AusNet Electricity Services Pty Ltd

Demand Management Innovation Allowance Annual Report 2015

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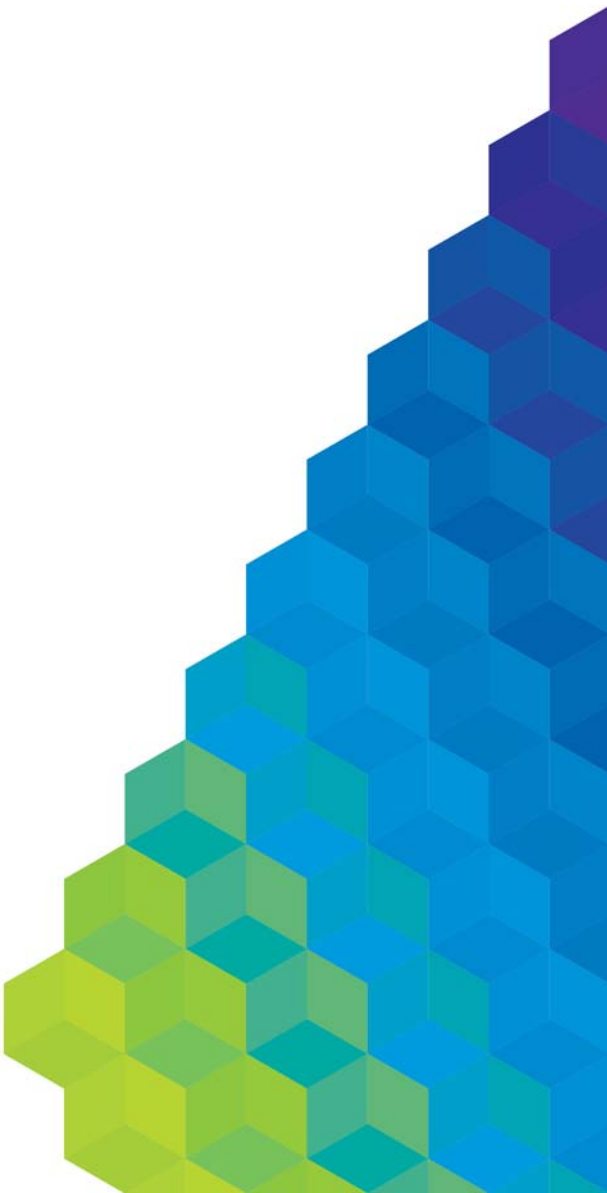

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1 Introduction

This annual report has been prepared pursuant to the Demand Management Incentive Scheme (DMIS) scheme applied to AusNet Services by the AER in the 2011-15 Victorian Electricity Distribution Price Determination (the 2011-15 Price Determination). The Demand Management Incentive Scheme provides revenue designed to encourage innovation in demand side participation.

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.

This report details the DMIA projects undertaken by AusNet Services in the 2015 calendar year which satisfy the DMIA criteria.

DMIA expenditure claims to date (in nominal dollars) are summarised in the following table.

YEAR	2011	2012	2013	2014	2015
STATUS	Approved	Approved	Approved	Claimed	Claimed
Mallacoota hot water time clock adjustment	$10,715				
Residential battery storage trial		$148,760	$51,643	$174,416	$48,652
Grid Energy Storage System (GESS)		$40,000	$246,095	$2,437,495	$485,130
Mallacoota sustainable energy study			$29,100	$22,010	
Solar forecast uptake study			$33,000		
Annual total	**$10,715**	**$188,760**	**$359,838**	**$2,633,921**	**$533,782**

2 Background to the DMIA

In the 2011-15 Price Determination the AER approved a DMIA of $3 million for AusNet Services. The DMIA is provided as an ex-ante allowance in the form of $600,000 (real 2010) of expenditure at the commencement of each year of the 2011-15 regulatory period. While it is provided on an annual basis, AusNet Services has the flexibility to select an expenditure profile over the period which suits its needs. The total amount of expenditure recoverable under the DMIA cannot exceed $3 million (real 2010) in total.

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.

Expenditure under the DMIA can be in the nature of capital or operating expenditure. Capex made under the DMIA has been excluded from the regulated capex reported in the Regulatory Accounts and has not been rolled into the Regulatory Asset Base.

3 DMIA Reporting Requirements

Under Section 3.1.4.1 of the, AusNet Services' DMIA annual report must include:

1. The total amount of the DMIA spent in the previous regulatory year, and how this amount has been calculated.
2. An explanation of each demand management project or program for which approval is sought, demonstrating compliance with the DMIA criteria detailed at section 3.1.3 with reference to:
    a. the nature and scope of each demand management project or program,
    b. the aims and expectations of each demand management project or program,
    c. the process by which each project or program was selected, including the business case for the project and consideration of any alternatives,
    d. how each project or program was/is to be implemented,
    e. the implementation costs of the project or program, and
    f. any identifiable benefits that have arisen from the project or program, including any off peak or peak demand reductions.
3. A statement signed by a director of the DNSP certifying that the costs of the demand management program:
    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 next regulatory control period, or under any other incentive scheme in that determination.
4. An overview of developments in relation to projects or programs completed in previous years of the regulatory control period, and any results to date.

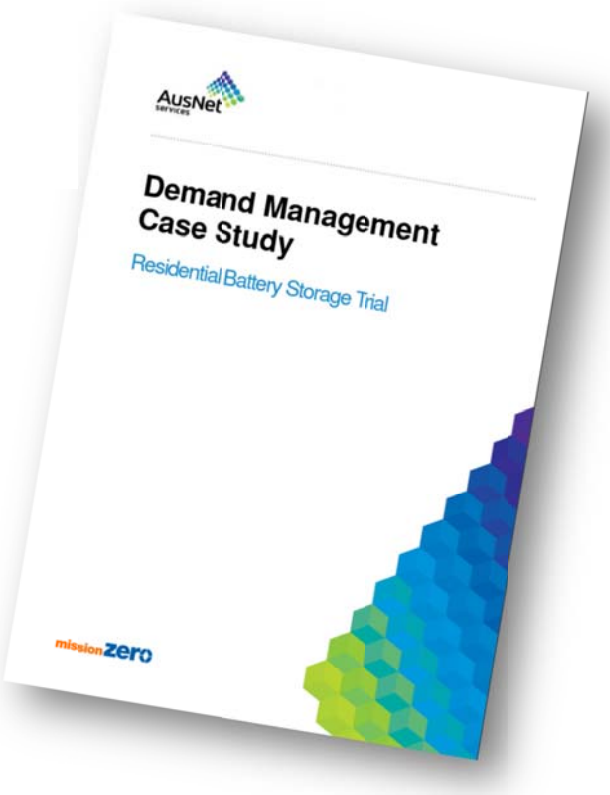
4 Residential Battery Storage Trial

4.1 Project Overview

AusNet Services' Residential Battery Storage Trial investigates the capability of battery and inverter systems connected to consumer homes to reduce residential peak demand. The systems are fully programmable and can be remotely controlled by AusNet Services.

The battery systems are capable of shifting customer demand from peak to off-peak times by discharging whenever the customer's instantaneous demand is high, and by re-charging overnight when the customer's demand is low, or recharging using excess solar generation. The flexibility provided by the programmable inverter makes this type of system capable of both addressing specific network constraints and providing broad-based demand management across the network if rolled-out in sufficiently large numbers.

The initial phase of testing was completed in early 2015, and eight out of the ten units were removed from service. Two units were kept in service to allow additional functionality to be developed and tested. Data analysis and reporting based on the completed trial phase was also undertaken across 2015, culminating in the public release of a case study report on the trial results. This case study is available on the AusNet Services web site.



DMIA expenditure was approved for this project from 2012 to 2014 and AusNet Services is claiming an additional $48,652 under DMIA for this project in 2015. Further DMIA costs are expected to be incurred in 2016 for the implementation of additional functions, broadband data costs and system maintenance for two remaining trialists.

4.2 Nature and scope

This trial delivered an integrated residential storage solution to ten customers, with a combination of batteries, solar PV, inverters, metering and energy management systems. The storage systems have internet connectivity enabling remote changes to system settings, retrieval of data and manual control of system operation. Data from the trial has been collected for a period approaching 3 years.

4.3 Aims and expectations

This trial explores how battery storage at the residential level can be used for management of customer peak demand. The main aims of the trial were to:

- Ascertain whether local storage can be used to flatten the network demand profile;
- Ascertain whether Solar PV / Storage combinations can be used to manage peak customer demand;
- Investigate the behaviour of solar PV systems, their impact on network voltage management and the benefit that residential batteries can bring to this challenge;
- Inform the economic viability view of distributed storage as a means to manage peak demand and defer network asset investment; and
- Inform the potential effect of controlled/uncontrolled charging of electric vehicles.

4.4 Process of project selection

An important issue for the electricity supply industry is the management of network peak demand, given that this is a key driver of augmentation capital expenditure. One method of managing network peak demand is to reduce or smooth individual customers' own demand profiles. Methods to achieve this include offering time of use tariffs, implementing Demand Response Enabled Devices (DREDs) in relevant household appliances and the use of battery storage technology. Battery storage was identified as an emerging technology with a strong but untested potential to generate both network and customer benefits.

Another issue that is predicted to emerge is the impact to the network caused by a growing uptake of electric vehicles. In order to effectively manage the network, utilities need to better understand this technology and the changes to customer demand patterns it may drive.

The Residential Battery Storage Trial has been selected as it has the potential to address both of the above issues. The Residential Battery Storage Trial will assess the ability of residential batteries to effectively shift peak demand to off peak periods and to simulate the impact of electric vehicles on the network by operating the residential battery in a similar manner to an electric vehicle.

4.5 Project implementation

By the end of 2013, the project transitioned from the installation phase to the operational phase. During 2013, nine out of ten systems were installed and undergoing site acceptance testing to validate functionality and data collection.

Figure 4.1 An installed Residential Battery Storage System (batteries in lower compartment of cabinet, inverter/charger and control system in upper compartment), and wall-mounted solar inverter.

In early 2014, all ten systems were installed and operational. Data gathered during the summer of 2013/2014 was analysed and led to the identification of several potential operational improvements to the systems. These improvements have since been implemented and have been trialled during the summer of 2014/2015. The data gathered during this period has been analysed and collated into a report that analyses the technology from technical and economic perspectives. The report titled 'Demand Management Case Study – Residential Battery Storage Trial' has been released to the public and is available on the AusNet Services web site.

4.6 Implementation costs

The approximate total cost of this project to date is $423,471. The expected cost has increased since last year due to completing the development of new operational functions, operating all units over the summer of 2014/2015, collating data and producing a trial report. Following this was the removal costs associated with decommissioning and storing eight of the residential battery storage units. Expenditure in 2015 amounts to $48,652 and only involves opex costs. These costs are made up of:

- Development and implementation of additional operational functions;
- Labour costs for operating all 10 units to a testing regime in order to gather required data for summer 2014/2015;
- Labour costs for producing and publishing internal and external trial reports;
- Contractor services for electrical works to decommission and remove eight systems; and
- Costs associated with downloading 3G data from the trialists.

The eight trialists that were a part of the decommissioning process were offered to purchase the solar PV system based on the estimated residual cost of the equipment. This amount was credited into the overall project expenditure.

4.7 Next Steps

Two trialists will continue on the extended Residential Battery Storage Trial in 2016. An additional function is being developed to cater for potential new residential network tariff structures that include a demand based component. In conjunction with this additional function, an enhanced control platform is also being developed to enable further flexibility in deploying new functions and algorithms.

4.8 Benefits

The expected benefits of the project are to enable AusNet Services to:

1. Assess the potential for deferred network augmentation through managing transformer and feeder peak demand. This can be measured by observing whether a battery is able to supply sufficient charge to limit the household peak demand.
2. Support the transition to smarter networks by studying how energy management solutions such as batteries and EVs can be integrated into the network for demand management. This can be measured by observing the installation of the system at a household level. This benefit will be realised through future planning for storage and EVs in the network.
3. Understand and test the use of domestic storage coupled to local renewable resources to extend the demand management potential of solar PV into the domestic peak demand period and mitigate the voltage rise issues that can occur from high concentrations of solar PV.
4. Investigate how residential storage can be utilised to provide financial benefits to both the end customer and the distribution network.

5 Grid Energy Storage System (GESS) 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 explore other benefits to network management such as power quality improvement and providing supply to an islanded group of customers as a minigrid.

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.

Whilst not yet cost competitive, this innovative technology is being trialled in anticipation of lower battery prices in future. 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 was commissioned by the end of 2014 and a trial was conducted during 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 ‘bumpless’ 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 bill board. These measures have allowed use of the generator in conjunction with the batteries across the 2015-16 summer trial period.

The annual comprehensive maintenance was carried out on all GESS equipment in December 2015 as planned. Many outstanding items including safety related test & bond points were also completed during the shutdown arranged for annual maintenance. A few minor outstanding items remain to be completed.

With the two summer trial periods complete, the project is now moving into the analysis and reporting phase.

DMIA expenditure during 2012, 2013 and 2014 has been approved for this project and AusNet Services is claiming an additional $485,130 of costs as compliant with the DMIA criteria for 2015. Further DMIA costs are expected to be incurred for this project during the analysis and reporting phase in 2016.

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 decline in the medium term offering good potential for an efficient low emission solution for grid support. The system is capable of working in both grid parallel and island mode as required.

Only the battery, inverter, controller and associated costs are claimed under the DMIA.

5.3 Aims and expectations

AusNet Services is exploring grid connected storage as a means of managing network demand 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 2015/16. 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 5.1 The GESS, installed and operational. Battery containers are in the background, with the inverter, transformer and switchgear containers in the foreground.

Figure 5.2 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 (pf) 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.

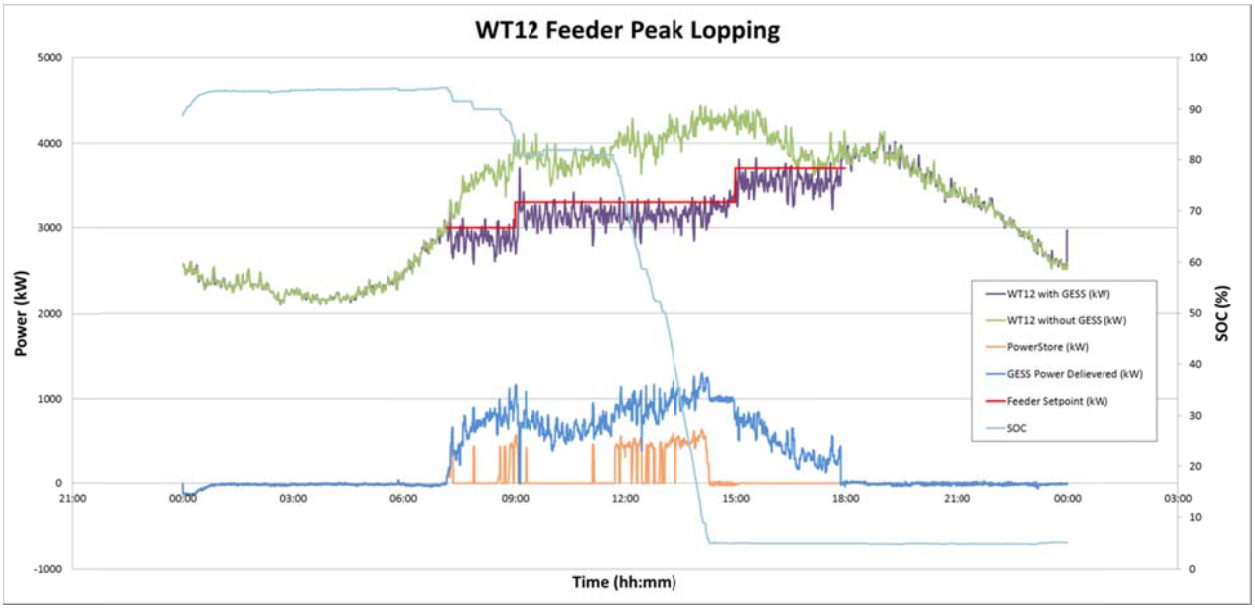


Figure 5.3 Example performance under a feeder peak lopping test on 15/12/2015. GESS output power (blue line) utilises both the battery (orange line) and generator to bring the feeder demand (green line) down to a setpoint (red line).

During 2015, the following key activities were completed:

1. Replacement of the neutral earth switch
2. Addition of feeder peak lopping functionality
3. Installation of test & bond points (safety requirement)
4. Installation of fan attenuator and a barrier (Genset noise related issue)
5. Resolution of several outstanding items
6. Comprehensive annual maintenance
7. Testing as per the trial plan

The supplier will continue to support AusNet Services with an ongoing service and maintenance contract for a 2 year period after final commissioning during the trial period.

5.6 Implementation costs

The total costs for the GESS including the two year trial are estimated to be around $6.6 million, comprising both capex and opex. This is made up of both company initiated expenditure and the expenditure funded by the Demand Management Innovation Allowance.

In 2015 the $485,130 of DMIA costs were mainly opex and related to:

- Resolution of outstanding items for satisfactory performance
- System enhancements required to achieve the aims
- Costs to run the trial tests
- GESS site annual lease
- 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 lot 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 the 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 Next steps

In order to complete the trial of the GESS, the following tasks will be undertaken

- Analysis of performance data from summer trial across 2015/16
- Preparation of final report with cost-benefit analysis for internal distribution
- Generation of public version report for external distribution
- Completion of remaining minor punch-list items
- Identification of any additional functionality required for system reliability and effectiveness.

After the experience of the GESS trial to date, confidence has been gained within the business regarding system operability and reliability. The GESS concept and use of its functions can be redeployed to a constrained or unreliable section of the network in order to maximise benefits to AusNet Services and customers. A separate piece of work will be undertaken around planning and evaluating a future relocation of the GESS.

The GESS project team will continue to collaborate with relevant teams within AusNet Services to further refine the technology with the aim of transferring it to ‘Business As Usual’ and to create standards and procedures to enable easier deployment of energy storage technology on the network in the future.

6 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.

7 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 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 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.