and energy diaries.

It’s worth noting that NAC, as an automated tool, was set to run continuously for a period. During this period it would continually monitor cable load, looking for forecast peak periods. There were some periods where NAC was set to run, but no peak demand events occurred. In other cases, simulated peaks were created to force NAC to acquire network support even though there was no actual network peak. The simulated peaks were created purely for the purposes of testing.



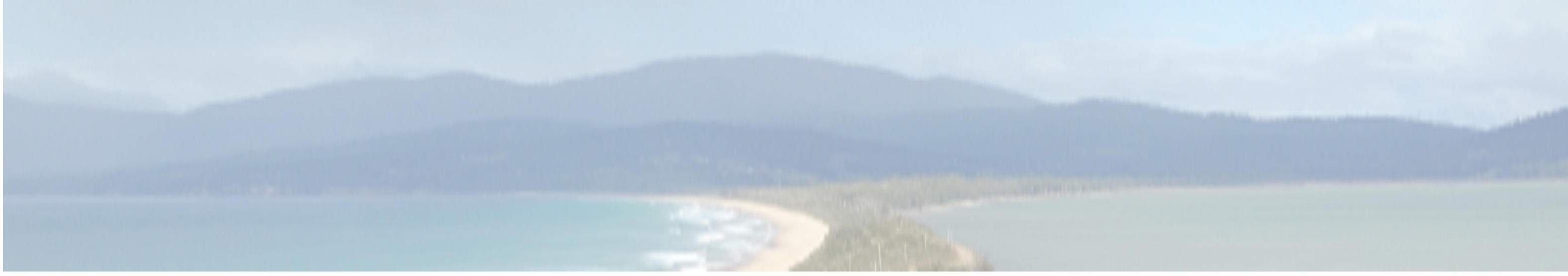
The key events in Phase 2 were:

Date	Details
12/2017	Dispatch over Christmas/New Year 2017-18 (fixed dispatch; fixed payment type)
01/2018	Dispatch over Australia Day (fixed dispatch; fixed payment type)
02/2018	First NAC trials on three customers (NAC dispatch; fixed payment type)
02/2018	Dispatch over Regatta Day long weekend (fixed dispatch; fixed payment type)
03/2018	First NAC event over 8 hour day long weekend (NAC dispatch; fixed payment type). No events.
03/2018	NAC running over Easter long weekend. First test of Energy reserve payment type (NAC dispatch; energy reserve payment type). 6 peaks
04/2018	NAC running over April school holidays and ANZAC day. 21 days of continuous operation (NAC dispatch; energy reserve payment type). 0 peaks with NAC action, 1 peak generator start
05/2018	Last battery installed
06/2018	NAC running over Queens Birthday long weekend (NAC dispatch; energy reserve payment type). 5 peaks with NAC action, 7 generator starts
07/2018	NAC running over July school holidays (2 weeks). First test of energy use payment type in week 2. New neural-network based load forecast implemented in week 2. (NAC dispatch; energy reserve payment type (week 1), energy use payment type (week 2)). 5 peaks with NAC action,11 generator starts. One avoided generator start on 21/7.
07/2018	Customers complete energy diaries during July school holidays
07/2018	Third round customer interviews from social science team
09/2018	Bruny voltage regulator fails. Network support dispatched to manage voltage (fixed dispatch; fixed payment type)
12/2018	NAC running over Christmas/New year period (3 weeks) (NAC dispatch; energy use payment type). No peaks



01/2019	Test of NAC with voltage control implemented over Australia day long weekend (NAC dispatch; energy use payment type). One peak with NAC action
02/2019	Second round of focus groups from social science team
02/2019	Test of improved Shapely value based reward calculation (NAC dispatch; energy use payment type). Shapely value based reward demonstrated successfully.

Most of the research activities were completed in this stage. NAC was successfully tested on the network, and two different payment types were tested.



Findings and results

The findings from each phase of the trial are presented in this section of the report. Key learnings have been extracted and are summarised in Appendix A.

Phase 1 - Community engagement, installation process, and customer interface

The community engagement and installation process was the longest single work package in the trial, commencing on the first day of the project and ending in May 2018.

Customer engagement and installation is a critical part of the future success of NAC or other orchestration platforms. Orchestration requires customers to select appropriate hardware and software. These decisions are usually made during during installation.

Although customers could not opt out of grid participation in this trial the social science team studies this process extensively. Their learnings will be important in future deployments. Key learnings are summarised in this report, with more detail in the Social Science final report [2].

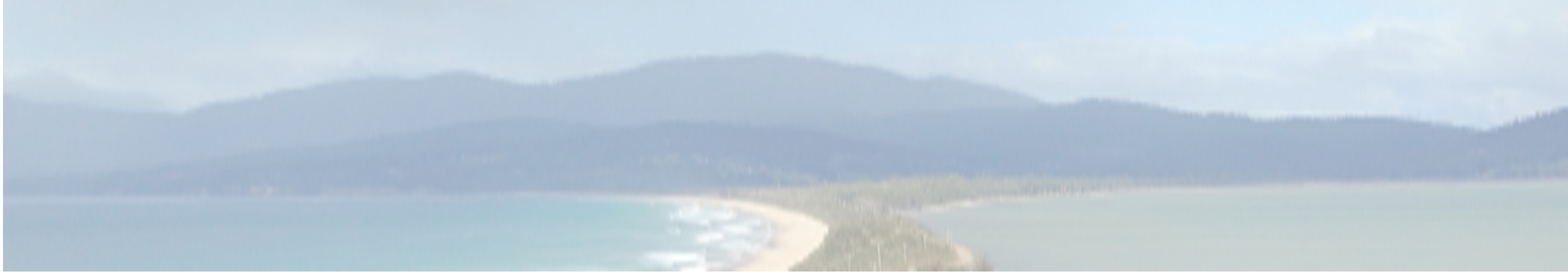
Installation process

Through community consultation and with the trial objectives in mind the installation process was designed with a few key principles:

- Customers would lead the installation process with TasNetworks and the other project partners available for assistance where required;
- Customers decide the hardware installed in their home and provide an internet connection;
- A battery subsidy would be available to reduce the cost of participation to an affordable level, however customers would always contribute to the cost of their systems; and
- Customers would be randomly selected rather than located according to network configuration.

The installation process for the selected customers and installers was:

Step	Detail
1	TasNetworks sends offer to participate to a selected customer. This offer includes: 1. A list of participating installers; 2. A pre-approval for customers to contact the installers.
2	The customer contacts and gets quotes from as many installers as they desire to install their solar/battery system
3	The customer selects their preferred installer/system. Their installer completes an



	application form that contains a list of topics for the installer to discuss with the customer. Optionally the customer may elect for the installer to manage the subsidy application process on their behalf;
4	If the application contains the required information and meets the technical requirements TasNetworks sends the customer an approval and indicates the amount of subsidy due;
5	The installer installs the system with the customer managing the process;
6	TasNetworks inspects the installed systems and when they are compliant with the installation standard TasNetworks pays the customer the subsidy. Most customers elected to have the subsidy paid directly to the installer.

In this process the customer managed the installation process the same way they would outside the trial. The project team had only an oversight role, but would step in when there were issues in the process. The points where TasNetworks had to step in and provide guidance revealed issues that may go unresolved outside the trial setting.
During the install process the social science team also undertook several activities to help measure the customer journey:

- A focus group held in concert with an information evening shortly after customer selection;
- An interview for each customer shortly before installation; and
- another interview two weeks after installation.

Through these activities the project delivered several important learnings. More detail on these learnings can be found in the Social Science final report [2] but the key learnings are described here.

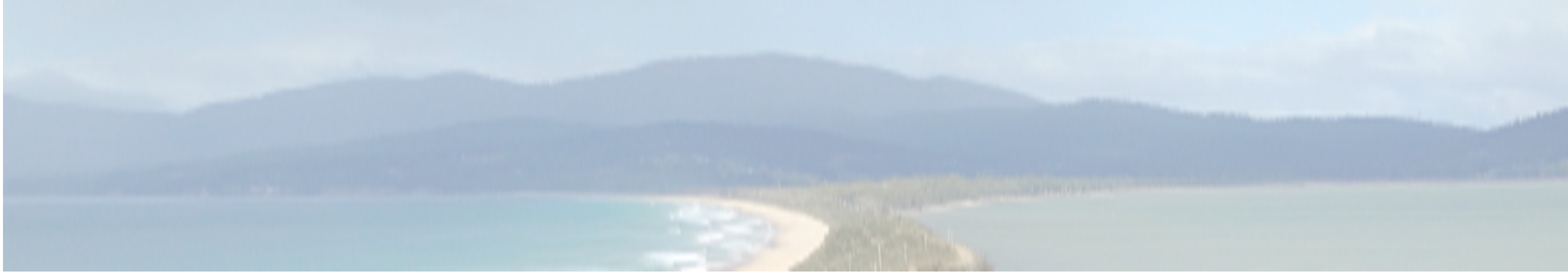
There were 34 participants who installed a system out of 46 offers made. Uptake was higher than expected and has been experienced in other similar trials.

Subsidy and customer contributions

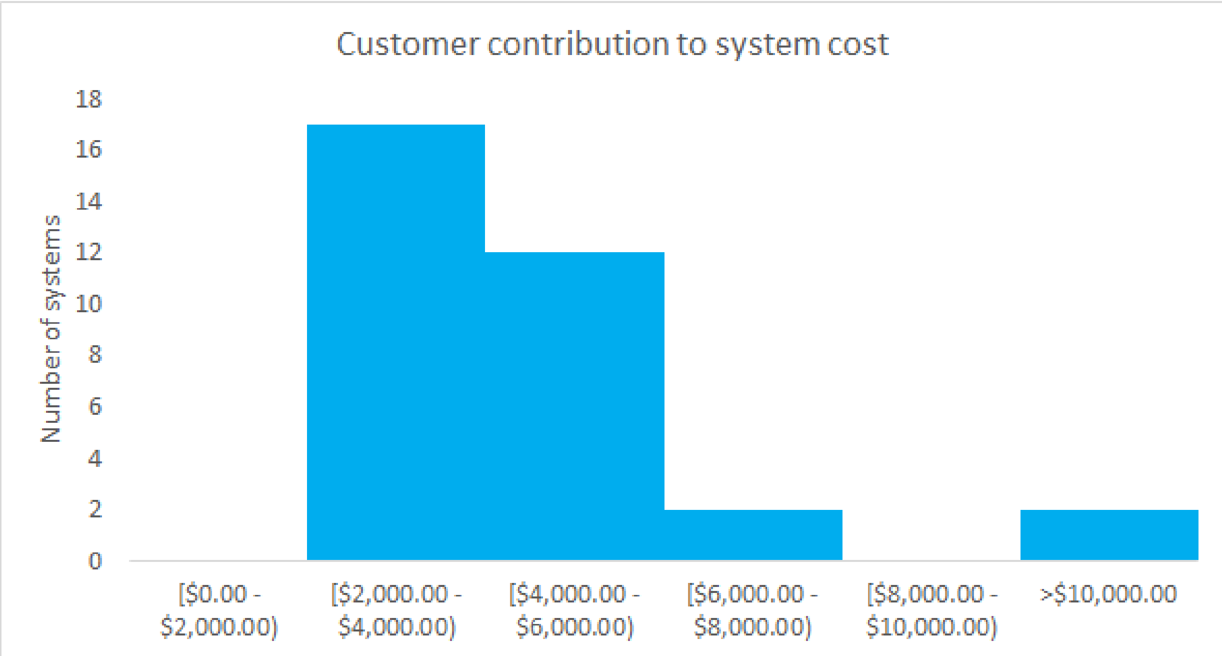
The subsidy's main purpose was to reduce the price of participation to a sustainable level. The amount of the subsidy was purely related to the capacity (kW) of the battery that was installed. It also ensured that customers always paid a contribution toward the cost of their system. The subsidy design was:

- A minimum customer contribution of **$2,000;**
- **$3,200/kW** of battery output power; and
- A maximum subsidy of **$17,200**.

The subsidy, while purely related to battery size alone, was designed to subsidise the entire system cost. Most customers installed 5kW/10kWh LG batteries and recieved a $16,000 subsidy.



A distribution of the customer contributions to system cost is shown below. The average contribution was $4,700. The lowest was $2,000 and the largest was $26,600. Only one customer did not receive the maximum subsidy for their battery size (i.e. the minimum customer contribution set the subsidy amount).

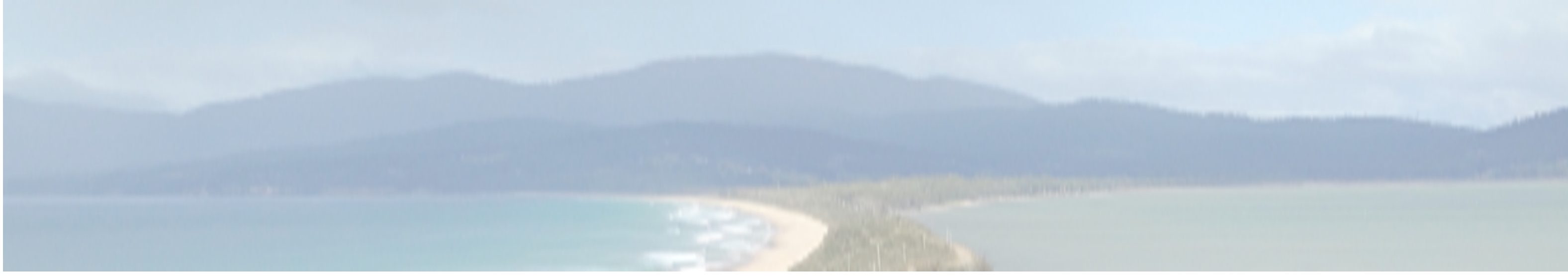


Technology choice

Battery technology

All customers opted to install a 5kW/10kWh LG battery, but there was a mix of the high voltage and low voltage variant. Both these batteries peak discharge power is 5kW so attracted a $16,000 maximum subsidy. There was also a mix of inverter type, with SolaX, Sungrow, and SolarEdge inverters in use. Some of these inverters limited the battery discharge power capability below what the battery itself could sustain. The battery/inverter combinations installed are in the table below:

System configuration	Peak battery discharge power	Number of systems
Battery: RESU10LV, Inverter: SolaX SK-SU5000	2.5kW	14
Battery: RESU10HV, Inverter: SolarEdge SE5000-RWS	5kW	7
Battery: RESU10HV, Inverter: SolarEdge	5kW	1



SE6000-RWS		
Battery: RESU10LV, Inverter: Solax TL5000 with BMU5000	5kW	8
Battery: RESU10LV, Inverter: Sungrow SH5K Hybrid+ESS	3.2kW	4
Total	**127.8kW**	**34**

The available battery energy capacity depends on the minimum state of charge setting. These settings exist in both the Reposit controller and the battery inverter. There was significant diversity in settings in the inverter which depended on:

- installer preference; and
- inverter default setting.

Some installers preferred a conservative and relatively high (as high as 60%) minimum state of charge setting. This may be related to experience with lead-acid batteries which can be damaged if discharged deeply.

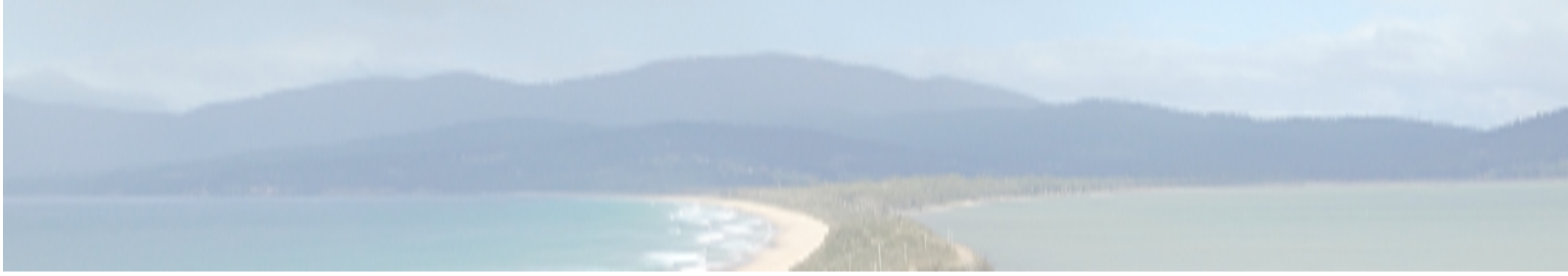
The battery performance of early network support events was impacted by a mismatch between the inverter and Reposit setting. a lower setting in the reposit controller than the inverter would tend to overestimate the energy available and cause underperformance toward the end of dispatch events. This issue was rectified before NAC was implemented.

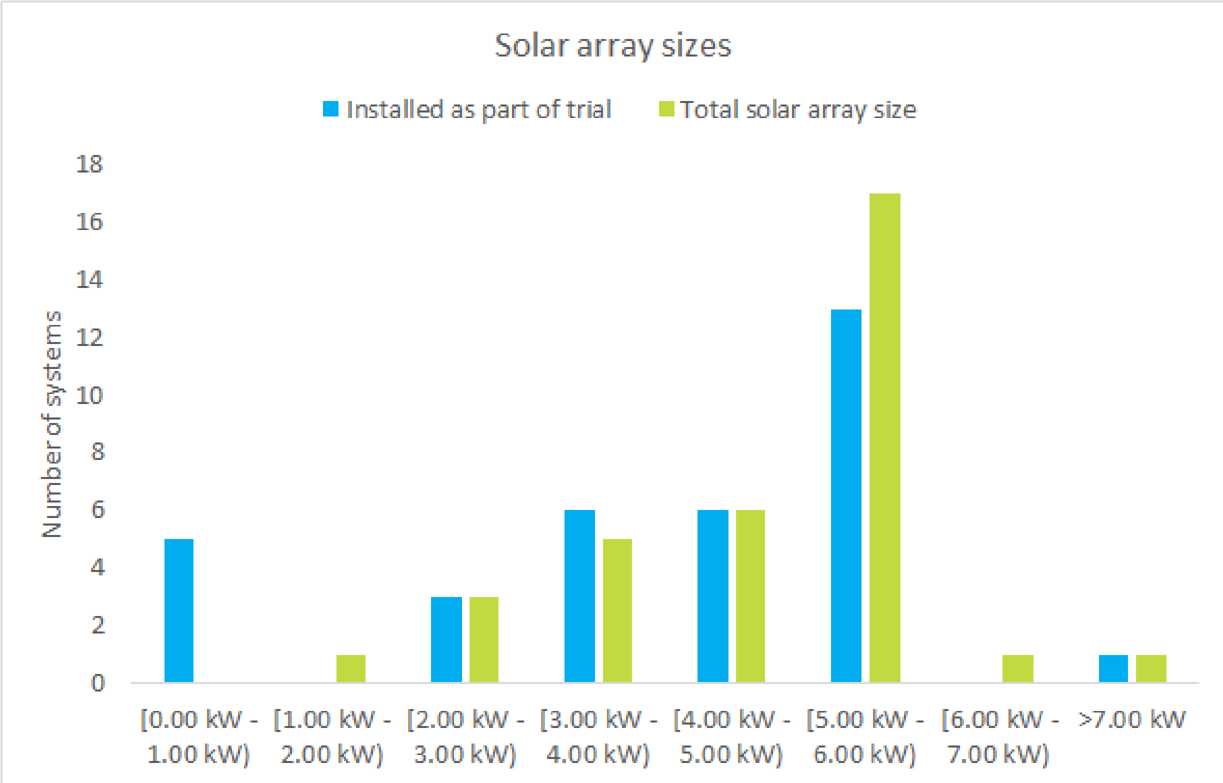
Solar Technology

Most customers chose to install a solar array or expand an existing one, although there were some who used their existing solar arrays alone. The total installed solar capacity is:

- **133 kW** installed as part of the trial;
- **25 kW** existing on participant households before trial;
- **158 kW** total solar capacity; and
- **4.6 kW** average final array size.

The distribution of installed capacity is shown below:



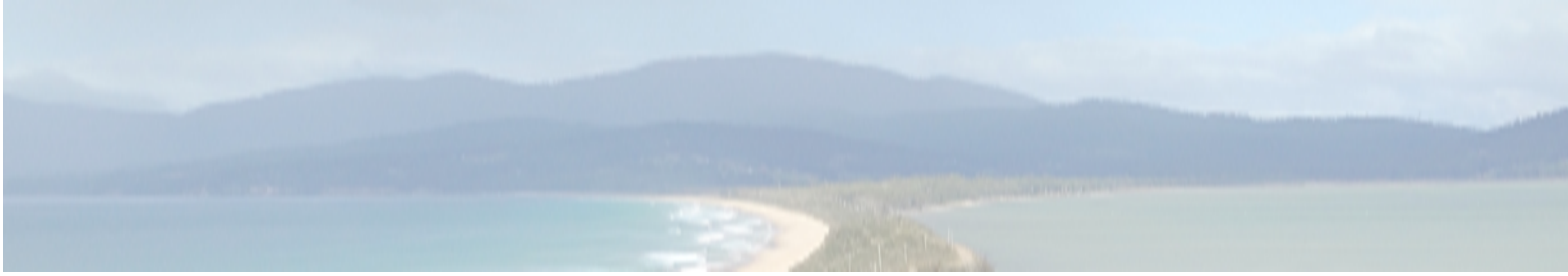


Backup power

All customers except for one elected to have backup capability on their system. The amount of load the backup system can supply depends on the inverter type:

Inverter	Backup capacity
SolaX SK-SU5000	2.0 kW
SolarEdge SE5000-RWS	5.0 kW
Solax TL5000 with BMU5000	4.0 kW
Sungrow SH5K Hybrid+ESS	3.2 kW
SolarEdge SE6000-RWS	5.0 kW

The capability of the system to provide backup depends also on the energy stored in the battery when the fault occurs. For many customers this was a point of contention as the Reposit controls do not keep energy in the battery in case of faults for backup purposes. Similarly, some customers were disappointed that their chosen systems could not backup some appliances. For example the 2.0kW SolaX can not power a water pump.



Installation process learnings

The install process met its intended outcomes. All systems were successfully installed at the end. There were however several challenges the project had to navigate as well as learnings generated on the way. The key issues and learnings are described by step in the installation process in the table below:

Step	Issues and learnings
1	Initially customers needed significant support from TasNetworks to become comfortable with the project and the participation requirements. Although this was an expected outcome of the trial, the support required was more than expected.
2	The array of choices provided by the installers were often daunting to customers. This was compounded the newness of the technology to the customer. Many customers would turn to a trusted advisor to help them determine the best course of action. This was often TasNetworks.
3	The installation part of the process required significant technical input from TasNetworks. Most quotes provided to TasNetworks for assessment were missing significant detail compared to what was in the specification. The specification was the same as the Clean Energy Council (CEC) solar retailers code of conduct with the addition of an itemised quote and a single-line diagram. The intent was that the quotes that were sent to TasNetworks for assessment were the same as the ones provided to customers during step 2. During the process it became apparent that this was not the case. The initial quotes provided to customers were generally significantly less detailed with installers only adding the extra detail for submission to TasNetworks. In most cases the customer appointed the installer to manage the subsidy application process on their behalf.
4	All of the customers elected to install the largest available battery (5kW/10kWh). This was an expected result of the subsidy design. For many customers the battery is much larger than they normally require. The additional battery capacity did provide useful network support capacity. It appears systems were designed to maximise the subsidy rather than the best systems for customer loads. This point is hard to validate however without a baseline provided by advanced meters. While the trial preferred permanent residents. Several participants were not always on the island or were very frugal with energy consumption and thus have very low daily consumption, leading to a lower return from their systems.

5	The installation process took far longer than planned. This was due to a number of reasons: ● Initially there were issues with the battery supply which delayed install; ● The installation itself was often completed over several visits, sometimes over months; ● The technology was new to the installers and on initial install required additional setup time; and ● Installers were generally small businesses and did not have the cash flow available to do large numbers of installs simultaneously. The need for TasNetworks to safety inspect every system and the issues that needed to be rectified increased this time further.
6	Most of the installed systems had faults that needed to be rectified. The most common ones were: ● Missing or misplaced labels; ● Switches without adequate protection from unintended operation; ● Wiring issues or loose terminals; The number of issues did not decline significantly with installer experience. Generally the installers handed the system over to the customer in a way that left householders lacking knowledge of their systems. Many customers did not understand how their systems worked. Installers generally did not allow significant amounts of handover time in their quotes. Much like the environment outside the trial where installers are competing on price therefore had an incentive to quote competitively. TasNetworks managed part or all of the install process for three customers. This occured after the installers these customers had selected were unable to complete the install.

The interviews conducted by the social science team revealed significant learnings about the customer's journey through the installation process (see subsection 1 in the Findings of the social report [2]). For a customer to participate in the grid they need to install appropriate hardware and have an ongoing relationship with a service provider, who can share the value of their services with them (for the trial this was Reposit Power). Installations experiences and their effects are important moments in householder relationships with DER and subsequent grid participation.

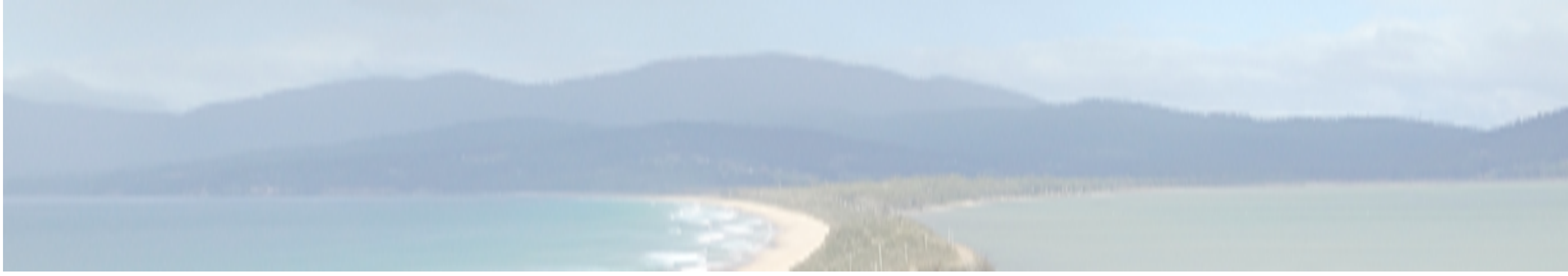
Householders reported that choosing installers, deciding on equipment and the installation was complex and that it was difficult to develop understanding fast enough to engage in the choice of technology for their home. Many householders at this stage relied on the installer advice to choose the technology for their systems. Installers however often had a limited understanding of what grid participation would entail, as they had no previous experience with this specific use of batteries and controllers. This made it difficult for installers to articulate the benefits to the customer. Similarly, installers often lacked the time to adequately introduce the technology to the householders, leaving them unsure of how to operate their systems, or how the grid participation component functioned. During the trial this service was provided by TasNetworks and UTAS, however outside the of the trial this (information provision support) is generally missing.

Once the technology is installed the customer must maintain an ongoing relationship with a service provider (“aggregator”) to remain an active grid participant. This service provider (Reposit Power) must:

- Manage the customer relationship;
- Procure the network benefit on behalf of their customers; and
- Distribute payments for services to customers;

Most aggregators will also provide other forms of value to customers (such as system monitoring and managing their retail tariffs). For customers though, this relationship can add complexity. For grid participation to be successful this complexity must be reduced as much as possible, and where it exists it must be explained in terms that are accessible to a customer.

A key learning from this trial is that information on grid participation must be provided to customers in a clear, concise form and come from a party they trust. This information will help customers navigate the complexity of installing and managing their grid-interacting batteries. See the social science final report [2] for further discussion of installation experiences of households.



NAC and reward structures

The key technical research outcomes of this trial were NAC and reward structures. These both form part of the solution that is required to orchestrate batteries:

NAC, or Network Aware Coordination (NAC), is a means to coordinate distributed energy resources (DER) in a way that respects network constraints and minimises the total cost to both the network provider and the DER owners (participating households).
The reward structures research component created value-reflective rewards to be presented to customers for network support services.
This chapter discusses two key facets:

1. The process and issues encountered implementing NAC and reward structures; and
2. The value delivered in terms of diesel and peak load reduction.

NAC and reward structures modelling and data requirements

NAC and reward structures can in principle operate with network models of various levels of details. The higher model fidelity, the higher the quality of the outcomes will be. For this trial, keeping in mind that the installed battery capacity was only 10% of the peak demand, we opted for a detailed model of the network configuration and its current state. This is achieved by NAC replicating the network as an unbalanced electrical model. The NAC model we used requires:

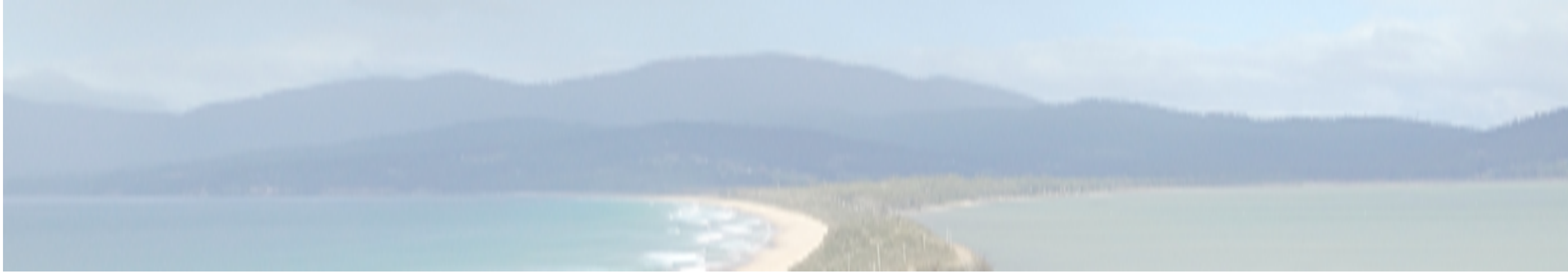
- The network configuration such as which phase a customer is connected to, conductor type, and configuration of transformers; and
- The current state of the network, such as voltage, current, and load.

DNSPs generally have lower quality data on their networks and collecting it has a significant cost. For the trial significant data was collected such as:

- Which phase the customer was connected to;
- The phasing of the MV network; and
- The phase and tap settings of the distribution transformers that connected participating customers.

This data was collected manually involving physical inspection and measurements on the Bruny Island feeder. Collecting this data, while manageable for the small number of trial participants, would come at a significant cost if required across the entire connected customer base. Within Tasmania alone there are over 250,000 connections to the distribution network. It will be important as this technology scales to:

- Measure the configuration of the network opportunistically as other work is undertaken; and
- Investigate innovative ways of determining the network configuration using data from other sources (such as the Reposit data or advanced metering data).



Correct operation of NAC and reward structures also requires good measurement data on the current system state (such as voltage, current, and load). During the trial it became apparent that many of the existing measurement devices (such as reclosers and sectionalizers) return low quality data. This is because these devices are primarily designed for protection and thus metering functions are not accurate. Similarly communication dropouts were common. As these devices assume a larger system management role it will become more important that the data they return is high quality and reliable.

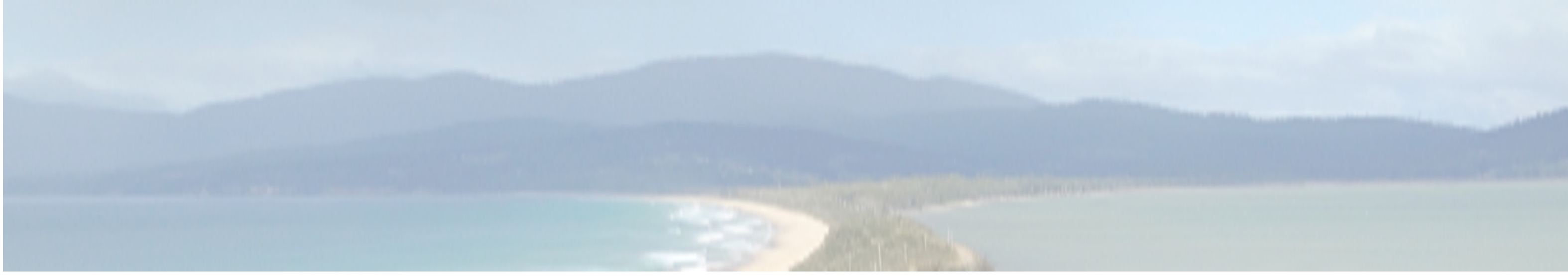
NAC also requires accurate short-term (<24 hours ahead) predictions of load to function correctly. For a battery to be able to discharge during a peak it must ensure there is sufficient change prior to the peak. Accurately forecasting load on Bruny Island proved challenging. This is partly because the load is small and partly because the load in a particular public holiday is difficult to predict. When NAC was first implemented it used a simple regression-based load forecast model. This generally performed poorly and on 16/7/2018 a neural network based forecast replaced it. This new forecast appeared to perform significantly better although there have only been two peaks subsequent to the forecast being implemented. Future implementations of NAC and similar should ensure an adequate load forecast is within scope.

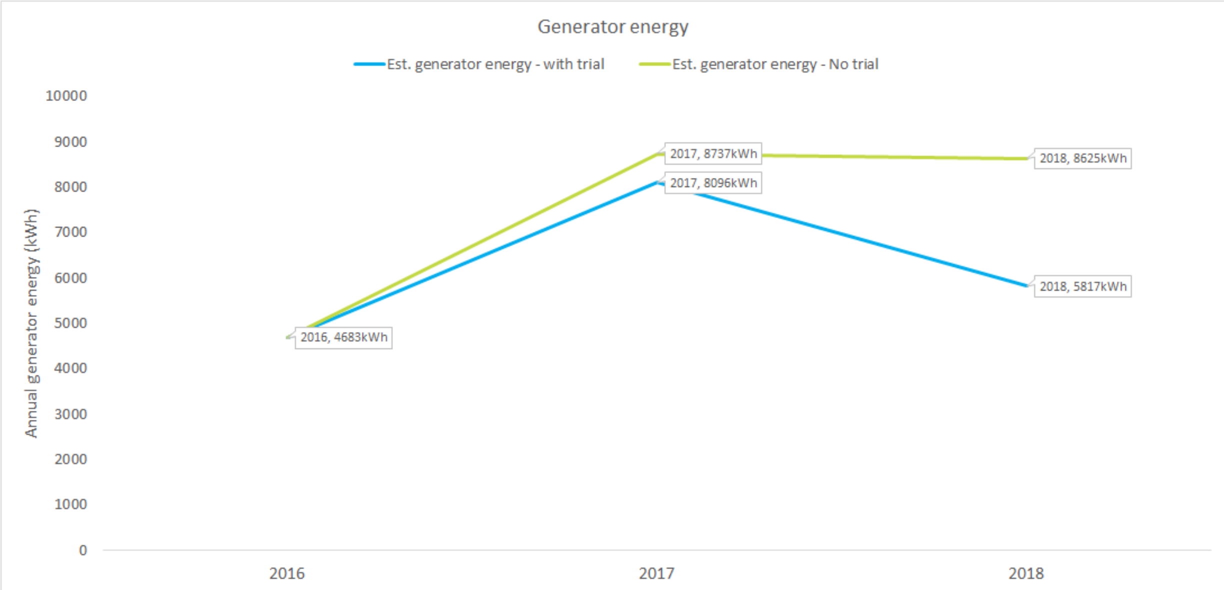
During the trial there were occasions where single points of failure (such as Reposit's platform or NAC) experienced outages. While none of these occurred at peak times if they had it may have caused all demand response services to fail. This makes these platforms significantly more important than the individual customers.These platforms need to be designed with sufficient redundancy to reduce this risk.

Impact on diesel consumption

The purpose of NAC and the battery orchestration was to demonstrate grid services from customer-sited batteries. These services were used to reduce the amount of diesel consumed managing an existing cable load issue. It's worth noting that the scenario on Bruny Island is somewhat unique across TasNetworks distribution network and indeed across Australia. There are very few instances where standby diesel generation is used for peak shaving on an ongoing basis.

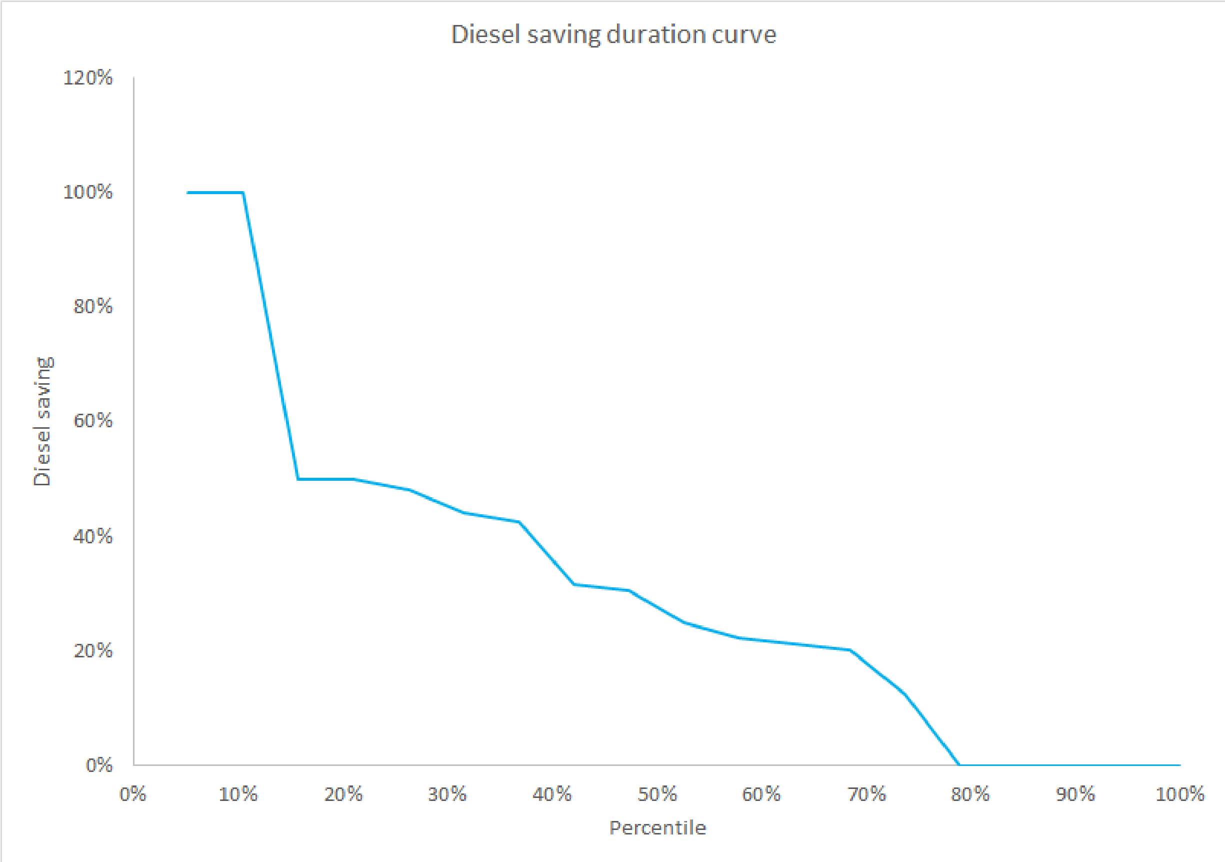
The chart below shows the impact the trial has had on diesel generation on Bruny Island:





This chart is based on modelled generator behaviour as currently the generator is manually operated.

This chart shows the trial delivered a 33% reduction in diesel usage. There were 24 events where diesel would have been required without the trial over 2018. These occurred in Easter, the April school holidays, Anzac day, Queens birthday long weekend, and the July school holidays. A duration curve of the diesel saving for each event is shown below:



There were three events where all diesel would have been avoided in the modelled case. In two of these events the manually started diesel was run, in the other it wasn't. There were two peaks where there were no diesel savings. Most of the other peaks saved between 50% and 20% of diesel generation.

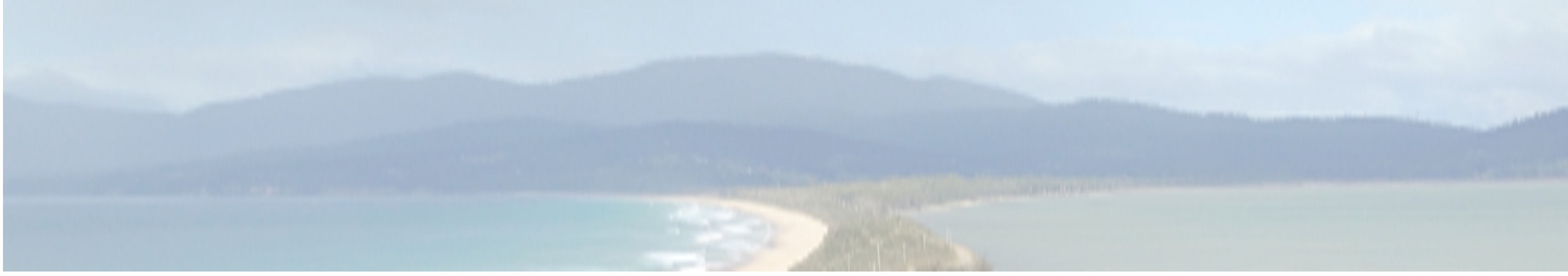
The diesel savings can be attributed the different technologies employed::

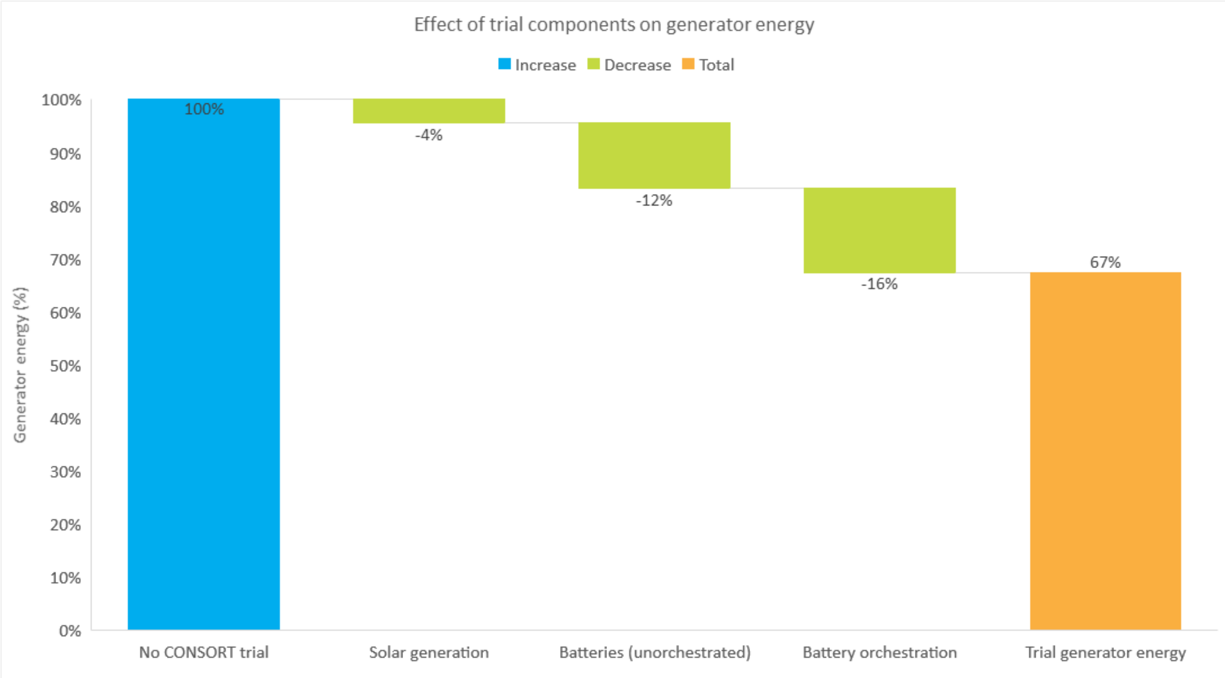
- The solar generation;
- The battery; and
- The orchestration (NAC).

The contribution of each component in reducing the diesel consumption can be derived by analysing modelled diesel use in:

- The case where there was no batteries or solar;
- The case where there is only solar generation;
- The case where the battery operation during periods when NAC was running is replaced with battery output of times when NAC was not running; and
- The actual island load.

Performing this analysis yields the contributions shown in the chart below:



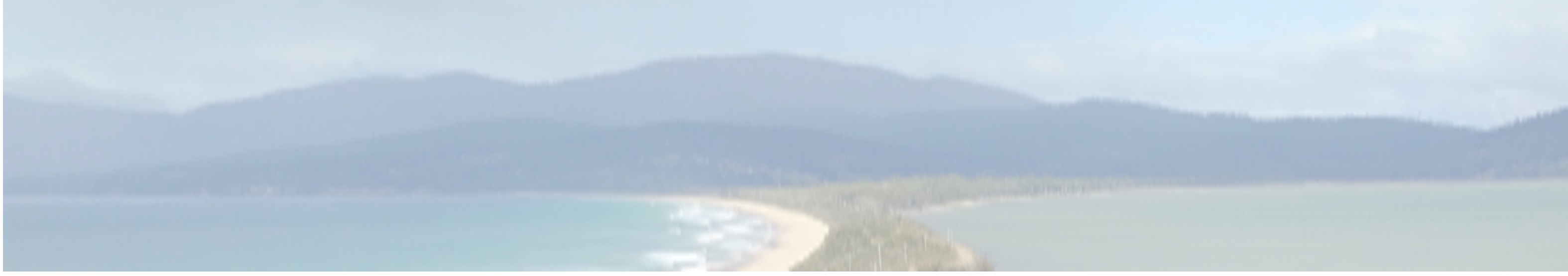


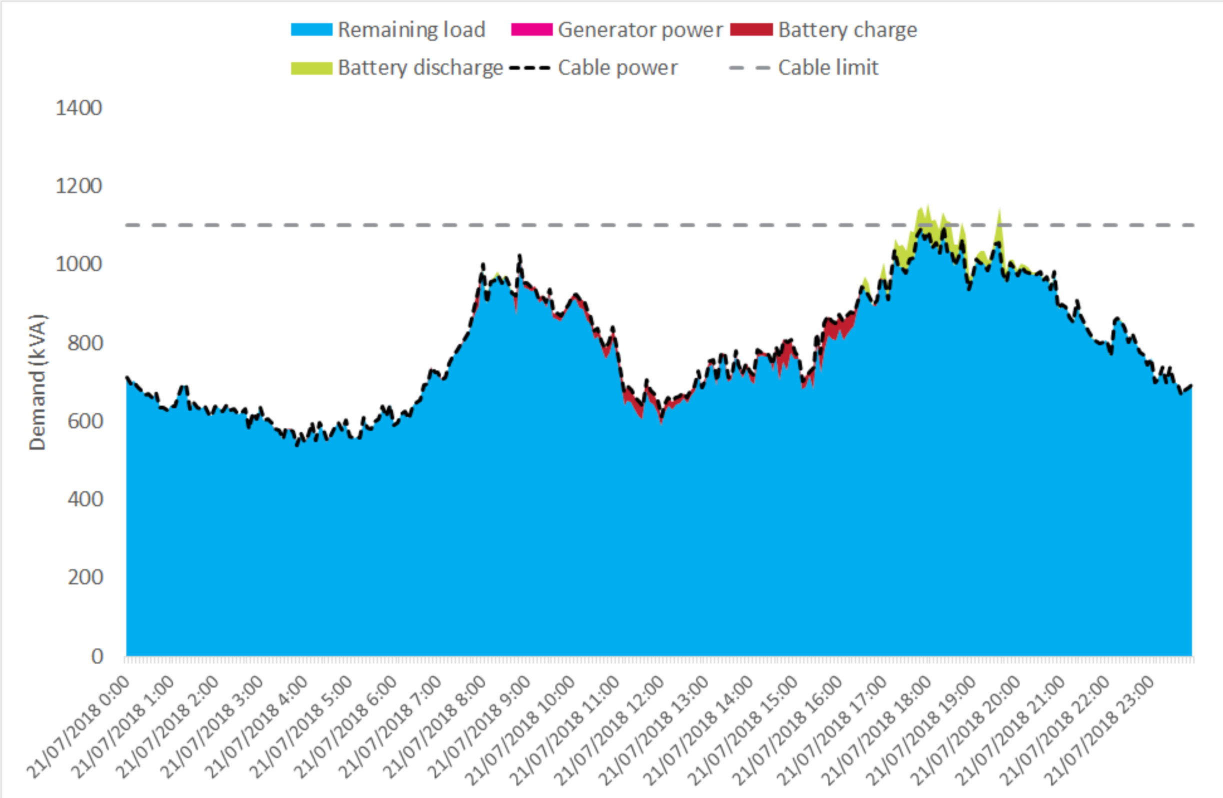
This chart shows:

- Solar provides only a relatively small diesel reduction (4%);
- Batteries alone, optimising for customer behaviour deliver a small but significant diesel saving (12%);
- Orchestration through NAC approximately doubles the value of the battery/solar systems in reducing diesel consumption.

This indicates that orchestration provides a valuable increment to the benefit derived from customer-sited solar and battery systems.

There was one event where all diesel generation was avoided with the battery support. The island load for that day is shown below:

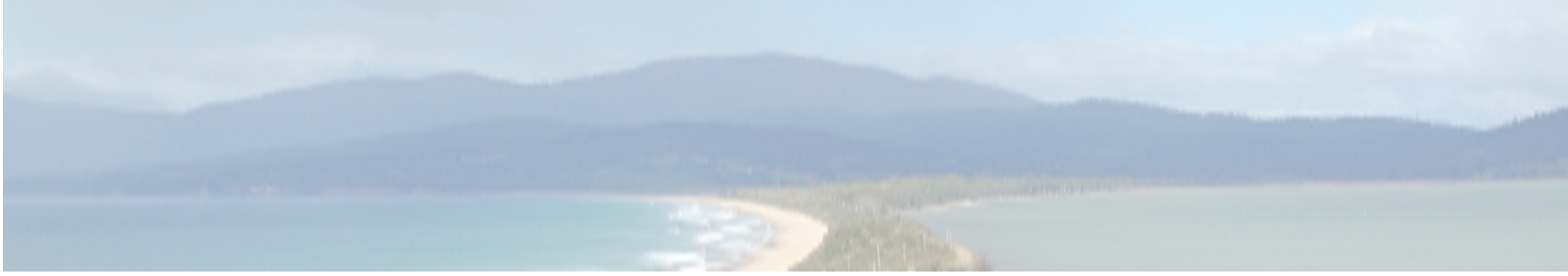


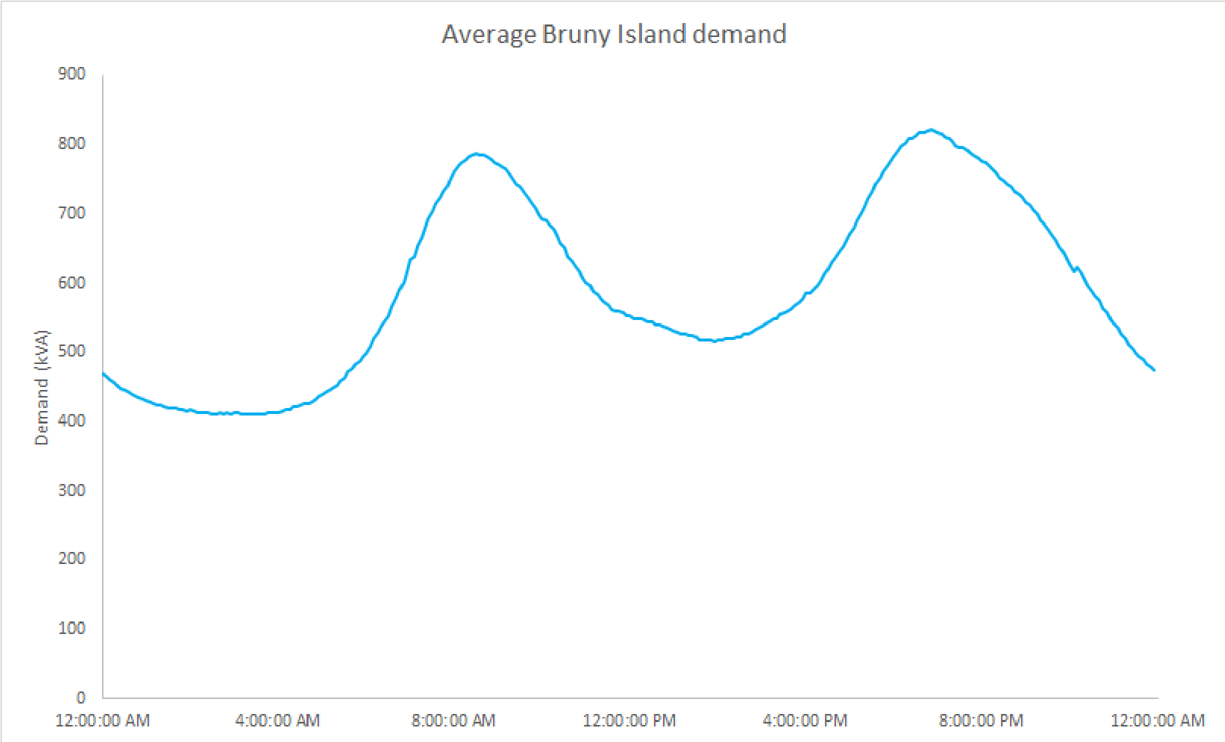


On this day NAC dispatched just enough support to avoid use of the diesel.

Impact on peak load

While on Bruny Island the key network issue is diesel consumption this is not the case everywhere. Generally peak load is a good indicator of system strain.
Bruny Island, like most cold-weather peaks, has two peaks per day - one in the morning, one in the afternoon. This is shown in the average peak load chart shown below:

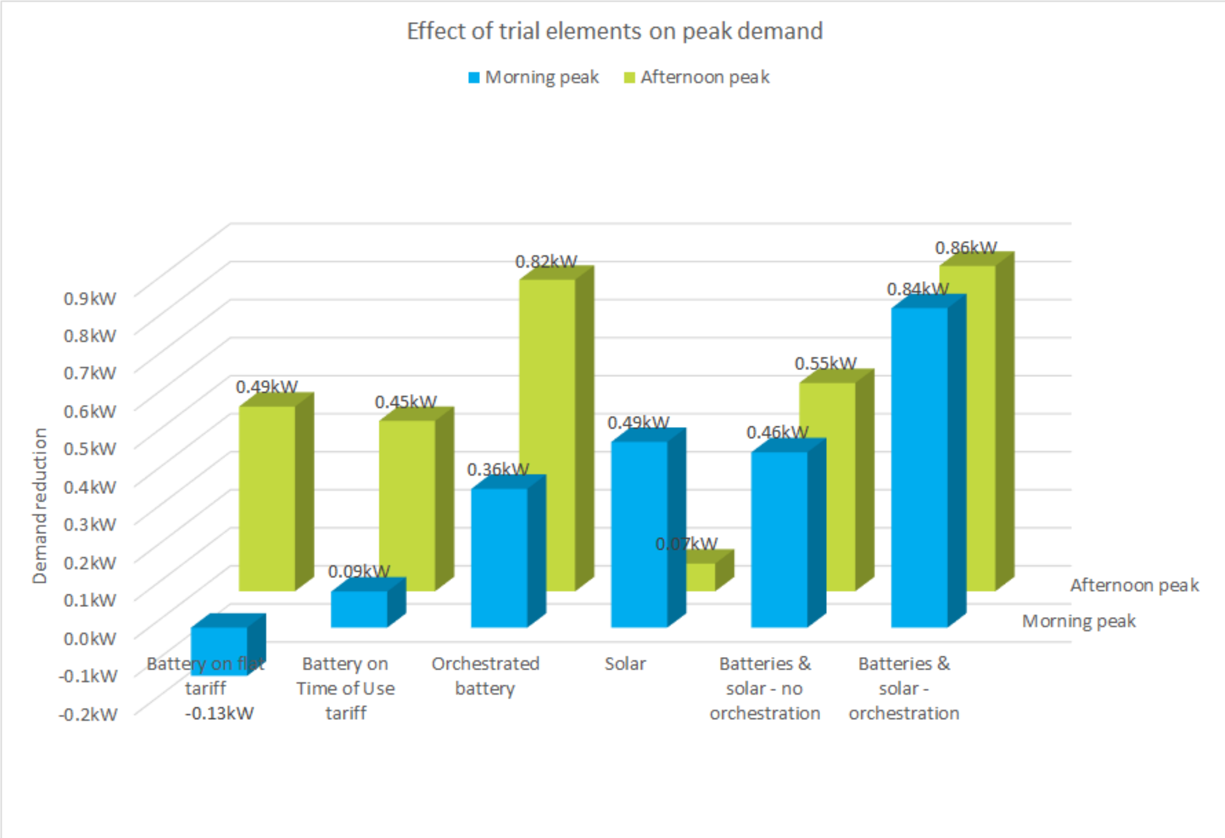




Either of these peaks can cause the diesel generator to start. Similarly to diesel use the impact of the trial components can be split into categories. As there is more available data the impact of more elements can be analysed:

- Solar;
- Batteries on a flat energy tariff;
- Batteries on a time of use tariff; and
- Orchestrated batteries.

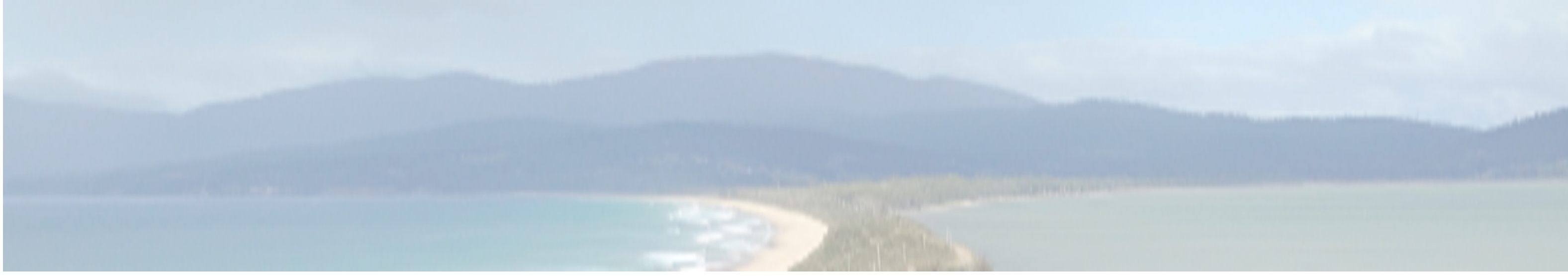
This is shown below.

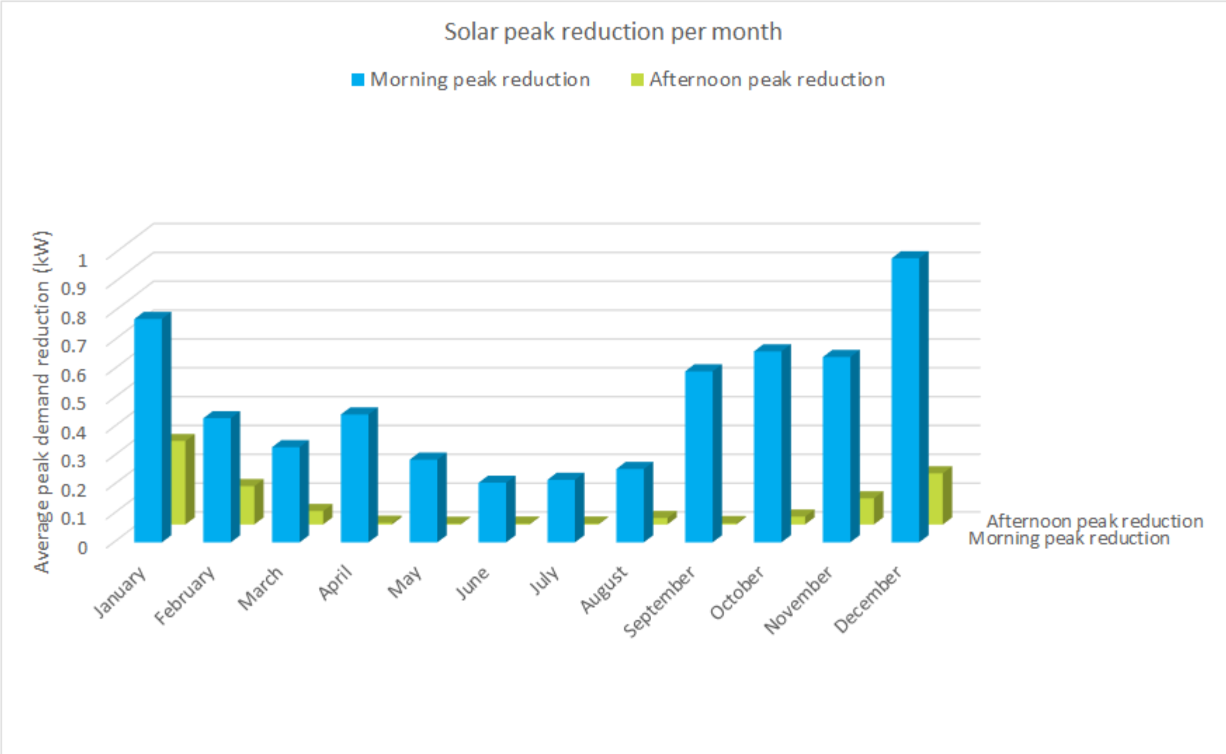


From this chart:

- Solar generation provides some benefit in the morning but little in the afternoon;
- For morning peaks, Orchestrated batteries alone (without Solar) are not as effective as orchestrated batteries with solar
- The benefit of a battery is dependant on what tariff the customer is on - time of use tariffs significantly increase the value of the battery. Batteries on flat energy tariffs increase peak demand in the morning due to them either being flat or storing excess solar; and
- Orchestration again provides significant value.

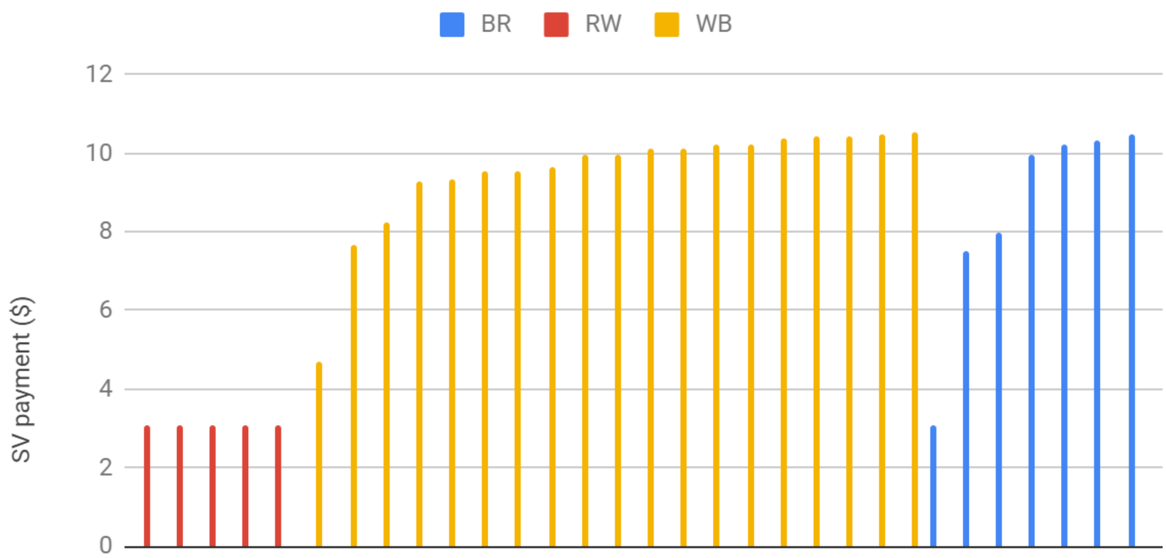
The solar contribution is strongly dependant on time of year, as shown below. Peaks are generally poorly coincident with solar contribution as they are more likely to occur in winter, nevertheless the solar generation provides some benefit to morning peaks (around 38% of all peaks).

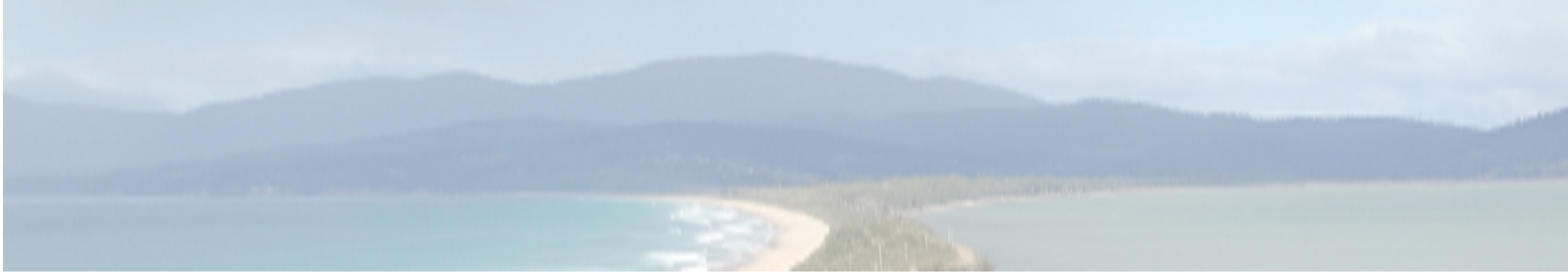




Reward structures

The reward structures defined a value-reflective means of pricing network support services. Customers were paid an amount related to where they were in the networks and the specifics of their system relevant to it's value to the network. Due to the unbalance in the network the strongest determinant of the customers payment was which phase they were connected to, with a weaker dependance on location. This is shown below:





The customers on red (RW) phase were paid significantly less as the phase was less heavily loaded.

There were two different methods of presenting the payment trialled:

- The **energy reserve** payment type estimated the support required for the battery before the event and paid customers based on that estimated value; and
- the **energy usage** payment paid customers after the event based on the actual usage of their battery.

From the participants' point of view, receiving notifications of the size of network support payments before or after the events - that is, as energy reserve or energy use payments, respectively - appeared to have very little salience or effect on behaviour. This finding is discussed in more detail in the Social Science final report [2].

Similarly, as discussed above, the pricing was mostly dependent on the customer's electrical phase connection. This concept was difficult for the customer to understand. Indeed this was not explained to most customers.

Implementing the reward structures algorithm proved problematic because the algorithm was very computationally intensive and attempts to simplify it were difficult. Only one trial was attempted using the full Shapley value calculation.

Overall however the trial did prove that value-reflective pricing was possible and could automatically generate relevant price signals for a range of network limitations.

Customer benefit

Customers must see benefit to be interested in participating in grid management schemes. There are several components to the hardware inside a customer's home that are required for grid-response:

- A battery and inverter; and
- A control interface.

Usually the customer will also have a solar system, but this is not required for grid participation.

Customers were free to choose their retail tariffs on the trial. the two tariffs customers chose were:

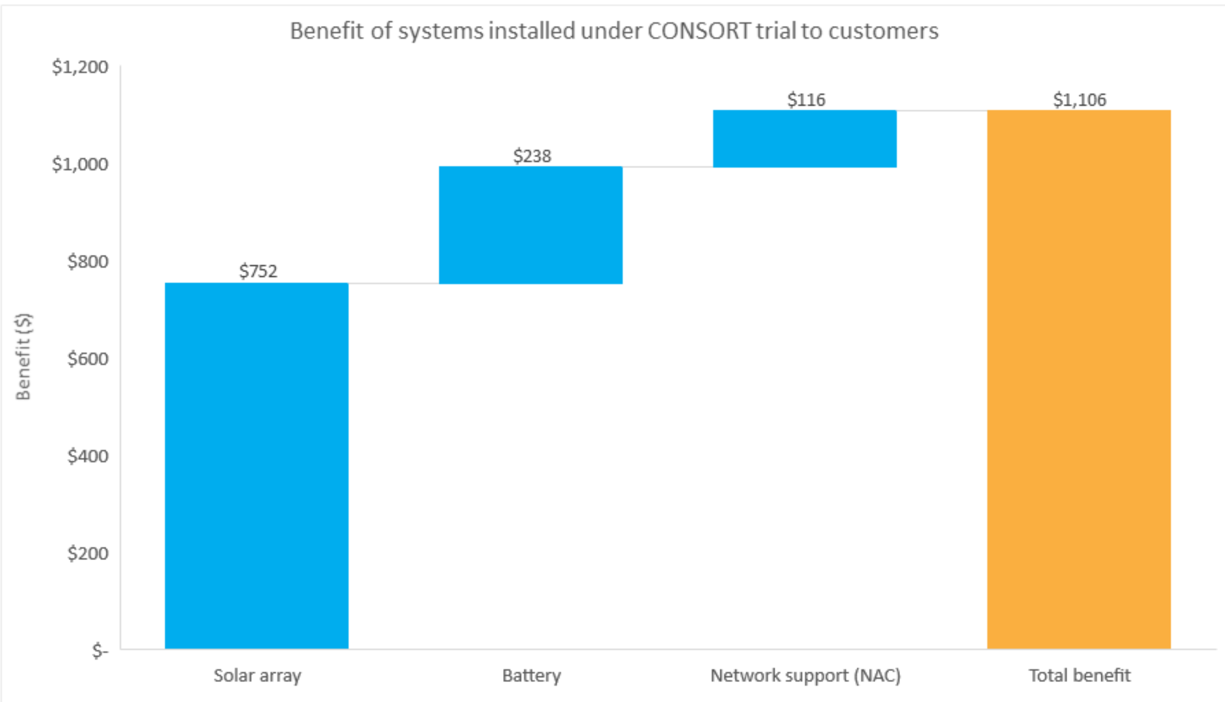
- Time of use energy (Tariff 93); and
- Flat energy (Tariff 31/41).

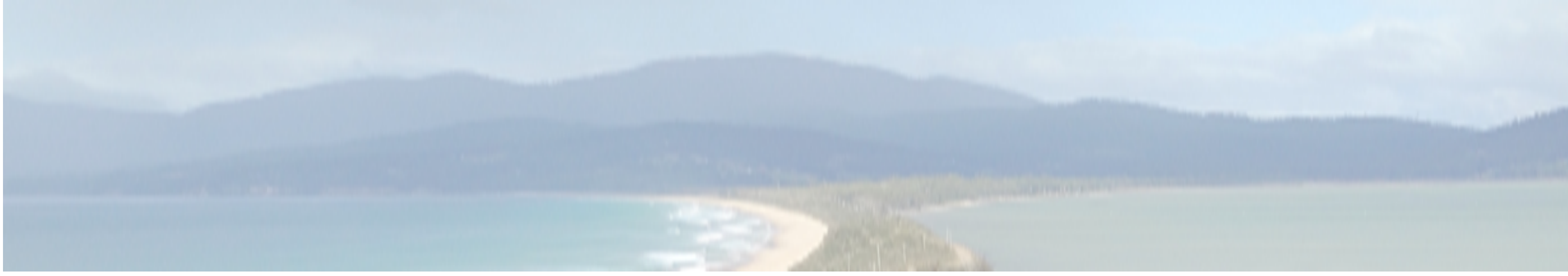
Information on these tariffs can be found here.

The system provides customers benefit in several ways:

- It can manage their energy tariff if they are on the time of use tariff Tariff 93 (charge off-peak and discharge at peak);
- It can store excess solar generation for later usage;
- it can provide backup services; and
- it can provide grid services.

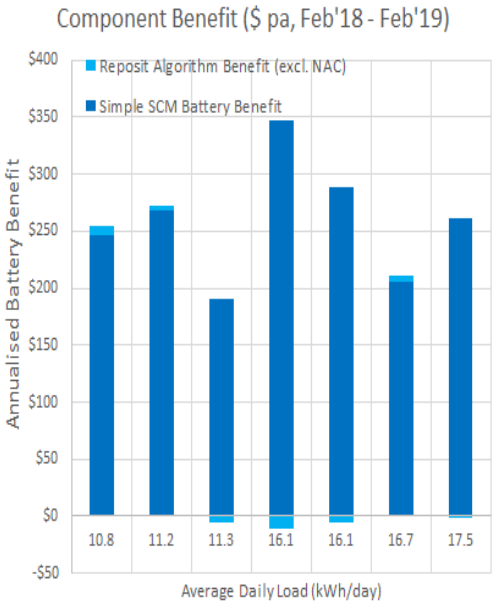
All of these services except for backup can be valued as a bill saving or revenue increase for the customer. During the trial, the average customer benefit of the installed systems to customers is shown below:

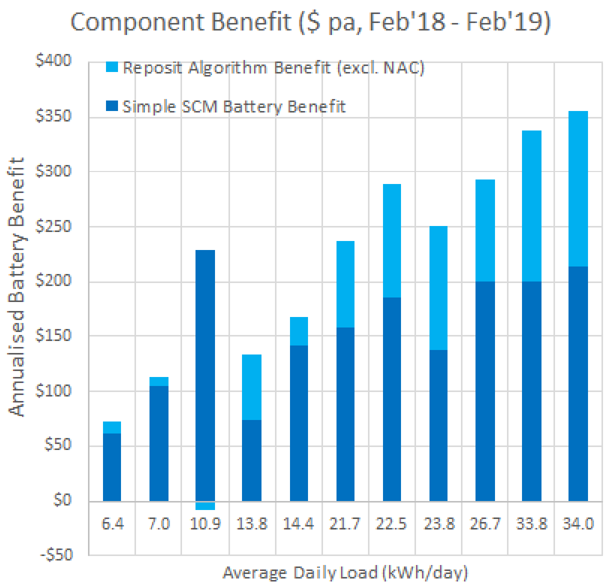




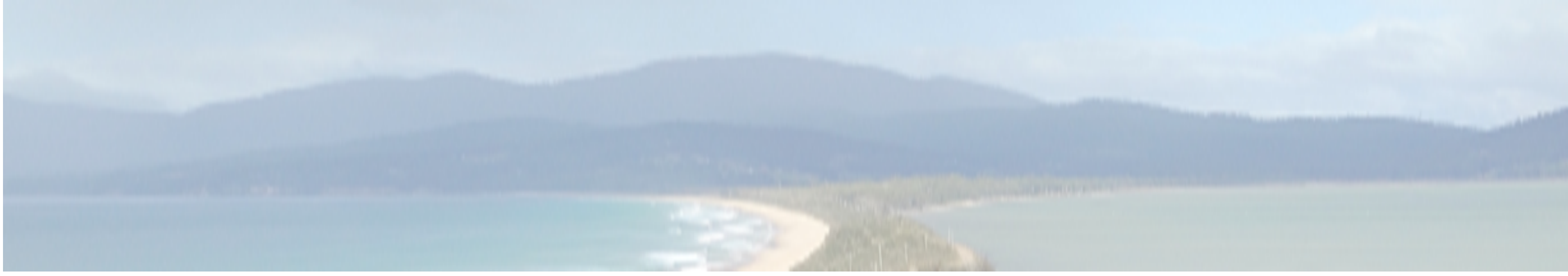
The bulk of the benefit comes from the solar array. The total benefit of the battery and optimiser is around half that of the solar array.

The benefit (particularly of the battery) was strongly related to the tariff the customer was on. The battery could deliver significantly more value (particularly with the Reposit optimiser installed) when the customer was on a time-of-use tariff. The charts below show the benefit of the Repoisit algorithm (light blue) and a simple solar arbitrage algorithm for customers on the flat (left) and time of use (right) tariff. The customers on a flat tariff do not receive an incremental benefit from a more advanced controller.





As described in the network findings and results section above, a time of use tariff delivers more network benefits as the battery is more likely to be discharging at peak times. Therefore a time of use tariff delivers benefits to both the customer and the network.



Perspective of a Distribution Network Service Provider

TasNetworks as the DNSP partner and a key beneficiary of services created in the project has a unique perspective on the trial outcomes. Overall the trial delivered the value that was intended at the start of the trial - it reduced diesel consumption by around 33%. The trial was implemented as a series of three research packages:

- Orchestration of DER delivered through NAC;
- Value-reflective pricing for grid services through reward structures; and
- Social science to capture insight on the customer journey.

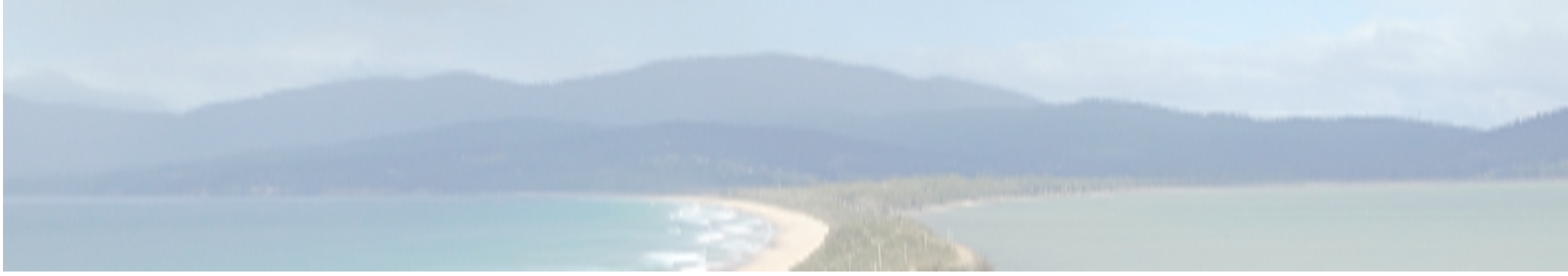
The project overall has shown the value of a diverse research team. The diversity of the team has allowed research of concepts at a much deeper level than would have been the case without the broad capabilities within the team.

Orchestration of DER

This trial has shown that orchestration can provide a significant increase to the value a battery provides the network. The key to high adoption of this service however will be ensuring it is low cost, efficient, and has low overheads to operate. It is also important it ties into other work in the industry such as the Open Energy Networks consultation. Future applications of this technology should be built on the critical principles:

- **Open access**: it must work with a variety of platforms and types of demand response;
- **Minimal incremental cost**: It must have as low cost as possible to operate and add additional network segments to manage;
- **Integrate with other systems**: It must integrate with existing distribution management and market systems;
- **Minimal data collection effort**: Particular in parts of the network with few constraints it must be able to work without significant data collection effort.

The NAC trial on Bruny Island has shown that technical and economic optimisation converges to a lowest cost solution within the technical operating envelope of the network. Indeed, the NAC trial results show NAC doubles the effectiveness of battery storage when compared to manually dispatching an aggregated VPP. As such TasNetworks is keen to see the development of NAC continue into a platform that can be used to coordinate DER across other constrained parts of the network. Further to this point, the use of NAC as a constraint engine also shows great potential as a mechanism to ensure the network always remains within its operating limits. At the time of writing TasNetworks is working with ANU to develop a plan to see the use of NAC continue on Bruny Island.



Reward Structures

The reward structures research package was indeed a challenging work package. The approach, born from the cost reflective pricing rhetoric sought to develop the optimum value reflective reward for network support services. While this was a worthy objective, two key issues arose:

1. The computational effort required to compute the true Shapely based result is too high
2. Customers (as a whole) clearly do not understand the complexity of network support payments, let alone the “value reflectivity” measure of those.

These two points are reflective of the implementation. That is, near real-time calculation and customer facing value-reflective pricing will be required for large-scale adoption of DER orchestration, much the same as cost-reflective network usage pricing can deliver significant value in reducing network expenditure.

It’s value however is likely better suited between the buyer (DNSP) and seller (Aggregator/Retailer), rather than direct to customers. From a network point of view network services are unlikely to be paid directly to a customer, much like network pricing operates currently. Instead an aggregator will provide this value to customers. In doing so they may change the way it is paid significantly. For example they may offer it as part of an energy retail contract. Based on experience with pricing and interacting with aggregators future applications should consider changing how value reflective pricing is applied:

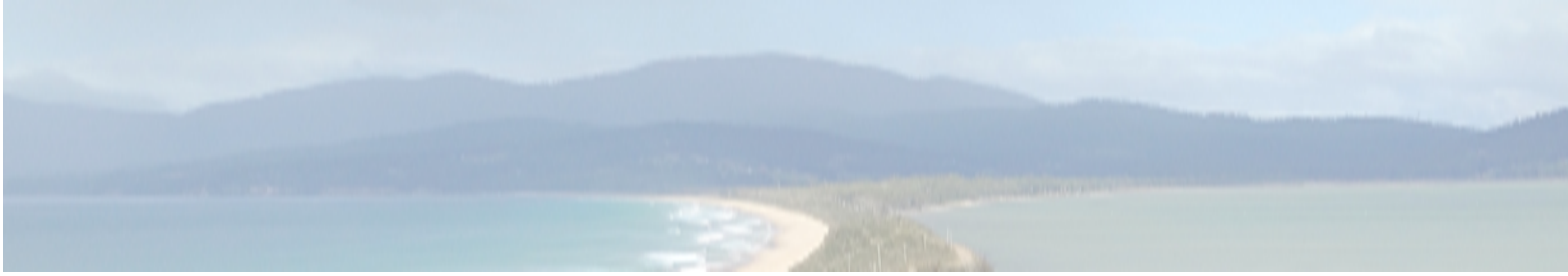
- Offline calculation for example at yearly intervals can give customers/aggregators certainty on pricing and allow networks to offer longer-term contracts;
- Removal of phase dependance would simplify pricing and communication of customers, particularly as customer’s phase is generally unknown; and
- A standard algorithm offers transparency.

Social science

The social science work package delivered significant insight into the customer journey. It showed how customers react to the new technology installed in their home as well as what interaction form the network they desire.

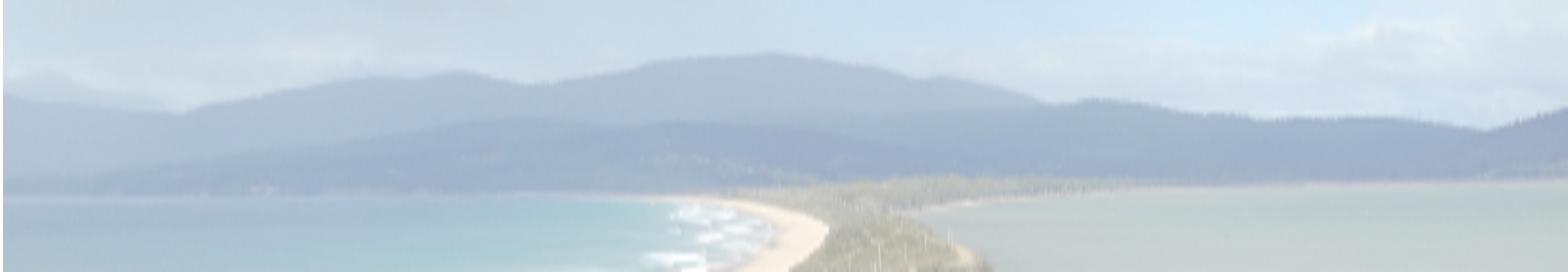
From a network point of view the key learnings delivered from this research package were:

- Customers are diverse and engagement strategies need to allow for this and recognise their different drivers;
- Involving customers in the grid requires the customer experience to be integrated deep within even technical tools such as NAC;



- Customers found advice from a trusted party (such as TasNetworks) valuable throughout the trial; and
- Installers are poorly equipped to educate customers on grid participation and often lack the resources to provide guidance on the grid participation elements of a customer's installation.

More detail can be found in the Social Science Final Report [2].



Areas for further work

While the trial was a success, the story is not over. There were many learnings that can be taken from this project and applied to future activities in this space.
The list of key learning is in Appendix A. This chapter summarises key learnings as well as presenting other learnings that will be relevant to future implementations of NAC or other orchestration algorithms.

Load forecasting

An accurate short-term (24hrs ahead) load forecast is critical to the function of orchestration algorithm. For this trial a specific Bruny Island load forecast was developed using a neural network algorithm.
Future distribution optimisation projects should consider load forecasting as a critical input and ensure adequate effort is assigned for development.

Distribution network state and operational data

Orchestration algorithms require significant data to work optimally:

- Static/physical data such as conductor types and phase connection;
- State data such as the position of switches;
- Planned network outages; and
- Operational data such as power flows or voltage.

Often this data currently is poor quality or requires effort to collect. As orchestration forms a larger part of the grid it will be increasingly important that this data is available, high quality, and reliable.

Customer interface

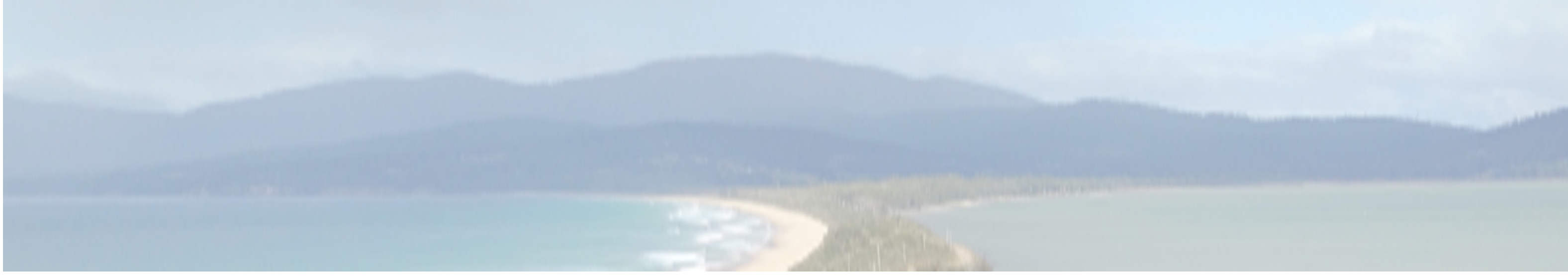
The technology developed and being implemented is new and complex from a customer standpoint. For this trial the project team provided several functions:

- Information on what grid participation means, and a “call to arms” to galvanise customer interest;
- Trusted advice and influence to ensure the install process was completed successfully; and
- Information on what the grid-wide impact on their services was.

Outside of the trial these services are generally not provided, leading to a lower uptake of grid participation. The industry should consider how these services may be provided outside of trials.

Voltage control

A common issue in networks with a high DER penetration is voltage control. During the CONSORT trial there were only preliminary trials of voltage control (“proof of concept”).



Future implementations of NAC should consider voltage control implementation to manage high DER penetration

Market interface

NAC operates much like a market. Integration with the transmission level market (operated by AEMO) can unlock significant additional value for participating customers while observing the limits in the distribution network. Future work using NAC should consider integrating with AEMO markets.

Other forms of demand response

Batteries are only one source of demand response. There are many possible other sources of services that can be used to manage network constraints, such as:

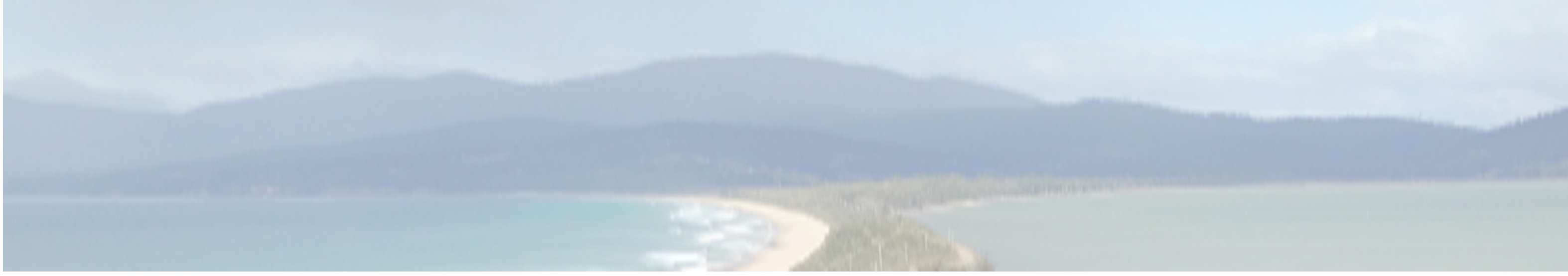
- Behavioural demand response;
- Control of load (such as hot water cylinders, industrial processes, or HVAC systems);
- Electric vehicle charging; and
- Backup generation.

Future implementation of NAC should expand its capability beyond batteries to other resources.

Reward structures

The reward structures research package showed that value-reflective price signals for demand response were credible. The price signals generated however are unlikely to be able to be applied directly to customers in their current form as they are dependant on network properties such as phase which are difficult to explain to customers.
Future applications should consider changing how value reflective pricing is applied:

- Offline calculation for example at yearly intervals can give customers/aggregators certainty on pricing and allow networks to offer longer-term contracts; and
- Removal of phase dependance would simplify pricing and communication of customers, particularly as customer’s phase is generally unknown.



Summary and Conclusions

The CONSORT Bruny Island Battery Trial has demonstrated how customer-owned distributed energy storage can deliver significant value to the network. The 34 participating batteries were orchestrated to reduce the amount of diesel generation that was required to manage an existing constraint in the cable supplying Bruny Island. The batteries and orchestration system combined to deliver a 33% reduction in the amount of diesel generation in 2018.

The project delivered four key deliverables:

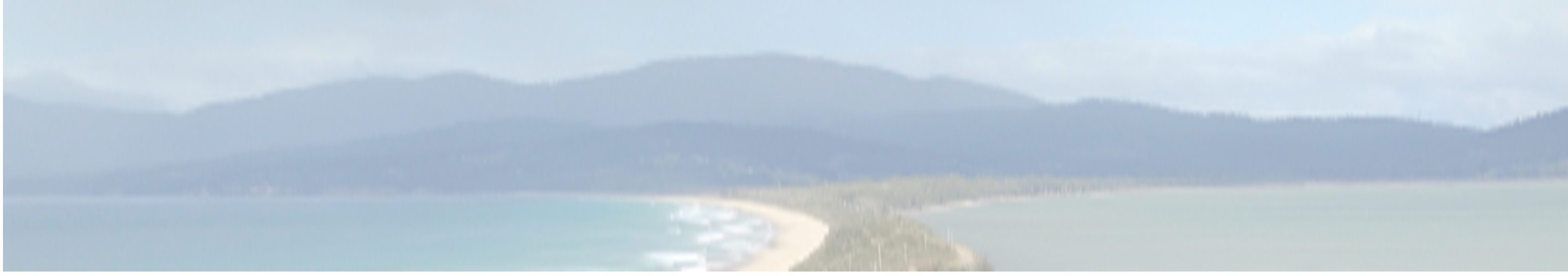
- 34 households with solar/battery systems equipped with Reposit Power battery controllers totalling 127.8kW/333 kWh;
- An advanced battery orchestration algorithm, Network Aware Coordination (NAC), developed by the Australian National University (ANU);
- A means of pricing network services that reflects the value they provide the network developed by The University of Sydney (USyd); and
- A map of the customer experience and insight into how future demand response and orchestration programs by the University of Tasmania.

This report summarizes the deployment of NAC and reward structures. It distils the key learnings that are relevant for a large-scale application of this type of technology elsewhere in Tasmania and Australia.

The key outcome of the trial was that orchestrated customer sited DER successfully managed a network constraint; the batteries and orchestration algorithm were able to deliver a 33% reduction in diesel and completely avoid all diesel generation on one occasion (see Network Aware Coordination final report [1]). The community remained engaged throughout the whole trial and continue to provide valuable insight (see Social Science final report [2]). A new Shapley value based means of pricing network services was demonstrated (see Reward Structures final report [3]). The use of batteries at peak times delivered a 33% diesel saving. Half of which was attributable to the NAC battery orchestration algorithm, the other half being from optimising the customers own consumption.

There were many learnings generated at all stages of this trial the key learnings were:

- Asset and operational data is often poor quality which can affect the ability of orchestration platforms to work effectively;
- For customers to become a key providers of network services they should be engaged early and often. It is important to provide real-time relevant feedback;
- Customers and installers are often ill-informed about the benefits of grid participation which can limit uptake of these technologies. It would be beneficial for a trusted party to step into an “informing” role to assist uptake; and
- Short term load forecasting of small blocks of load is important and difficult to get right, but required for orchestration to work effectively.

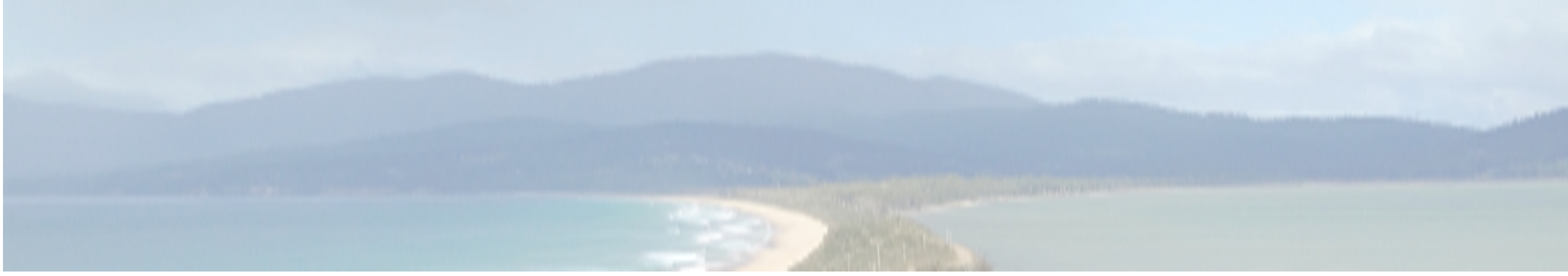


References

[1] Paul Scott, Dan Gordon, and Sylvie Thiébaux. Network-Aware Coordination, Final Report, CONSORT Bruny Island Battery Trial Project. April 2019.

[2] Phillipa Watson, Heather Lovell, Hedda Ransan-Cooper, Veryan Hann, and Andrew Harwood. Social Science, Final Report, CONSORT Bruny Island Battery Trial Project. April 2019.

[3] Archie Chapman, Sleiman Mhanna, and Gregor Verbič. Reward Structures, Final Report, CONSORT Bruny Island Battery Trial Project. April 2019.



Appendix A - Lessons learnt

#1 Lessons Learnt Report: Short term load forecasting

Project Name: *CONSORT*

Knowledge Category:	Technical
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

Dispatching batteries accurately to manage network load requires a good forecast of the load in the immediate future. A poor load forecast will cause either over dispatch (network support when not needed) or under dispatch (missed peaks). This is particularly true for automated algorithms such as NAC.

Implications for future projects

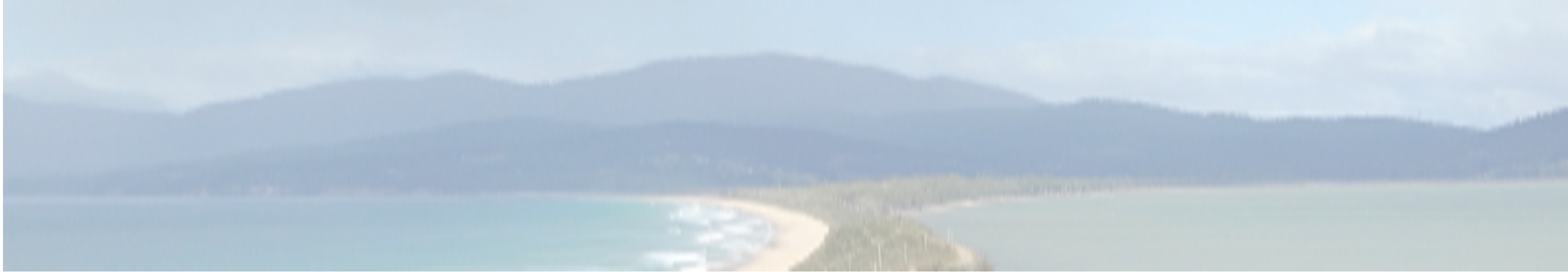
Future distribution optimisation projects should consider load forecasting as a critical input and ensure adequate effort is assigned for development.

Process Undertaken

In the CONSORT project developed three methods of prediction:

1. Initially network support was manually dispatched based on operational experience
2. The first uses of NAC used a simple regression-based load forecasting engine
3. Later uses of NAC used an advanced transformer neural network load forecasting engine

The initial dispatches were relatively unsuccessful in offsetting diesel, Predicting peak days required significant over dispatch or the risk of missed peaks was too high. Similarly the regression based forecast required conservative settings to ensure response on all peaks, which resulted in over dispatch. The final forecasting engine delivered better performance, avoiding diesel generation successfully on one occasion.



#2 Lessons Learnt Report: Network configuration data

Project Name: *CONSORT*

Knowledge Category:	Technical
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

Advanced battery orchestration algorithms such as NAC require significant additional data to be collected on the network ‘s physical configuration such as phase connections. Traditionally this data has not been collected so implementation of NAC/RS required this data to be collected.

Implications for future projects

Future projects should consider:

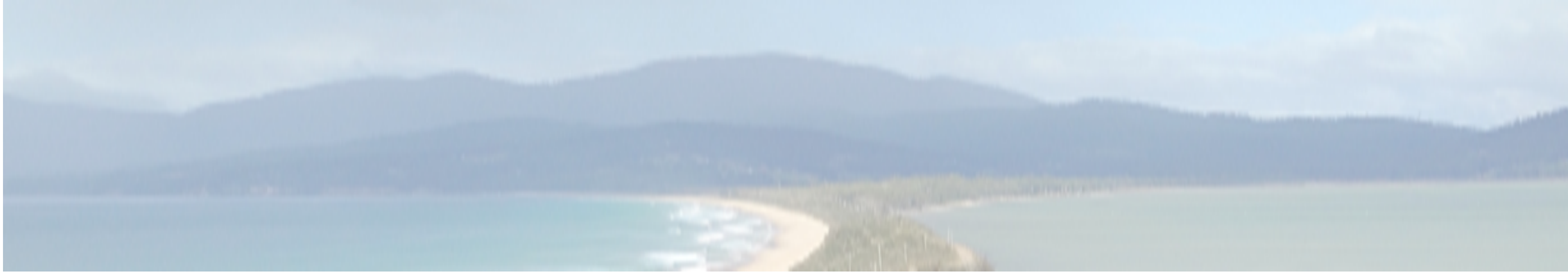
- To include in the scope to collect some additional network data;
- Ensuring algorithms can work with low-quality data.

Similarly networks should consider opportunistically collecting data as sites are visited.

Process Undertaken

For this trial the actions undertaken were:

- Some additional data was collected as other trial activities were carried out (such as installing a new household meter); and
- The NAC algorithm was successfully tested using simplified assumptions on some data.



#3 Lessons Learnt Report: Network risk management

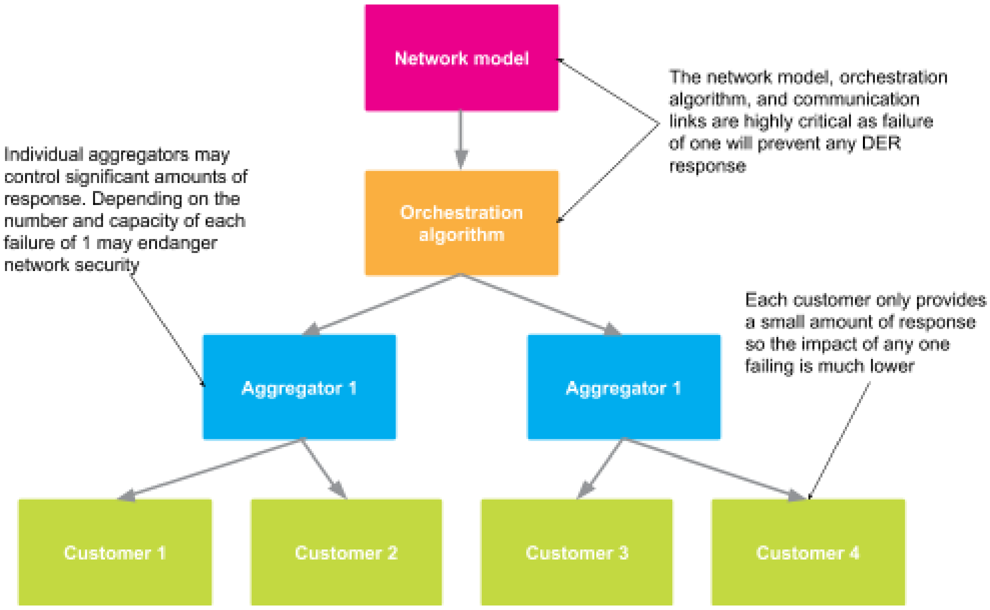
Project Name: *CONSORT*

Knowledge Category:	Technical
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

NAC was one of the first implementations in Australia of a true distribution services market resolving a real network issue. The impacts of the system, or any part of it, failing can be large as it may leave the system insecure without any means of rectifying the issue.

These risks apply across the entire demand response chain however is much more critical where there is a single point of failure. This is shown below:

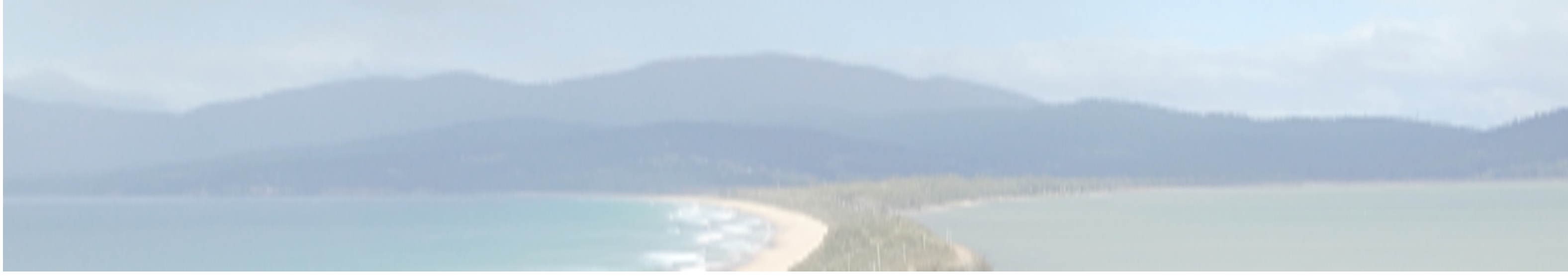


Implications for future projects

Future projects should consider this risk explicitly in their design. This may require some redundancy or hardening of certain stages.

Process Undertaken

For the CONSORT project the diesel generator was used to mitigate this risk.



#4 Lessons Learnt Report: Quality and reliability of data from network devices

Project Name: *CONSORT*

Knowledge Category:	Technical
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

Orchestration of demand response requires real time accurate data on the network state. Often this will come from devices such as reclosers. This is a significant expansion of the use of these devices. The two issues that have occurred in this use is:

- The devices are not usually calibrated for metering purposes; and
- Communications dropouts and bad data is common.

This can adversely impact the performance of orchestration algorithms which rely on this data to operate.

Implications for future projects

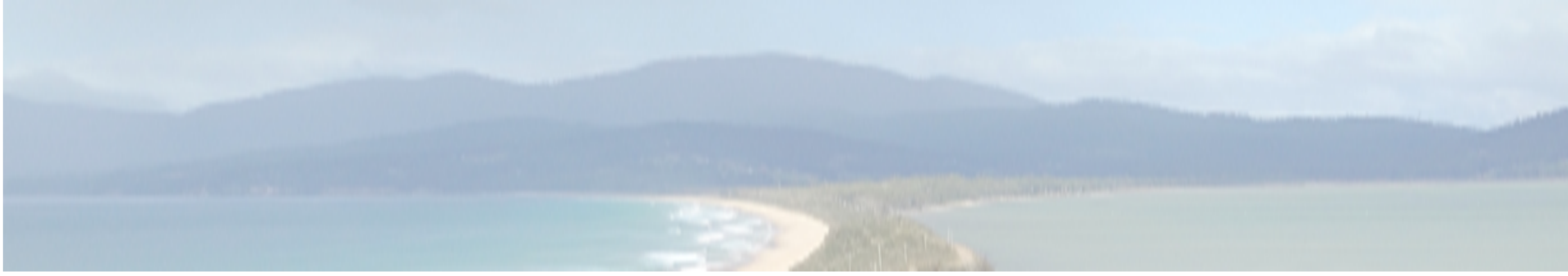
Critical network devices should have a higher level of communications security and data quality applied. This may include:

- A redundant communications channel; and
- Calibration of sensors.

Similarly orchestration algorithms should be developed to detect and gracefully manage bad data.

Process Undertaken

During the trial the NAC algorithm was capable of successfully managing the data quality, however no major dropouts occurred during a time when it was actively managing cable load.



#5 Lessons Learnt Report: Customer management as part of orchestration

Project Name: *CONSORT*

Knowledge Category:	Social
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

The algorithms must interact with as part of the CONSORT trial (NAC, reward structures, and the standard Reposit controls) are technically complex. Their success requires customer participation. When developing and implementing algorithms and customer engagement strategies it is important to consider the overall environment and system the algorithms exist in. Customer management, engagement, and retention need to be considered explicitly in the design of the orchestration algorithms. It is easy to create an environment too complex for the customer to manage. This may cause customers to opt out of participation or to become dissatisfied.

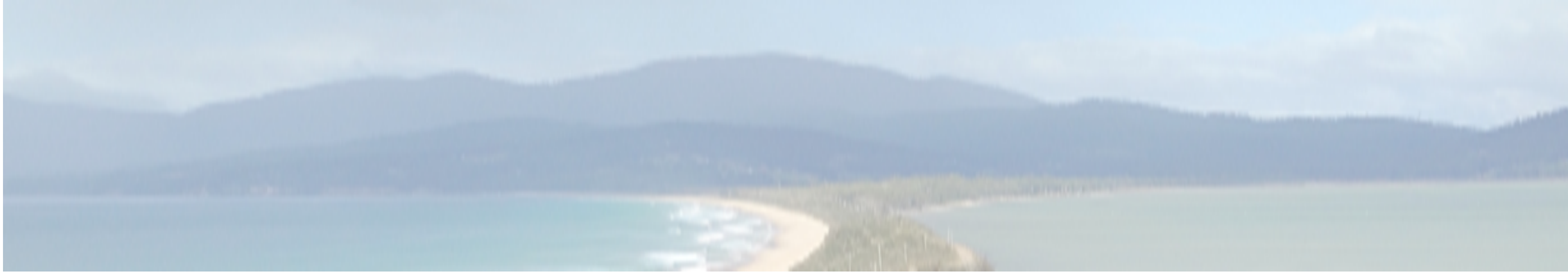
Implications for future projects

Customer management, engagement, and retention need to be considered explicitly in the design of the orchestration algorithms. The customer experience is critical for success as they are the ultimate providers of the service the algorithm is orchestrating.

Process Undertaken

Within this project this issue was managed across the project team:

- The social science team measured, reported, and intervened on issues as they arose;
- TasNetworks resolved issues, provided information, and were a first point of call for issues where responsibility was unclear;
- Reposit Power resolved technical issues for customers about the Reposit hardware and provided information and training on the use of their platform;
- Installers resolved issues with installed hardware; and
- The rest of the project team provided information and guidance where required.



#6 Lessons Learnt Report: VPP Integration with Network Optimisation

Project Name: *CONSORT*

Knowledge Category:	Technical
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

DER has the potential to both address network constraints and provide additional benefit to wholesale markets. As demonstrated in this project, DER can optimally be coordinated by negotiating their power profiles with a network orchestrator, in our case the NAC. This negotiation, which can alternatively be interpreted as an iterative bidding process, or steps of a distributed optimisation, needs to follow particular principles in order to converge towards the optimal outcome.

As we discovered in this project, it might be overly optimistic to assume all VPPs or aggregators would be willing to ensure that their software can follow these rules. The originally available optimisation approach used by Reposit Power was not fully compatible, and we do not expect any of the other VPPs to be compatible out of the gate.

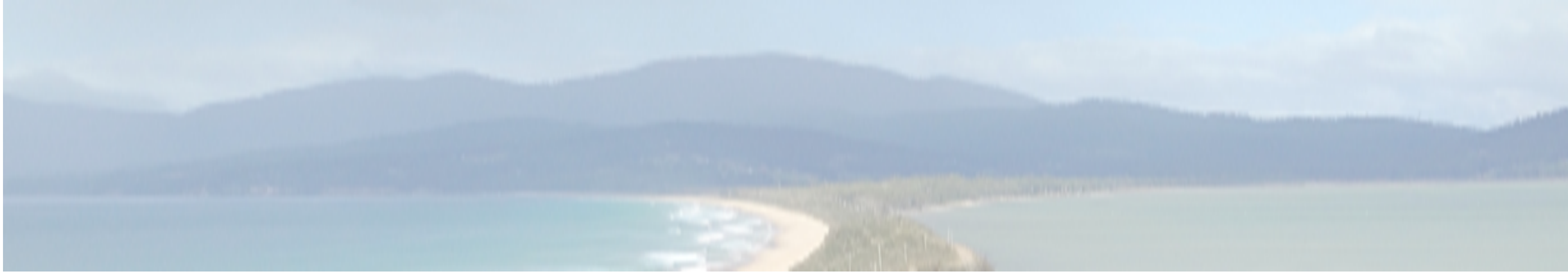
Implications for future projects

Significant work will have to go into working with VPPs to make sure that their software and underlying optimisation algorithms, are NAC-capable. To one degree or another, coming up with a standard interface to VPPs will be a problem for other techniques aimed at coordinating DER. However, for some VPPs at least, NAC compatibility could be particularly onerous due to the NAC's ambitious capacity to solve *optimal power flow*.

In the future we expect to develop an open reference DER optimiser, that VPPs can either directly use, or use as a example for making their own solutions compatible.

Process Undertaken

Within this project this issue was managed by the ANU working closely with Reposit Power to deliver a DER optimiser that achieves the key capabilities of Reposit's original optimiser, but extends its functionalities to be compatible with the NAC negotiation.



#7 Lessons Learnt Report: Customer engagement/acquisition

Project Name: *CONSORT*

Knowledge Category:	Customer
Knowledge Type:	Network connections
Technology Type:	Storage
State/Territory:	TASMANIA

Key learning

Orchestration is built on customer participation. This requires customers to be comfortable enough to install the appropriate technology in the first place.

During the trial it became apparent that:

- The technology is new to customers; and
- installers are not well equipped to explain the benefits of grid participation to customers.

Implications for future projects

The industry should consider coordinating to create a trusted information source for customers, installers, and other market participants to help navigate this space.

Process Undertaken

For this trial the project team provided this service to customers.