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# AusNet Electricity Services Pty Ltd

**Demand Management Innovation Allowance  
Annual Report 2020**

Submitted: April 2021

**missionzero**



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## 1 Introduction

This annual report has been prepared pursuant to the Demand Management Incentive Scheme (DMIS) scheme applied to AusNet Services by the AER in the 2016-20 Victorian Electricity Distribution Price Determination (the 2016-20 Price Determination). The DMIS provides revenue designed to encourage innovation in demand side participation and non-network solutions.

The DMIS requires AusNet Services to submit a report on expenditure attributed to the Demand Management Innovation Allowance (DMIA) for each regulatory year. This expenditure must fulfil the DMIA criteria set out in the DMIS. While AusNet Services exhausted its total allowed DMIA for the 2016-20 regulatory period in 2019, the current regulatory period has been extended by six months and an additional \$0.33m (real \$2020) has been allowed by the AER in its six month determination<sup>1</sup>. AusNet Services' total DMIA-related expenditure in 2020 exceeds this amount and so we are only claiming the operating costs to be funded under the DMIA, with the balance reported as regulated capex in the 2020 regulatory accounts, which will roll into the Regulatory Asset Base.

Nonetheless, we have provided full information on all DMIA projects in this report to provide stakeholder transparency, knowledge sharing and continuity, as DMIA funding will be claimed for several of these projects over the next regulatory period.

This report details the DMIA projects undertaken by AusNet Services in the 2020 calendar year which satisfy the DMIA criteria. The five projects are:

- **DER Marketplace (EDGE Project):** aims to trial a functioning marketplace that efficiently operates distributed energy resources (DER) located in the Hume region to provide grid services within a security constrained distribution grid and create a replicable model that can be used elsewhere in the National Electricity Market (NEM).
- **Dynamic LV Phase Balancing Trial:** demonstration of two grid-based, dynamic, and deployable power electronics technologies and intelligent control systems to demonstrate their ability to increase network DER hosting capacity, located in Montrose, Melbourne.
- **Mooroolbark Community Mini Grid:** A cluster of 18 interconnected residential customers, most of whom have solar power, a battery storage system and an advanced control platform, located in Mooroolbark, Melbourne.
- **Grid Energy Storage System Trial:** A 1MW/1MWh battery storage system combined in hybrid format with a 1MW diesel generator, located in Thomastown, Melbourne.
- **Good Grid:** A residential demand response project targeting a 22kV distribution feeder in the urban growth corridor around Clyde North.

DMIA related expenditure for 2020 (in nominal dollars) is summarised in the following table. Note only the operational expenditure contained in the below table is reported in Template 7.11.1 of the Annual RIN as DMIA project submitted for approval by the AER, for the reason outlined above.

**Table 1. DMIA expenditure in calendar year 2020**

Name of project	Operational expenditure	Capital expenditure	Total expenditure
DER Marketplace (EDGE Project)		\$300,434	\$300,434
Dynamic LV Phase Balancing Trial		\$95,741	\$95,741
Mooroolbark Community Mini Grid		\$14,940	\$14,940
Grid Energy Storage System	\$86,833		\$86,833

<sup>1</sup> AER, *Final Decision, AusNet Services, Six month extension – variation decision*, October 2020

GoodGrid	\$139,160	\$47,276	\$186,436
<b>Total</b>	<b>\$225,993</b>	<b>\$458,391</b>	<b>\$684,384</b>

## 2 EDGE

### 2.1 Project overview

The DER Marketplace project (now referred to as the EDGE project) aims to trial a functioning marketplace that efficiently operates DER to provide grid services within a security constrained distribution grid and create a replicable model that can be used elsewhere in the NEM.

This brings together new capabilities from AusNet Services as a smart distribution system operator, Mondo as an aggregator of DER services, and AEMO as the central independent market operator.

The EDGE DER marketplace project will:

- Build on the evolve project to develop a security constrained dispatch model for AusNet Services' network in the Hume region.
- Build on AEMO's existing Virtual Power Plant (VPP) trials to integrate dispatch into AEMO's central platforms.<sup>2</sup>
- Bring this work together to trial a functioning DER marketplace for the Hume region, based on the work of the Open Energy Networks program.

There is a major expansion taking place in the amount of DER connecting to the Australian grid. AEMO's 2018 Integrated System Plan forecasts that by 2040, rooftop solar will represent approximately 13 percent of underlying consumption under the neutral scenario or 22 percent in a high DER scenario.

System security risks are emerging now across the NEM and in Western Australia's SWIS, as the increase in large-scale renewable generation and DER displaces the dispatchable thermal generators that have historically provided system security services such as inertia, frequency control, system strength, and voltage control.

In addition, voltage stability issues in the distribution grid could start to slow the uptake of solar right when consumer demand is higher than it has ever been.

This project seeks to support the management of power system security and effectively integrate DER in a way that facilitates efficient utilisation of existing and future electricity sources.

The key objective of this project is to demonstrate at small scale an end-to-end marketplace that can be replicated across the NEM where eventually DER participation in the electricity market is:

- fully integrated into AEMO's market operation and dispatch, and co-optimised against other sources of wholesale energy.
- fully visible to the system and market operator, to enable it to manage both the distribution and transmission systems.
- effectively managed via the use of dynamic operating envelopes in the distribution network.
- evaluated in its ability to provide transmission and distribution system support services.
- able to provide value and incentives to the owners of the systems and other energy users.
- incentivised and recognised as a legitimate alternative to large scale generation and network augmentation.

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<sup>2</sup> Additional information on VPP trials can be found at: <https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/virtual-power-plant-vpp-demonstrations>

## 2.2 Nature and scope

This project is a two-and-a-half-year demonstration project (2020-2023) on the pathway for progressive enablement of distribution-connected DER.

Aligned with the Open Energy Networks Hybrid model, project roles will include:

- AEMO as the project lead, taking the role of the market platform operator
- AusNet Services adopting the role of the Distribution System Operator (DSO)
- Mondo as the Aggregator in phase 1, with other participants to enter the market in phase 2.

In this context, and consistent with the aims of the project as a small-scale trial, the project delivery will occur through a combination of in-market activities and simulated, out-of-market activities.<sup>3</sup>

## 2.3 Aims and expectations

The DER marketplace arrangements to be trialled as part of the EDGE project will allow AusNet Services and other participants to design and review what market mechanisms may allow DER to be efficiently and effectively aggregated and dispatched to provide local network and wholesale services. Ultimately, this will provide DNSPs with alternate options to manage network constraints without the need for large network augmentation projects. Flexible connection agreements to be trialled as part of EDGE will also reduce the need to constrain DER customers seeking to export excess power into the grid. In time, the EDGE workplan is expected to lead to an evolution of the NEM and the WEM as the markets move to a 2 sided structure.

## 2.4 Process of project selection

The EDGE project was selected to trial DER marketplace arrangements and specifically to conduct experimentation that can refine and direct the design of the Open Energy Networks frameworks and provide data for definition of functional requirements. The north eastern region (Hume) of AusNet Services' network was selected due to the presence of active sustainability minded organisations and communities.

## 2.5 Project implementation

This trial design includes three phases:

- Trial phases one and two, where AEMO will develop the conceptual design of the market and gain insight into the system architecture required to build an operational market. During trial phase one, AEMO, AusNet Services and Mondo will test the development of the market design in a limited and controlled context.
- As the project moves through each trial phase, we will seek to increase the number of participants in the marketplace. Trial phase one will initially begin with 38 residential customers. Trial phase two will introduce 8 commercial/industrial customers as well as an additional 20 residential customers.
- Trial phase three, where additional participants will be invited into the trial to test the market design principles and systems built. This will include, at a minimum, inviting additional aggregators to participate in a trial. Trial phase three will aim to have a minimum of 30 commercial/industrial customers and 200 residential customers.

In 2020, the EDGE program entered trial phase one, where project setup and design planning were implemented. AusNet Services (with support from Mondo and AEMO) will test the viability

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<sup>3</sup> Additional information can be found at: <https://arena.gov.au/projects/victorian-distributed-energy-resources-marketplace-trial/>

of residential and commercial/industrial DER being offered via a market platform to be dispatched in aggregate to provide wholesale and network services. The network services that will be trialled will utilise the aggregated DER and demand management to support network operations in order to avoid/defer the need for network augmentation.

## 2.6 Implementation costs

In 2020 the **\$300,434** of EDGE costs were related to the program setup and initial design and planning works:

- Program management and team mobilisation
- DERMS specifications and vendor engagement
- Operating envelope logic design and development
- Market platform and services design and development

The EDGE project is partially (but not fully) funded by ARENA. The costs outlined above are distinct from ARENA-funded costs.

## 2.7 Benefits

The benefits derived from this project will be predominantly related to future customer outcomes, specifically the enablement of customer choice in investing in DER portfolios. This will be achieved through:

- Creation of an end-to-end technology solution that will underpin future flexible customer DER connection contracts, which in turn results in less rejections or constraining of customer DER connection applications.
- Introducing new and improved mechanisms to manage customer supply power quality, especially voltage levels.
- Enablement of future network services (e.g., demand management, provision of reactive power support etc.).
- More efficient DNSP investments in the next regulatory period relating to DER integration.

## 2.8 External communications undertaken

The EDGE program has extensive stakeholder engagement and comms activities within its scope. During 2020, much of the activities related to program establishment and mobilisation. The project partners (AEMO, AusNet Services and Mondo) have issued public announcements and held dedicated stakeholder forums.

## 2.9 Next Steps

Phase 2 of the program will continue for much of the 2021 calendar year leading to the commencement of the 1<sup>st</sup> trial phase in November. Key activities during this phase include trial customer incentives and acquisition, systems development, and DER services design.



### 3 Dynamic LV Phase Balancing Trial

#### 3.1 Project overview

The Dynamic LV Phase Switching Project also known as the Solar Friendly Neighbourhoods trial is a \$2.25M trial partly funded by ARENA. The trial demonstrates two innovative technologies to increase customer uptake of Solar PV by dynamically balancing load and generation on the low voltage network. AusNet Services undertook a two-year trial in partnership with Jemena (lead partner), the University of New South Wales (UNSW) and XJ Group (State Grid of China). The project commenced in 2019 and will be completed in early 2021.

#### 3.2 Nature and scope

The two technologies being trialled on AusNet Services’ network are represented in the schematic figure below. The first is a smart inverter known as a Power Compensation Device (PCD). Located parallel to the distribution substation, can dynamically balance the three phases on the low voltage side of the lv transformer to show a balanced load to the upstream HV network. Additionally, it can improve the power quality at the low voltage level.

The second device is a Phase Switching Device (PSD) located at the customer’s service pole and can shift the customer load between phases. Fourteen of these devices have been installed in a residential street in the suburb of Montrose. A central controller located at the substation pole constantly monitors, computes real time information, and accordingly dispatches commands to the equipment based on an optimised algorithm to achieve three phase load balancing.

Jemena are additionally trialling a battery storage device along with the PCD and PSD’s.

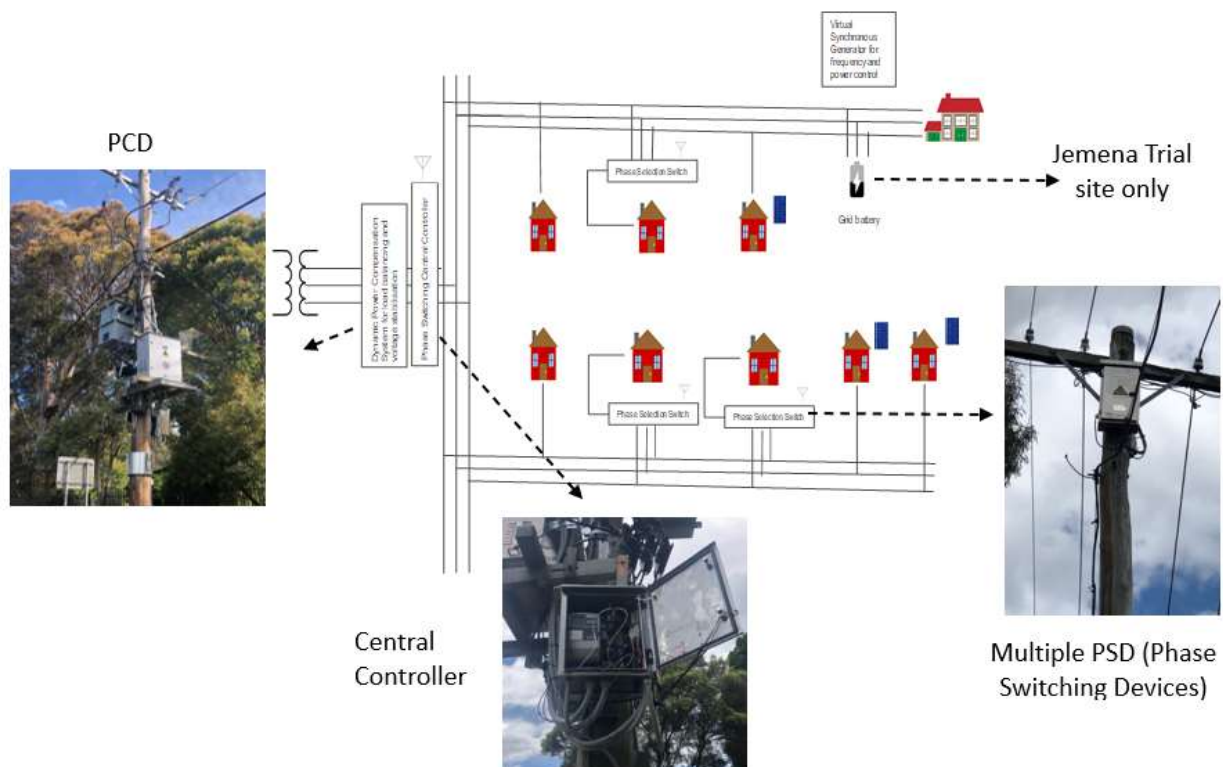


Figure 1 Schematic Representation

### 3.3 Aims and expectations

The objectives of the trial are to:

- Demonstrate the effectiveness of the chosen technologies in increasing DER hosting capacity of the networks in the demonstration project.
- Capture the leanings from the design, installation, commissioning, and operation phases of the technologies.
- Understand how transferable the demonstration results are to other distribution networks.
- Determine costs and the benefits associated with the chosen technologies.
- Understand the pathway for mass adoption of the technologies.

### 3.4 Process of project selection

The demonstration site is in a residential street in the suburb of Montrose situated 33km east of Melbourne's CBD. This site was chosen since it is representative of the average PV penetration in Victoria of 26% and presents unbalance issues, especially during the summer months due to high solar export back into the grid. The site is easily accessible for the project team and field crew.

### 3.5 Project implementation

The project is divided into four key stages as follows:

#### **Stage 1 – Program Design & Procurement (circa January 2019 to May 2019)**

Project partners developed the detailed design for the project, including conducting the modelling and simulation to input into the design. As the design progressed, the key materials and services requirements were identified, and detailed specifications were developed. Requests for tender were issued, evaluated and orders for equipment placed. The key items of equipment procured and installed for each technology.

#### **Stage 2 – Detailed design, off-site equipment testings and delivery (circa June 2019 to November 2019)**

Detailed design of the equipment panels and control logics was undertaken during this period. As the equipment was purchased from an overseas supplier, testing to relevant Australian and international standards, where appropriate, were carried out.

Upon completion of equipment manufacture and assembly, the supplier conducted Factory Acceptance Testing (FAT) at its factory to demonstrate that the equipment met the purchase specifications. FAT was witnessed by representatives from Jemena and AusNet Services. After the successful completion of FAT, the supplier shipped the equipment to Australia.

AusNet Services and Jemena carried out designs for the construction and installation of the equipment at their respective sites.

#### **Stage 3 – Installation, commissioning, and trial commencement (circa December 2019 to February 2020)**

This stage involved the installation, commissioning, and commencing operation of the equipment at the selected LV sites on the Jemena and AusNet Services networks.

#### **Stage 4 – Trial operation, evaluation, and final report (circa March 2020 to June 2020)**

After the installation, the project partners will monitor and refine the operation and performance of the equipment. Use cases will be developed and conducted to undertake the analysis in different conditions, and data collected. After an extensive period of performance monitoring, the project partners will collate the data and perform the analysis to underpin the evaluation of the trial. Specifically, the trial outcomes will provide findings including, but not limited to:

a) Quantifying the improvement in network DER hosting capacity.

- b) Interpretation and modelling of how transferrable the results are likely to be for other network types.
- c) Undertaking a cost-benefit analysis of the technologies, considering the network regulated expenditure process, to help inform the potential for subsequent deployment of the technologies.

### 3.6 Implementation costs

The DMIA costs in 2020 for this project of **\$95,741** were largely associated with purchasing of hardware, installation, commissioning, and testing.

### 3.7 Benefits

- Improve customer supply voltage compliance through the deployment of new dynamic network devices.
- Increase DER hosting capacity and improve efficiency of DER connection processes.
- Defer network augmentation and optimise future investments.
- Inform costs and benefits for future at-scale deployments.

### 3.8 External communications undertaken

UNSW and project partners hosted an industry knowledge sharing webinar on 30<sup>th</sup> September 2019 to share the interim project learnings. Further communications and webinars will be held towards June 2020 to share final project learnings.

### 3.9 Next Steps

Currently in stage 4 which includes completing the final report, knowledge sharing activities and data analysis which will include analysing the hosting capacity improvement brought by introduced devices.

## 4 Mooroolbark Community Mini Grid Trial

### 4.1 Project overview

The Community Mini Grid project in Mooroolbark is designed to test a future role for the distribution network, in an environment of widespread distributed energy resources (DER) that can be coordinated to deliver services and value to both customers and the network. This network role is aligned to the concept of the Distribution System Operator (DSO).

In particular, this innovation project will allow AusNet Services to:

- understand the full value potential of concentrated and controllable distributed energy resources (DER) in providing demand management and network support, as well as the techniques to achieve this;
- develop strategies to manage an increasing level of customer-driven DER; and,
- learn how to facilitate community driven energy initiatives such as renewable energy projects and micro grids in a way that is not only efficient but is beneficial to the network.

The project encompasses the design, build and operation of an 18 house mini grid in Mooroolbark, a typical suburban community in Melbourne's East, that will be monitored and controlled by a cloud based mini grid control system that can implement DSO control functions and algorithms. Melbourne-based energy technology company GreenSync is supplying the residential solar and battery storage systems and is configuring their cloud-based control platform to AusNet Services requirements.

The project will also test the performance of DER systems in providing backup supply to individual customers in case of network outage, and also the ability for the mini grid as a whole to operate as an island (grid-separated mode) for short periods of time, with sharing of power between customers in order to maintain system stability and longevity. Both cases have undergone considerable investigation from the perspective of safety and protection system performance. In particular the intent to operate the whole mini grid as a 3-phase island with 100% inverter based supplies is a ground-breaking technical initiative.



**Figure 2 a) Site layout and key components of the Mini Grid, b) Official opening of the Mini Grid**

The development of the mini grid 'stabiliser' device to allow islanded operation constitutes a major innovation within the industry. Close collaboration between AusNet Services and Power Technology Engineered Solutions, a small local company supplying the device, has been instrumental in developing the device.

To date, the home solar-battery systems have been deployed, remote monitoring and limited control via the cloud-based control platform is available, and the central assets including the grid

switch and stabiliser are installed and commissioned. An Incident Response Plan has been developed to facilitate the operation of the facility and allocation of responsibilities between the suppliers and various teams in AusNet Services.

The next phase of the project centres on the evolutionary development of control strategies on the home solar-storage system, the proprietary mini grid control system and the in-house DSO platform. This will subsequently enable a program of physical trials to be rolled out that test key technical and customer focussed scenarios.

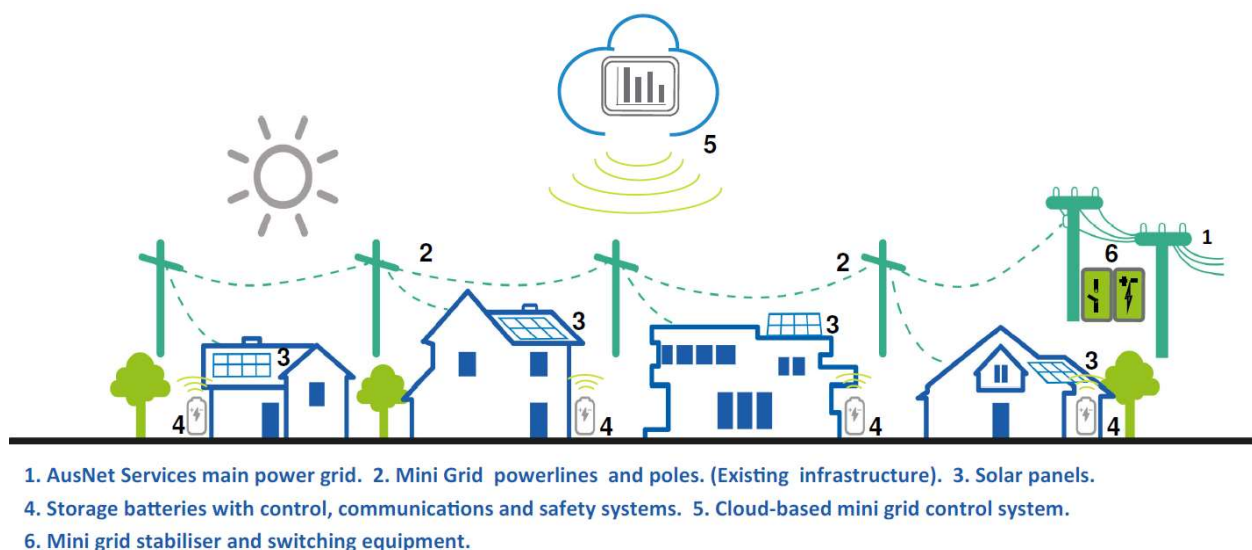
Key learnings to date have clearly highlighted:

1. Complexities associated with site preparation for installation, including the need to perform several upgrades to customer supplies to comply with the Service Installation Rules.
2. Intricacies associated with working with small supplier companies that do not possess the same levels of documentation and process than typical AusNet Services delivery partners.
3. Procurement under a high level functional specification supports innovation through capturing the diversity of technical solutions in the marketplace and allowing an agile approach to system design but necessitates significant technical and project management resource during project delivery.
4. The current lack of technical interface, design and performance standards for inverters and battery storage systems.
5. Protection issues are significant for inverter based supplies that have relatively low fault currents and thorough scenario analysis and modelling is required to ensure system safety.

In 2020, the DMIA capital expenditure was **\$14,940** for this project. Further DMIA costs are expected in 2021 for the closing out relocation of the stabiliser.

## 4.2 Nature and scope

For this project, a location was chosen by AusNet Services, and the local customers were engaged on the basis of recruiting them into the project. In this regard the community engagement process is quite different to cases where a community self-organises, initiates a project and seeks for AusNet Services to support the project. Maintaining the goodwill of participants through personal relationship building and interaction is of paramount importance to the success of the trial and requires an ongoing commitment.



**Figure 3 Pictograph of mini grid components**

The project involves the development, deployment, safe operation and extensive testing of the following mini grid components:

- integrated rooftop solar PV and battery storage systems at 14 of 18 houses on a single street. The mini grid originally comprised 16 houses but has since seen two subdivisions.
- central network devices including a grid switch, power meter, and mini grid stabiliser unit at the low voltage grid connection point to allow the mini grid to operate in islanded mode
- a centralised mini grid control system with a 3G communications, that can optimise power flows within the mini grid and perform various control functions while grid connected or while islanded, and which feeds into a network level “Distribution System Operator” platform
- a customer web portal to allow customers to monitor and configure their energy systems
- potential to add air conditioner load-control at one home

Due to the extremely broad application potential of this live mini grid environment, a trial period once fully operational of more than 12 months is anticipated.

### 4.3 Aims and expectations

The objectives of the mini grid project are aligned to the following main areas.

1. **Technical:** To understand the technical benefits to the network that can be delivered from a controllable cluster of DER, and the challenges in establishing and operating a mini grid that consists of purely inverter based supply sources.
2. **Community:** To understand community appetite and concerns around the use of local renewable generation and storage to become more self-sufficient, to interact with neighbouring energy systems and to provide services back to the network.
3. **Business:** To understand the economic viability and value in establishing mini grids and in establishing a level of DSO capability. The project allows AusNet Services to be more fully prepared for the expected future of high customer uptake of DER.

The project is expected to inform a wide range of groups and teams across the business regarding the management and leverage of customer uptake of DER. It also aligns to the central theme of network optimisation in the ENA/CSIRO Electricity Network Transformation Roadmap.

### 4.4 Process of project selection

In preparing for the 2016-2020 EDPR, AusNet Services had identified a number of priority demand management innovation projects to undertake utilising the DMIA. The investigation of mini grids was one of these projects and built upon previous technical projects and trials such as the Mallacoota Sustainable Energy Study, the Grid Energy Storage System and the Residential Battery Storage Trial.

The mini grid project was selected as an opportunity to build on this prior work and respond to a set of relevant business drivers:

1. Increasing levels of deployment of distributed energy resources (such as solar PV, battery storage and home energy management), increasing maturity of DER technology, and decreasing costs. Residential rooftop solar penetration in Australia is amongst the highest internationally, and the residential storage market is one of the most active.
2. Customer and community trends prioritising energy self-sufficiency, reduced reliance of the grid-delivered energy, adoption of renewable resources and an expectation that network businesses will play an active role in community energy projects.
3. Availability of control technology and platforms that can coordinate large fleets of DER in combination with big-data analytics

4. The need to run the network more efficiently and deliver on customer expectations in a way that optimises the value of distributed energy resources to all stakeholders

As well as providing the ability to deliver direct benefits to the operational efficiency of the network (e.g. through demand management and improved asset utilisation) the mini grid construct was identified as a suitable test-bed environment to investigate the functionality that could be achieved by a future DSO capability.

AusNet Services needs to prepare for near to mid-term future scenarios (5 to 10 year horizon) in a fast evolving energy ecosystem by undertaking a real-world trial of the DSO concept that can test multiple operating configurations. The changing customer and distributed energy environment heralds significant implications for the efficient scale and operation of the networks. The distribution network may become a platform for energy and energy services trading. A DSO capability provides the additional network controls that are needed to facilitate these new markets, manage the variability of DER generation and extract value from the diversity of connected devices.

## 4.5 Project implementation

One of the first challenges for project implementation was finding a suitable site and community. Although initially focussing on more remote communities, it became clear that a more urban location would serve better as a test facility. Towards the end of 2015, the project team identified a number of locations with 3-phase overhead supply, relatively small distribution transformers, good coverage of smart meter data, no sensitive customers, high occupancy rates and evidence of average or above average take-up of solar power. A site in Mooroolbark was selected, and the community was engaged to understand their needs and their level of interest in participating in such a trial.

Since the approval of the project, the specification, design and construction of all the hardware systems, as well as the integration into a remote monitoring system, have been the dominant focus. An EOI and RFQ process was conducted with potential suppliers in late 2015, and equipment delivery started in early 2016.

Participant engagement remained intensive throughout each phase of installation and testing at the 14 homes, which was completed in October 2016. Since then, the central monitoring system, GreenSync's proprietary MicroEM™ platform, has been operational, allowing visibility and basic remote control of the integrated home solar-storage systems.

The stabiliser and LV switching cabinet were installed and energised in February 2017. The mini grid is currently remotely monitored and operated according to a comprehensive 24/7 incident response plan.

As part of the technical specification phase, a comprehensive network protection analysis was undertaken with all the hardware providers to ensure that the protection risk profile of the mini grid was not increased.

To model the future potential DSO environment, AusNet Services has developed a cloud-based control software layer called the Distributed Energy Network Optimisation Platform (DENOP). The software architecture for the DENOP that links to GreenSync's control platform was designed in mid-2016, with development continuing across 2017.

The bulk of 2017 has focussed on the evolutionary development of the remote control capabilities in the two platforms to allow an ongoing series of physical trials to be conducted. These trials have worked through the list of use cases and value streams that clustered DER can provide to customers and the network.

The Mooroolbark Community Minigrid trial progressed into Stage 2 that aims to focus on voltage control. In 2018, the battery equipment for all the residential trialists were removed and decommissioned. Designs have been explored for a new PLC for the solar systems. The

Stabiliser has undergone a process to upgrade its functionality to enhance its capability to better manage voltage on the network.

Upgrades to the stabiliser was initiated, installed and commissioned over 2019-2020. The stabiliser also had functional upgrades implemented to maximise the use of reactive power to maintain the network voltage within compliance limits despite a high concentration of renewables connected.

#### 4.6 Implementation costs

A large portion of the project cost to date is associated with the installed hardware, and much of this was delivered during 2016 and 2017 with upgrades in 2019-2020.

Capital expenditure in 2020 amounted to **\$14,940** and comprised:

- Upgrading the stabiliser from 17kVA to 30 kVA to account for the loss of customer battery storage.
- Commissioning and testing of the system.

#### 4.7 Benefits

In practical terms, mini grids (or sub-elements of mini grids) offer the potential for the following benefits to AusNet Services under a DSO framework.

- a. Coordinate distributed energy resources to provide network peak demand reduction, reduce energy at risk and potentially defer asset augmentation
- b. Increase asset utilisation through shifting peak loads and peak generation into off-peak times, and balancing loads across phases
- c. Increase electricity system resilience and flexibility by utilising fast response of DER assets in the event of network contingencies or major events
- d. Increase supply reliability by providing islanded supply to customers during outages
- e. Bushfire risk reduction by enabling overhead lines to be de-energised when customers are supplied in island mode
- f. Deliver on customer expectations for increasing self-reliance, reducing energy costs, and utilisation of renewable energy for personal use or to access emergent markets.
- g. Enable local infrastructure to support community-driven energy initiatives, including reliable supply capacity that avoids the need to sub-optimally oversize DER systems.
- h. Facilitate higher penetration of distributed generation by using smart inverters and battery storage to control thermal loads and network voltage.

This trial project will test the technical viability of the mini grid to demonstrate these benefits, test the customer appetite and acceptance, and evaluate the economic viability of different structures of mini grids and community energy projects.

The learning of the project will ultimately help build AusNet Services' toolkit for delivery of non-network and demand-side solutions.

#### 4.8 External communications undertaken

During 2019-2020 the trial mainly focused on upgrades, commissioning, and monitoring of the device. External communication was primarily via updates to the AusNet Services corporate website.



## 4.9 Next Steps

Mooroolbark Community Mini Grid Trial Part 2 explored implication of centralized energy storage and control combined with low level household control from both technical and financial perspectives. The device performed reliably for almost a year after the enhancements and will be relocated to another part of the network and transitioned to BAU.

## 5 Grid Energy Storage System Trial

### 5.1 Project overview

In 2012 AusNet Services initiated a Grid-scale Energy Storage System (GESS) project to trial the use of a large battery storage system to manage peak demand on the distribution network and explore other benefits to network management such as power quality improvement and providing supply to an islanded group of customers as a mini grid. Large battery systems offer demand levelling and voltage support services which can not only defer asset investment but also improve the quality of supply to customers.

The GESS is able to shift demand on a particular feeder from peak to off-peak times by discharging during feeder peaks and re-charging overnight when the feeder demand is low. In practice, the GESS is suited to addressing a specific network constraint and is containerised to allow relocation to areas of network need.

When the GESS trial was initiated, large scale battery storage was not yet cost competitive, but the decision was made to trial this innovative technology in anticipation of reductions in battery prices in future. Now, the gap between costs and benefits has reduced significantly, and large scale battery storage is not far off being economic.

The GESS was commissioned by the end of 2014 and a trial was conducted during the 2014-15 summer using batteries only for peak lopping along with voltage support/power factor improvement. A power quality recorder was also installed to monitor harmonics, negative sequence voltage and flicker under varying operating conditions.

The GESS initially had only a “local peak lopping” set point capability, i.e. it was programmed to provide demand management of downstream loads only. Soon after, a “feeder peak lopping” set point functionality was added in order to also support upstream loads. An upgrade was also performed to the neutral earth switch to enable “bump less” transition between grid connected mode to island mode. This along with several other outstanding items was resolved before achieving practical completion in May 2015.

In order to address noise emissions from the diesel generator and achieve EPA compliance, a fan attenuator box was installed, and a temporary noise barrier was deployed in the form of a mobile billboard. These measures allowed use of the generator in conjunction with the batteries across the 2015-16 summer trial period.

With the two summer trial periods complete, the project has since moved into the analysis and reporting phase and has also seen planning towards a potential relocation of the facility to an area of the network where it can provide improved reliability of electricity supplies to customers as well as support power quality. To maximise benefits in providing supply reliability a series of innovative functional enhancement have also been designed.

DMIA expenditure during 2012 to 2017 has been approved for this project and AusNet Services is claiming an additional **\$86,833** of costs as compliant with the DMIA criteria for 2020. Further DMIA costs may be incurred for this project during 2021.

Benefits of undertaking the trial include quantifying the system performance potential and gaining experience in the practical considerations of deployment and grid-integration of large-scale battery systems, such as protection settings and supporting infrastructure requirements. Significant experience has already been gained in this area through the process of implementing the system within the AusNet Services network operations environment.

### 5.2 Nature and scope

The project involves installing a large (1 MW / 1 MWh) battery system including four-quadrant inverter to support the peak load on a 22kV distribution feeder that exhibits a mix of residential and commercial customers. The trial is providing operational data to verify performance of the battery, inverter and

control system to support the grid for peak demand, voltage and power factor. The system has been designed to provide a full 1 MWh of storage capacity after 10 years of service therefore the initial installed capacity is in excess of the nominal 1 MWh rating.

The system includes a 1 MW diesel generator set to extend the MWh rating of the battery system to provide full coverage of the peak demand period. This has been done in order to keep the costs of the entire system down while fully simulating a larger capacity battery system. Battery prices are expected to continue declining in the medium term offering good potential for an efficient low emission solution for grid support.

### 5.3 Aims and expectations

AusNet Services is exploring grid connected storage as a means of managing network demand, improving reliability and deferring augmentation in areas of forecast capacity constraint. The benefits of additional functions such as voltage support, power factor correction and phase imbalance are also being explored.

Ongoing development of batteries and smart controllers has made battery storage an attractive technical option. AusNet Services intends to gain knowledge and experience in this technology by conducting this trial project. It is expected that if the trial is successful, the grid storage solution will have potential for wider deployment subject to sufficient reduction in battery prices in the medium term.

### 5.4 Process of project selection

In 2012 AusNet Services conducted a feasibility study into a trial of large scale energy storage in terms of the costs and the availability of the technology and suppliers. It was found that the technology was available and that there were adequate numbers of experienced suppliers in the market to implement such a trial.

Six potential locations for the trial were considered: Euroa (BN1), Clyde North (CLN21), Ringwood North (RWN26), Thomastown (both TT7 and WT12) and Watsonia (WT13). These locations were evaluated based upon the peak demand levels, voltage support requirements, islanding potential and demand growth forecasts.

Thomastown WT12 was chosen as a preferred location to conduct the trial based upon the evaluation results and because it offered flexibility to conduct experimentation, which is an important part of the trial. After the initial trial, it is expected that the system will be relocated to a more critical location. All units are containerised so that they can be moved to alternative locations once the trial period is complete.

### 5.5 Project implementation

In March 2013, a Request for Proposal was issued which closed on 21st June 2013. Twelve tender submissions were received. The submissions indicated that there were sufficient reputable and experienced suppliers with proven equipment at comparable prices to ensure that the probability of a successful trial was high.

After a formal and competitive tendering and assessment process, a contract was awarded to ABB Australia Pty. Ltd. (consortium of ABB Australia as lead party, and Samsung Korea) for the design and construction of the GESS.

By the end of 2014, the GESS hardware had been delivered and installed, and commissioning tests were underway to allow the trial phase to begin during the summer of 2014/15. Delays were experienced during project design, delivery and testing as a result of the complexity and uniqueness of the system, with new approaches required to be developed to implement the system within the AusNet Services network operations environment.

The site layout and a view inside one of the battery containers are shown in the figures below.



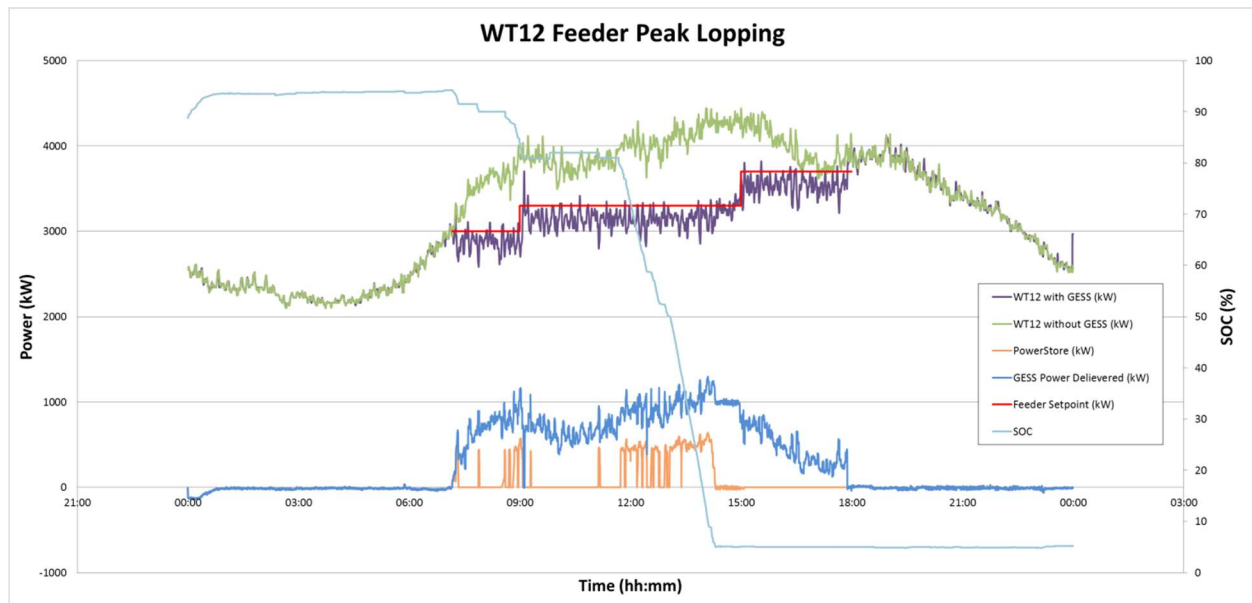
**Figure 4** The GESS, installed and operational. Battery containers are in the background, with the inverter, transformer and switchgear containers in the foreground.



**Figure 5** Battery container view from inside.

A two-year trial plan was developed for the summer peak periods of 2014/15 and 2015/16. The trial plan comprised a comprehensive range of tests including; peak demand lopping, power factor correction, voltage support, voltage waveform harmonics, current waveform harmonics, negative sequence voltages, phase load balance, flicker and islanded operation including transitions to and from islanded supply.

An example of the performance of the system under peak demand lopping is shown in the following figure.



**Figure 6 Example of a feeder peak lopping test. GESS output power (blue) utilises both battery (orange) and generator to bring the feeder demand (green) down to a setpoint (red).**

During 2017, the following key activities were completed:

1. Finalised scoping of a series of innovative enhancement works to improve the performance and value of the system, and awarded contract to ABB
2. Development of a project concept to relocate the GESS to a site on the distribution network where it can deliver both reliability improvement as well as power quality support

The supplier has continued to support AusNet Services with ongoing service and maintenance across 2017.

From 2018 to the end of 2019, the GESS was upgraded with various functional enhancements and reliability improvements to enable it to be relocated to Mallacoota to be used as a BAU facility to improve power supply reliability in the region. Extensive relocation planning activities were undertaken across 2019. In parallel, a testing regime was executed to test the new functional enhancements.

From 2019 to the end of 2020, civil works for the GESS relocation was completed. The GESS itself was also physically relocated from Thomastown to Mallacoota. Commissioning works commenced in December.

## 5.6 Implementation costs

In 2020 the **\$86,833** of DMIA costs were related to ongoing operation of the facility while the relocation project was being developed and while the suite of functional enhancements was being delivered:

- Site maintenance
- Site office rental
- Fuel and energy charges
- Project management and engineering costs including appropriate labour charges.

## 5.7 Benefits

The expected benefits of using large-scale storage connected at grid-level include the ability to defer asset augmentation, reduce the risk of asset overloads, improve power quality and mitigate the risk of customer outages. A key output of the GESS project will be an ability to quantify these benefits.

Specifically, the trial will provide AusNet Services practical experience to better understand and assess the level of network value that grid-scale energy storage offers in:

- managing peak demand;
- reducing levels of network energy-at-risk;
- deferring asset augmentation;
- offsetting operational costs such as hire of temporary generators;
- improving power factor, voltage and other power quality parameters; and
- supplying customers in islanded mode.

Benefits of undertaking the trial also include gaining experience in the practical considerations of deployment and grid-integration of large-scale battery systems such as protection settings and supporting infrastructure requirements. A volume of experience has already been gained in this area through the process of implementing the system within the AusNet Services network operations environment.

The trial will inform future innovation and applications of grid-scale energy storage in other areas of the distribution network. This trial will help to establish whether battery storage is a credible non-network solution to manage demand and set the parameters around when it can be economically deployed for the benefit of energy consumers.

## 5.8 External communications undertaken

In early 2017 the Demand Management Case Study that serves as the public report for the GESS project was updated. A presentation was also made at the NEM Future Forum in Sydney.

These follow a series of presentations made in 2016 on the operational results of the GESS trial, covering Australian Energy Week, All Energy Australia and Energy Storage Australia.

In 2018, the design and control scheme for the GESS auto islanding scheme was shared with Western Power to help them develop their auto islanding system.

In 2019 external communication was specifically with the community in Mallacoota to prepare them for the delivery of the GESS into their town.

In 2020, continued external communication with the community during the GESS commissioning phase.

## 5.9 Next steps

Steps to be completed for the GESS project in 2020 include completion of system performance enhancements and to relocate the facility to Mallacoota.

After the experience of the GESS trial to date, confidence has been gained within the business regarding system operability and reliability. The project to relocate the facility has been completed within the 'business as usual' environment and is now serving to embed the learning from the innovation trial into the network engineering and field engineering functions of the business.

The GESS project team is continuing to collaborate with relevant teams within AusNet Services to further the transfer of knowledge into BAU. This includes the assessment of energy storage within the network planning function as well as the creation of standards and procedures to enable more efficient deployment of energy storage technology on the network in the future.

During the year of 2018 and in the early part of 2019, there was a rapid expansion of renewable energy uptake in Mallacoota. This could cause an issue when the GESS disconnects from the network (upon detecting a power outage on the network) as there could be more generation from solar than load in the town. New control systems are being developed in the GESS to be able to handle this circumstance. In 2019 a specific project was also initiated to directly control hot water systems in Mallacoota to reduce the level of reverse power from a high volume of renewable generation. 2020 focused on the final delivery from Thomastown to Mallacoota. The innovation team provided SME advice to the BAU team to facilitate the successful delivery of the equipment.

The next and final step is to complete the commissioning works and leave the GESS in service to reduce outages for the Mallacoota community.

## 6 GoodGrid

### 6.1 Project overview

Across the summer of 2017/18, AusNet Services conducted its residential demand response (DR) project, targeting customers in the various urban growth corridors within AusNet Services distribution network. The GoodGrid program is the result of running the Peak Partners proof-of-concept trial in 2017/18.

The Peak Partners program tested different types of demand response schemes and was intended to inform the path forward for further work to build a residential DR capability for cost-effective network management. The 2017/18 project was successful in proving both a strong level of customer demand response during events (40% reduction) and an overall positive customer experience (96% willing or very willing to recommend to friends and neighbours). The 2019/20 GoodGrid program also exhibited a strong customer demand response during events, with a 58% reduction on average.

AusNet Services had previously initiated preparatory work on residential DR in 2014. Subsequently, it was proposed as an area of demand management innovation in the 2016-2020 EDPR. A team was formed across Network Innovation, Customer Engagement, Customer Services and Business Owner to design and deliver the project in a short time period.

### 6.2 Nature and scope

Residential DR is still a new concept in the energy industry, and a consensus around program design has not yet emerged. The original Peak Partners program sought to test four DR product offerings:

- Behavioural response to a Critical Peak Rebate incentive, with AMI data portal (delayed data)
- Behavioural response to a Critical Peak Rebate incentive, with real-time data portal
- Air conditioning load control (marketed as 'Autopilot') via Demand Response Enabling Device
- Supply Capacity Control (marketed as 'Essential Power') via the AMI smart meter

The trial concluded that the behavioural response to a Critical Peak Rebate incentive using AMI data would be the model used in the following GoodGrid programs. Compared to the other methods trialled, this method used existing data from AusNet Services AMI meters, had no requirement for external hardware to be installed and provided similar demand response outcomes when compared to the other methods trialled.

### 6.3 Aims and expectations

The project aimed to develop and test a demand response program for residential customers in real-world conditions.

In most parts of AusNet Services' network, peak demand is driven primarily by residential customers, and in particular, residential summer air-conditioning. By contrast, most of AusNet Services' Demand Management (DM) activities to date have been focussed on Commercial & Industrial (C&I) customers (critical peak tariff and DM network support contracts), grid-scale initiatives (mobile gen sets and permanent generation) and battery storage technology. These DM activities can be used to offset residential demand peaks but do not address the cause of the peaks, hence the interest in developing a residential demand management capability.

The objectives of the GoodGrid program were to test and assess:

1. If a small incentive can encourage households, in targeted areas, to actively participate in reducing their energy usage on days of significantly increased network stress
2. The level of energy awareness amongst participating households



### 3. How responsive communities are to receiving energy education from AusNet Services

This leverages upon the existing objectives of a residential demand management program, which tested and assessed:

1. Proving the concept of residential demand response in a live environment and real-world conditions
2. Progress the development of a residential demand response capability as part of a comprehensive demand management portfolio that can:
  - a. reduce the level of energy at risk on the network and/or defer network augmentation;
  - b. reducing the network costs ultimately borne by customers.
  - c. improving network reliability and quality of supply for our customers
3. Deliver insights around the price sensitivity of customer load to feed into considerations of tariff design

Essentially, the project sought to answer the basic question of whether residential demand management can work as a tool for network management, and in particular:

- Can we get customers interested?
- Do customers respond & participate?
- Does the technology work?

## 6.4 Process of project selection

Both critical peak rebates and air conditioning load control were identified in the 2016-2020 EDPR as priority innovations around residential demand response that AusNet Services intended to pursue across the regulatory period. These techniques were mapped into the AusNet Services demand management program.

## 6.5 Project implementation

The Peak Partners program proposed to test three vastly different DR techniques as part of this project: critical peak rebate offer, air conditioning load control and supply capacity control. The GoodGrid program relied solely on the Critical Peak Rebate offer technique.

### Customer Offers

- **Critical Peak Rebate offer:** Also known as a Peak Demand Rebate, this technique is based on customers making voluntary reductions in demand for a short and defined period of time in response to a financial incentive that is provided directly from the network business to the customer. The technique relies on AMI data to quantify the DM potential, measure DM performance and to determine the financial incentive payments. There are a wide variety of ways to structure the incentive, to communicate with the customer. The technique used in Peak Partners was to split into two 'customer product offers', one that included a real time energy data portal, and one that included an AMI data portal (delayed data). Subsequent GoodGrid programs relied on the latter.
- **Air conditioning load control:** Utilising the in-built capability of modern air-conditioners, it is possible to signal the unit to reduce electrical power consumption while still running the fan and providing cooling to the customer. The signalling can be via different communications channels such as the AMI home area network, the internet or local 3G/4G modem. The interface and performance requirements for this type of load control are captured in AS/NZS 4755 for Demand Response Enabling Devices (DREDs).
- **Supply Capacity Control:** Also known as Supply Capacity Limiting, this is an in-built function of the AMI meters that allows remote enabling of a capacity limit within the meter such that if the customer demand rises above the limit, the customer is de-energised for a short period of time. Enabling this in-built function of the meter requires a significant amount of development

work to upgrade the various levels of software, firmware, communications systems and data management systems that form the overall AMI solution.

### Location

To observe the impact of the program, the project was run in a particular section of our distribution network where continued load growth is evident and where there is risk of a network constraint emerging within the next few years. This was designed to enable a forward path to scale up the initial project and derive real network benefits if the first phase proved successful.

The sites selected for the project encompassed the following suburbs in the urban growth corridors of our electricity distribution network:

South Morang – 3752	Narre Warren – 3805
Mernda – 3754	Berwick – 3806
Doreen – 3754	Cranbourne – 3977
Garfield – 3814	Cranbourne North – 3977
Bunyip – 3815	Clyde – 3978
Longwarry – 3816	Clyde North – 3978
Drouin – 3818	

These regions in our network have been identified as experiencing consistent peak demand growth, in this case driven by greenfield urban housing development.

### Customer Engagement Plan

The aim of the customer engagement plan was to recruit the target number of participants (around 1,000) into a residential DR program within the target network supply zone in the listed postcodes. The team was mindful of initiating relationships that might contribute to the success of future DR programs in the area.

The main obstacle was the generally low baseline of understanding; meaning we had to provide background on AusNet Services, then support the value proposition with information and explanation. High levels of retail electricity and solar marketing activity add to participant confusion in these situations. This same problem was encountered during the Mooroolbark Mini Grid project.

Engagement activity was also constrained to a degree by a short time frame and limited resources.

### Operational Tools

The Peak Partners operational tools were developed in-house primarily, with the support of vendors for each of the specific in-home device types. Subsequently, the GoodGrid operational tool was based upon the AMI metering approach trialled in Peak Partners.

**Baselining tool:** To quantify demand reductions, a customer baseline is calculated and compared to actual consumption on event days for each customer. Baseline calculation uses the customer's AMI data (half-hourly interval data) on similar historical days. This baseline is then adjusted using customer's consumption curve prior to event or via a control group performance. This approach is standard industry practice and leverages consultancy work undertaken for AEMO by DNV KEMA in designing the proposed AEMO Demand Response Mechanism.

**Messaging tool:** For each GoodGrid event, most customers are notified:

- 24 hours before the event
- 15 minutes before the event
- At the end of the event
- Within a week after the event with their reduction and rebate results

To enable this, a SMS messaging platform was utilised.

### **Project Delivery**

A cross-functional team was developed to establish and run the Peak Partners Program. The team consisted of:

- Project Sponsor
- Product / Scheme Owner
- Project Team

Program delivery was tracked through weekly team operational meetings and monthly status reports.

AusNet Services Portfolio Framework for governance on capital investments applied and PM&R stage gates were followed for confirmation of the business case and program delivery.

The “Future of the Networks” forum acted as the Project Steering Committee for this project. This forum comprised the key strategic and operational representatives to oversee the project and provide:

- Oversight of project status
- Guidance and direction
- Review and endorsement for project key deliverables/decisions
- Dissemination of information to other relevant parties
- Facilitate the Transition to Support Process
- Escalation Process for resolution of risks and issues.

## **6.6 Implementation costs**

In 2020, **\$186,436** of the total expenditure related to the 2019/20 GoodGrid program were related to the program setup, development, testing and deployment works:

- Leveraging the existing AMI-based approach from the Peak Partners program
- Conducting a comparison between baseline methodologies to validate the existing methodology from the Peak Partners program
- Developing the baselining tool and end-to-end pipeline to a production-quality standard
- Thorough testing and quality assurance of the baselining tool
- Setting up functionality to send event results to the participants by email (new feature in the GoodGrid program)

## **6.7 Benefits**

It has been proven that customers will respond strongly to price incentives to reduce demand, but questions remain regarding how the approach translates to the higher customer density required to achieve network benefits. Currently the application for network support is challenging due to the early stage of the supply market and the costs involved in establishing a program.

Over time, and with ongoing interest from regulatory bodies, retailers, aggregators, networks and technology providers it is expected that the evolution of business models and technology solutions in the residential DR space will enable it to become a common offering to customers. Business model innovation is likely to help join the value chain across network benefits, wholesale market benefits and retail benefits. Ongoing technology innovation will likely lead to lower cost customer engagement

platforms and lower cost load control solutions. These developments will support the overall economic viability of residential DR.

### **6.8 External communications undertaken**

Communication has been undertaken with retailers, other networks, customer advocates & Government bodies to identify business models and efficiencies. The emerging nature of residential DR means that many industry participants are experimenting and looking to understand where the technique can fit with their business. The program was also communicated via the AusNet Services website.

### **6.9 Next steps**

The Peak Partners trial was concluded in 2019 with the removal of all the trial hardware and the decommissioning of the software platform. The GoodGrid program was run for the 2019/20 summer and is currently operational for the 2020/21 summer. For future GoodGrid programs, there may further refinement of the baselining algorithm (to improve outcomes for participants with solar installed) and to reward incentives.

## 7 Certification of costs

Appendix-1 of this report contains a statement signed by a director of AusNet Services confirming that the costs of the above demand management projects:

- a. are not recoverable under any other jurisdictional incentive scheme,
- b. are not recoverable under any other state or Commonwealth government scheme, and
- c. are not included in the forecast capex or opex approved in the AER's distribution determination for the regulatory control period under which the DMIS applies, or under any other incentive scheme in that determination.

## 8 Developments in previous DMIS projects

The project to manage peak demand at Mallacoota (manage hot water peak) claimed against the DMIA in 2011 was completed in the same year and resulted in the net peak reduction of 0.5MW as reported. There are no further developments from this project to report.

The project to improve solar uptake forecasting claimed against the DMIA in 2013 was completed in the same year and resulted in updates to the forecasting model that continues to be used by AusNet Services. There are no further developments from this project to report.

The Mallacoota Sustainable Energy Study claimed against the DMIA in 2013 and 2014 and was completed in 2014. This study has put AusNet Services on a better footing to capture the benefits that mini-grids offer in improving customer reliability, both for Mallacoota and other locations, through:

- Increased technical and commercial knowledge of options to locally supply remote communities through local embedded generation and islanded mini-grids.
- Increased corporate awareness of the potential reliability benefits of non-network alternatives to remote power supplies.

The project and the feasibility study have served as a point of engagement with several stakeholders including non-network providers. Options to improve supply at Mallacoota are still being investigated and the Feasibility Study is being leveraged in these investigations.

The Residential Battery Storage Trial has come to a formal conclusion after the publication of the public version final report. Eight of the ten storage systems were removed from service in 2015. The two remaining units are still in operation for general observation. The running costs of the two additional units have been absorbed by AusNet Services over 2016. Further DMIA funded expenditure for this project is not currently planned.

## 9 The DMIA criteria

The expenditure recoverable under the DMIA must satisfy the following DMIA criteria:

1. Demand management projects or programs are measures undertaken by a DNSP to meet customer demand by shifting or reducing demand for standard control services through non-network alternatives, or the management of demand in some other way, rather than increasing supply through network augmentation.
2. Demand management projects or programs may be:
  - a. broad-based demand management projects or programs—which aim to reduce demand for standard control services across a DNSP’s network, rather than at a specific point on the network. These may be projects targeted at particular network users, such as residential or commercial customers, and may include energy efficiency programs and/or
  - b. peak demand management projects or programs—which aim to address specific network constraints by reducing demand on the network at the location and time of the constraint.
3. Demand management projects or programs may be innovative, designed to build demand management capability and capacity and explore potentially efficient demand management mechanisms, including but not limited to new or original concepts.
4. Recoverable projects and programs may be tariff or non-tariff based.
5. Costs recovered under the DMIS:
  - a. must not be recoverable under any other jurisdictional incentive scheme
  - b. must not be recoverable under any other Commonwealth or State/Territory Government scheme and
  - c. must not be included in forecast capital or operating expenditure approved in the distribution determination for the regulatory control period under which the DMIS applies, or under any other incentive scheme in that determination.
6. Expenditure under the DMIA can be in the nature of capital or operating expenditure.