Demand Management Innovation Allowance Mechanism

Annual Compliance Report, 2021-2022

September 2022

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Contents

1 Introduction

This compliance report has been prepared as required for the application of the Demand Management Innovation Allowance Mechanism (DMIAM) by the Australian Energy Regulator (AER) for Ausgrid's 2019-2024 regulatory control period.

Ausgrid is required to submit an annual compliance report on expenditure under the DMIAM for each regulatory year by no later than 4 months after the end of the regulatory year (see section 2.3 of AER Guidelines for DMIAM – Electricity distribution network service providers, December 2017).

This Ausgrid annual DMIAM compliance report for the 2021-2022 regulatory year fulfils this requirement and is considered suitable for publication (with no confidential information included). As specified in Section 2.3 (3) of the DMIAM Guidelines, this annual DMIAM compliance report includes the following required information with section references bolded in brackets:

a) the amount of the allowance spent by the distributor; **[2.2]**
b) a list and description of each eligible project on which the allowance was spent; **[2.1]**
c) a summary of how and why each eligible project complies with the project criteria; **[2.1]**
d) for each eligible project on which the allowance was spent, and in a form that is capable of being published separately for each individual eligible project, a project specific report that identifies and describes **[3 to 10]**:
    i) the nature and scope of each demand management project or program,
    ii) the aims and expectations of each demand management project or program,
    iii) how and why the eligible project complies with the project criteria;
    iv) the distributor's implementation approach for the eligible project;
    v) the distributor's outcome measurement and evaluation approach for the eligible project;
    vi) the costs of the project or program:
        1. incurred by the distributor to date as at the end of that regulatory year;
        2. incurred by the distributor in that regulatory year; and
        3. expected to be incurred by the distributor in total over the duration of the eligible project.
    vii) for **ongoing** eligible projects:
        1. a summary of project activity to date;
        2. an update of any material changes to the project in that regulatory year; and
        3. reporting of collected results (where available).
    viii) for eligible projects **completed** in that regulatory year:
        1. reporting of the quantitative results of the project;
        2. an analysis of the results; and
        3. a description of how the results of the eligible project will inform future demand management projects, including any lessons learnt about what demand management projects or techniques (either generally or in specific circumstances) are unlikely to form technically or economically viable non-network options.
    ix) any other information required to enable an informed reader to understand, evaluate, and potentially reproduce the demand management approach of the eligible project.
e) Where an eligible project has extended across more than one regulatory year of the regulatory control period, details of the actual expenditure on each such project or program in each regulatory year of the regulatory control period to date. **[2.2]**
f) A statement declaration signed by an officer of the distributor delegated by the chief executive officer of the distributor certifying that the costs being claimed by each demand management project: **[2.3]**
    i) are not recoverable under any other jurisdictional incentive scheme,
    ii) are not recoverable under any other state or Australian Government scheme, and
    iii) are not otherwise included in forecast capital expenditure (capex) or operating expenditure (opex) approved in the AER's distribution determination for the regulatory control period under which the mechanism applies, or under any other incentive scheme in that distribution determination.

2 DMIA project and cost summary

This section of the report provides a summary of the Ausgrid projects and project costs over the 2021-2022 regulatory year for which DMIAM expenditure was incurred.

2.1 Project list, description and project criteria summary

The below table provides a list, description and summarises how and why each eligible project complies with the DMIAM project criteria (as required in Section 2.3 (3) (b) and (c) of the AER DMIAM Guidelines):

Project	Description	How and Why Project meets DMIAM Criteria
Ongoing Projects past 30 June 2022		
Hot Water Load Control	This project was developed to understand the current and future capability of dynamic load control as a demand management solution appropriate for the Ausgrid network and to explore how Ausgrid, retailers and customers can collaborate to optimise operation of the load control system for the benefit of all consumers. This understanding will be built through internal analysis, collaboration with customers and industry and load control field trials. Where necessary the trials will include partnerships with third parties including metering providers and energy retailers.	This project aims to research and develop the capability and capacity for using hot water load control as an effective demand management solution. The project is considered innovative in that it will explore the use of the latest control technology and platforms for controlling hot water systems through a diversity of smart meter types, metering providers and retailers and will engage with a wider range of stakeholders including customers, retailers and metering providers to better understand the multiple values provided by hot water load control to customers and the energy industry. With around 90,000 customers with controlled load devices in the smart meter this puts Ausgrid in a unique position to trial a range of different demand management options in collaboration with customers, retailers, and metering providers.
Peak Time Rebate	Ausgrid is seeking to assess the cost-effectiveness of a peak time rebate (PTR) as a demand management solution in localised areas of the Ausgrid network area. The project will explore whether a rebate offer with customers on peak demand days can be used to alleviate location specific short-term network constraints, to defer	This project was designed to research, develop, and implement DM capability and capacity in the form of peak time rebates as a non-network alternative. It is considered innovative in that the proposed PTR trials will utilise technologies, techniques and processes that differ from those previously used in the market. Specifically, the project will

	or reduce the need for longer term network infrastructure upgrades.	leverage the roll out of smart meters and collaboration with electricity retailers.
Electric Vehicle Demand Research	This project will explore the future impacts of electric vehicle (EV) charging on the Ausgrid network and the viability and customer response to various demand management interventions. The project aims to first understand the possible electricity demand impacts from electric vehicle charging on network assets and then conduct or participate in EV trials that investigate the potential demand management options for addressing future network investment needs.	This project aims to build capability and capacity in managing the electricity demand from electric vehicle charging which is forecast to be a significant electrical load in the future. This research project is considered innovative in that it is Ausgrid's first in-depth research study into the emerging electric vehicle market in NSW and on Ausgrid's network. The modelling and research techniques utilised in the first phase of the project in conjunction with project partners also involve innovative modelling and analysis techniques.
Digital Energy Futures	This project is a 3-year research project being led by Monash University and in which Ausgrid is both co-funding and an in-kind contributor in partnership with Energy Consumers Australia and Ausnet Services. The project aims to understand and forecast customers' changing digital lifestyle trends and their impact on future household electricity demand, including at peak times.	This project aims to build demand management capability and capacity in the household customer segment by better understanding households existing and future trends in everyday household energy use practices and how effective demand management solutions can be developed for the household segment. This research program adopts innovative approaches by applying ethnographic research techniques and sociological theories to investigate how changing social practices will impact on electricity sector planning.
Cost Reflective Network Pricing Research	The nature and scope of this project is to quantify the peak demand reduction benefits from the introduction of cost reflective network pricing to residential customers to better understand the effectiveness of these pricing structures as a targeted demand management tool for network investments. The project also aims to understand what complementary measures can be used to increase the effectiveness of these network pricing signals.	This project is targeted at researching and developing demand management capability by better understanding how effective cost reflective network pricing is as a demand management option to reduce long term network costs. The project is considered innovative as it employs analytical and customer surveying techniques not previously implemented to research this topic. In addition, the segment of customers being studied is considered significantly different to other jurisdictions because of the significant length of time that residential customer's in Ausgrid's network area have been exposed to time of use network and retail pricing (10 to 15 years).

Community Battery Feasibility Study & Research	This project aims to investigate the potential for locally based community batteries paired with an innovative business model to offer both a competitive alternative to traditional local network investment and introduce a novel way to markedly improve equitable access to energy storage for customers. The project will involve a feasibility study on the engineering, regulatory and commercial aspects of the community battery concept and to conduct research to explore customer response, awareness, and interest in the concept to inform the development of a potential trial. Over the course of the trial, the project will support ongoing customer engagement activities to maintain engagement and customer experience related activities.	This project aims to build capacity and capability in demand management options specifically focusing on the potential for local community batteries to be used to cost-effectively address network investments driven by maximum or minimum demand network constraints or other drivers such as voltage management or system reliability or security. The project is considered innovative in that this concept is relatively new and has not been trialled by Ausgrid and within the National Electricity Market which makes the regulatory and commercial aspects of the concept challenging.

2.2 Project cost summary

Actual project costs incurred are collected from project codes in Ausgrid's SAP reporting system. The amounts claimed are those booked to each project in the regulatory year. Costs include research and development of projects, implementation costs, project management and other related project costs from Ausgrid staff labour time or procurement of good or services from external parties. All costs are net of any project partner contributions.

Ausgrid incurred costs in the 2021-2022 regulatory year on a total of eight ongoing projects with a total of $766,587 claimable costs under the DMIAM. The below table provides a project cost summary outlining the amount of the allowance spent during all regulatory years in the regulatory control period 2019-2024 (Section 2.3 (3) (a) and (e) of the AER DMIAM Guidelines):

Project	Project status at end of June 2022	Incurred project costs 2019-2020 (excl GST)	Incurred project costs 2020-2021 (excl GST)	Incurred project costs 2021-2022 (excl GST)
Hot Water Load Control	Ongoing	$0	$14,296	$65,752
Peak Time Rebate	Ongoing	$40,786	$193,488	$323,418
Electric Vehicle Demand Research	Ongoing	$202,134	$33,722	$73,345
Digital Energy Futures	Ongoing	$174,565	$105,610	$41,931
Cost Reflective Network Pricing Research	Ongoing	$38,029	$175	$5,216
Community Battery Feasibility Study and Research	Ongoing	$267,578	$58,670	$10,438
Power2U (Demand management for replacement needs)	Complete June 2022	$311,450	$475,029	$4,811
Battery Demand Response (VPP) Trial	Complete June 2022	$290,314	$355,410	$241,676
TOTAL projects		**$1,348,147**	**$1,236,400**	**$766,587**

2.3 Statement on costs

In submitting this compliance report, Ausgrid confirms that the costs being claimed by each demand management project:

i) are not recoverable under any other jurisdictional incentive scheme,
ii) are not recoverable under any other state or Australian Government scheme, and
iii) are not otherwise included in forecast capital expenditure (capex) or operating expenditure (opex) approved in the AER's distribution determination for the regulatory control period under which the mechanism applies, or under any other incentive scheme in that distribution determination.

3 Hot Water Load Control

This project is a new Demand Management Innovation Allowance (DMIA) project introduced in the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

3.1 Project nature and scope

This project was developed to understand the current and future capability of dynamic load control as a DM solution appropriate for the Ausgrid network and to explore how Ausgrid, retailers and customers can collaborate to optimise operation of the load control system for the benefit of all consumers. This understanding will be built through internal analysis, collaboration with customers and industry and load control field trials. Where necessary the trials will include partnerships with third parties including metering providers and energy retailers.

Ausgrid currently has around 440,000 customers with controlled load tariffs which predominantly supply electricity to domestic hot water storage systems, although other loads such as electric vehicles, pool pumps and small business appliances can also be connected to these controlled load tariffs. We estimate that on a typical day the thermal energy storage potential in the hot water tanks connected to Ausgrid's controlled load tariff is in the range of 4 to 7 GWh, which is equivalent to around 400,000 to 700,000 household batteries of 10kWh usable electrical storage capacity.

The technology currently used by Ausgrid to control the on and off electricity supply times to appliances connected to the controlled load tariffs is currently mixed. The majority of load control devices in Ausgrid's network still use the traditional "ripple" control system but Ausgrid also uses separate time switches and load control devices within electricity meters.

Since the introduction of the Power of Choice metering reforms in 2017 there has an increase in the number of customers that have their load control device in the smart meter with around 90,000 customers now having a smart meter-based load control device. As smart meters are owned by independent metering providers, the switching times are not directly controlled by Ausgrid but rather specified in the controlled load tariff conditions in *Ausgrid's ES7 Network Pricing Guide*. Metering providers can remotely alter the control schedules of smart meters in a more dynamic manner, which allows a wider range of demand management solutions for off peak hot water systems.

3.2 Project aims and expectations

The primary objective of this project is to explore the optimal operation of controlled load hot water to identify appropriate dynamic operating terms and schedules and the resultant tariff conditions necessary. The project will also seek to understand the efficacy of using hot water load control to better manage local voltage. Additionally, the project will aim to explore the regulatory mechanisms that may assist in effecting optimal operation.

3.3 How and why project complies with the project criteria

This project aims to research and develop the capability and capacity for using hot water load control as an effective demand management solution. The project is considered innovative in that it will explore the use of the latest control technology and platforms for controlling hot water systems through a diversity of smart meter types, metering providers and retailers and will engage with a wider range of stakeholders including customers, retailers and metering providers to better understand the multiple values provided by hot water load control to customers and the energy industry.

3.4 Implementation approach

The project is planned to take place over two to three years from 2021 to 2022-2023 as follows:

<u>Phase 1 - Scoping study (data analysis, technology, and market assessments)</u>

The first phase of the project allows for the preparations needed to develop a detailed scope for a second phase of the project. At the end of phase 1 the scope for phase 2 will be reviewed and updated as part of a DMIA implementation proposal. Additionality, there is anticipated to be a Network Innovation component of the project which will be scoped with implementation to be funded from the network innovation program separate to the demand management innovation mechanism funding.

The first phase activities may include;

- Analysis of hot water load control and solar customer information to determine suitable trial locations, including penetration of smart meters, retailers and solar penetration and identification of locations with potential emerging network constraints.
- Technology assessment of smart meter control functionality in the market.
- Market assessment of metering provider and retailer commercial models and arrangements
- Customer research to better understand customer perceptions, understanding and responses to appliance load control and controlled load tariffs in general.

Phase 2 – Trials

The exact scope of Phase 2 and 3 trials will be developed during Phase 1 with the intention to run customer trials in collaboration with metering providers and retailers.

Phase 2 will involve running one or more trials in selected areas of Ausgrid's network. The trials will test the ability to move a portion of overnight hot water controlled-load energy into the daytime.

Phase 3

The exact scope of Phase 3 trials will be developed following Phase 2 with the intention to continue working with metering providers and retailers in Ausgrid network areas.

3.5 Outcome measurement and evaluation approach

The project outcome measurement will be assessed by evaluating the extent to which the aims and objectives are met as well as meeting the project delivery milestones as outlined in the implementation approach. Expected outcomes from the project include:

- Understanding the potential for using more dynamic control of appliances through the controlled load tariffs as a demand management solution
- Running a series of trials in collaboration with customers, retailers and metering providers that aim to explore the practical implementation of using dynamic control of appliances through the smart meter.

3.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2021-2022, total project expenditure to date and the total expected project costs by the completion of the project.

Table 1 - Project costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$65,752	$80,048	$315,000

3.7 Project Activity and Results

3.7.1 Summary of project activity to date

The project activity up to June 2021 has mainly consisted of conceptual development as well as commencing on the phase 1 data analysis, technology and market assessment activities as outlined in the implementation approach.

The 2021-2022 project activities consisted of:

- In August 2021 Ausgrid approached a metering provider to initiate a trial of controlled load schedule changes via smart meters.
- Testing schedule agreements were signed between Ausgrid and the metering provider governing the over-ride function of 638 meters to enable the modification of controlled-load

scheduling as part of the trial. The trial was scheduled to take place between October 2021 and April 2022

- Ausgrid applied the controlled-load schedule change. A portion of the daily energy normally consumed by hot water systems during overnight periods only was shifted into the daytime
- At the end of the trial, Ausgrid downloaded the participating customers' interval data and carried out post-trial analysis to verify the load shift impact results.

3.7.2 Update on material changes to the project

No material changes to the project as this is a new project.

3.7.3 Collected results

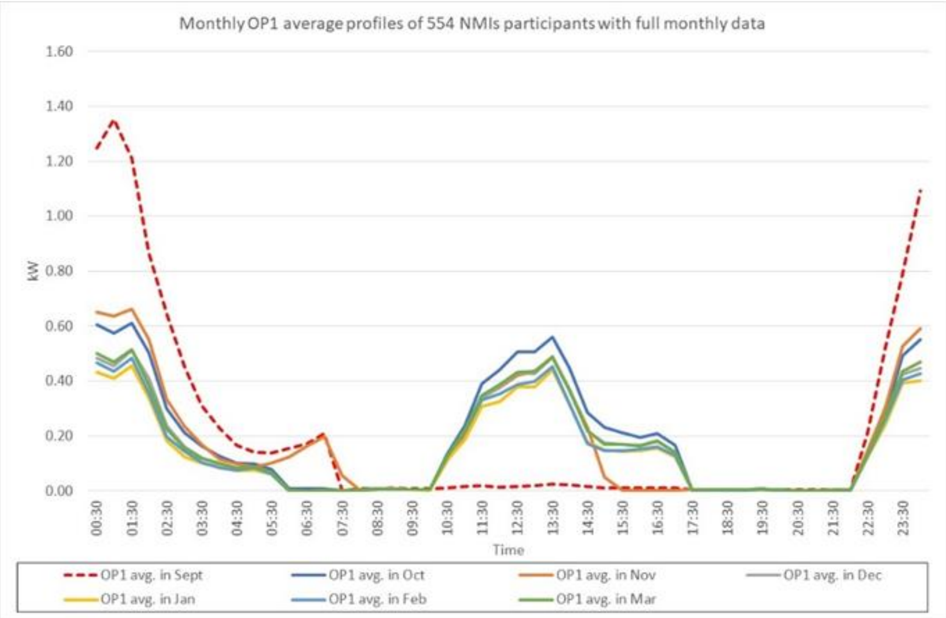
A total of 638 residential customers with smart meters were selected to be part of the trial, of which 233 had solar PV. The 638 residential customers came from different parts of Ausgrid's network, covering Sydney, Central Coast and the Hunter area. Additionally, all selected customers were required to be on either a time of use tariff (EA11 or EA25) or demand tariff (EA116).

Ausgrid engaged a metering provider to remotely modify the turn-on and turn-off of the controlled load circuit for trial customers. The smart meter functionality allowed programmable switching times differentiated by season and day of the week. Within each day under the trial, there were two separate periods when the scheduling was active.

The key parameter being tested during 2021-2022 was effectiveness of including an additional daytime scheduling window to the existing OP1 controlled-load tariff or "solar soak" in shifting overnight energy usage into the daytime. Note that the amount of energy able to be shifted is subject to variability based on each customer's hot water service pattern of use, primarily the hours of the day hot water is being used balanced against the characteristics of their hot water system such as tank capacity, state of degradation and its quality of insulation.

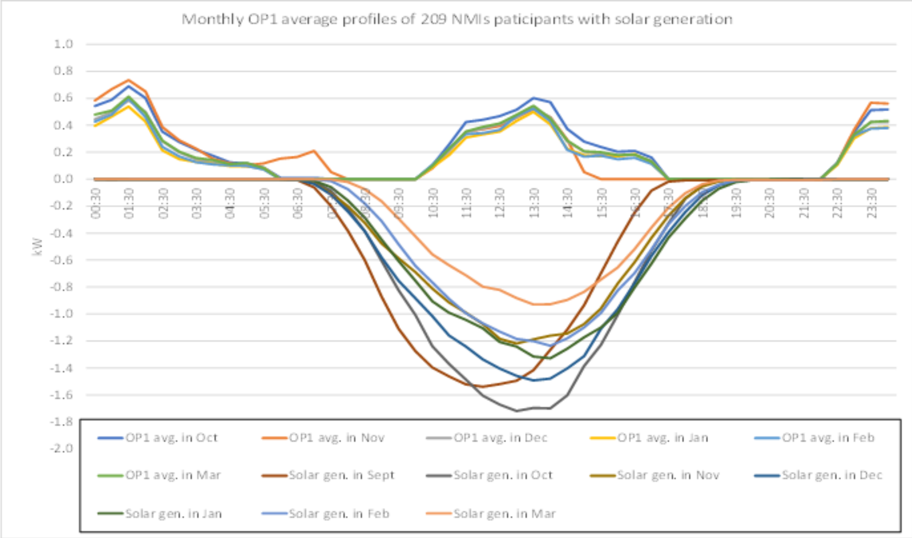
Figure 1 shows the results of the trial during 2021-2022 based on the average daily load profiles at various points in time taken across 554 customers having full monthly data. The red dotted line is pre-trial (Sep 2021) and clearly shows the overnight-only scheduling under the pre-trial OP1 tariff. The other lines show the average daily profiles during the trial from October 2021 to March 2022 indicating reductions in overnight usage and increased daytime usage. The chart shows around 30-50% of overnight OP1 energy was shifted into the daytime successfully.

Figure 1 – Average monthly load profile during trial



We also selected 209 customers with solar PV systems and derived their solar generation export profile for each month in the trial period. About 30-50% of solar energy exports can be off-set by the solar soak. Figure 2 shows the average OP1 daily average profile and daily average net solar export profile (only the amount that is exported to the grid) during each month from October 2021 to March 2022.

Figure 2 – Impact on exports during trial months



The results show the solar soak trial project has been successful as an effective way to shift the overnight energy to daytime. By way of demonstrating the possible financial benefit, we have estimated the market benefit of shifting half of the OP1 energy from overnight into the daytime, as above, at around $23 per OP1 customer per year based on an average wholesale market energy price of $58/MWh in October 2021[1]. It should be noted that due to the variable nature of wholesale energy prices, this benefits value is likely to fluctuate based on market conditions.

Customer experience

The rate of hot water related complaints from customers during the trial was only 0.3% (2 out of 638), which is low in comparison with the 1.1% call-out rate for hot water related complaints across the Ausgrid network. This meant that during the trial, the OP1 schedule changes had little to no noticeable impact on customers' hot water service.

The trial results demonstrate and confirm the success of the project. The next step is to expand the trials to additional Ausgrid network areas and include additional retailers and metering providers. We intend to survey customers to explore understanding and preferences around controlled load tariffs.

3.8 Other information

If you have a specific information request regarding this project which may assist you in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

General information can be accessed from Ausgrid's Demand Management web page from the Innovation Research and Trials link: www.ausgrid.com.au/dm

[1] This analysis was carried out in Nov 2021 based on early trial results obtained between Sep-Oct 2021 and assumes the same $58/MWh price as being constant throughout the entire year

4 Peak Time Rebate

This eligible project is a continuation Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

4.1 Project nature and scope

Ausgrid is seeking to assess the effectiveness of a peak time rebate (PTR) offer in localised areas of the Ausgrid network area on peak demand days. The program involves inviting customers to reduce their energy usage during PTR event times. The project aims to test whether this option can be used to alleviate location specific short-term network constraints, to defer or reduce the need for longer term network infrastructure upgrades. The project involves partnerships with energy retailers and other proponents and will be split into two phases as detailed in section 4.4 below

4.2 Project aims and expectations

The primary purpose of this project is to determine the viability of PTR as a demand management solution through building retail partnerships and conducting customer trials. As such the objectives are to gain an understanding of the:

- Scale and density of peak demand reduction offered by PTR under various modelled scenarios for constrained network assets;
- Various customer acquisition strategies and the resulting measure of localised PTR customer take-up;
- Effectiveness of various customer incentives;
- Customer experience;
- Reliability and availability of retailer PTR platforms; and
- DNSP costs associated with PTR events and payments to PTR providers.

4.3 How and why project complies with the project criteria

This project was designed to research, develop, and implement DM capability and capacity in the form of peak time rebates as a non-network alternative. It is considered innovative in that the proposed PTR trials will utilise technologies, techniques and processes that differ from those previously used in the market.

Collaboration with retailers across targeted geographic areas as nominated by Ausgrid is an expansion and modification on past retailer trials and will explore PTR customer density and peak event duration and provide insight into network support impacts.

If viable, the approach being trialed in this project has the potential to offer a cost-efficient alternative to network infrastructure upgrades in residential parts of the network. Collaboration on PTR trials is not eligible for recovery under the classifications specified under any other jurisdictional incentive scheme, state/Australian government scheme or included in forecast capital or opex approved in Ausgrid's distribution determination.

4.4 Implementation approach

The PTR project will take place across 2 phases, with the first phase having commenced in 2020-2021.

The first phase of this project includes the implementation of collaborative PTR trials with retailers. The initial PTR events have taken place in 2020-2021 and have confirmed the functionality of the basic retailer PTR process, provided insight into the Retailer customer recruitment strategy and customer demand response and satisfaction.

As in any collaborative venture, information sharing is a key enabler for the success of the trial. Consequently, Ausgrid is collaborating closely with our partners to better understand customer views and preferences.

Phase 1 of the trial has included suburbs in the Lower Hunter, Newcastle West, and Northwest Sydney areas of Ausgrid's service area. These areas have been selected as they are representative of the residential areas where local, residential network needs are forecast to occur in the near to mid-term.

Phase 2 of the DMIA project will focus on exploring how we can increase the density of customer adoption for this solution in the trial areas to better understand the viability of this solution for network support purposes. Phase 1 partnerships may be continued and/or expanded or alternatively partnerships with other proponents may be established. The later stages of the trial may explore options such as the recruitment of small business customers, modified offer structures, proactive smart meter changeover to increase PTR take-up, modified target geographic areas, adoption of appliance automation and other viable options identified in stage 1.

Further details for phase 2 will be determined as the trial progresses.

4.5 Outcome measurement and evaluation approach

The project outcome measurement will be assessed by evaluating the extent to which the aims and objectives are met as well as meeting the project delivery milestones as outlined in the implementation approach.

Measurement and analysis of program results will be completed collaboratively with our retailer partners and are expected to include quantitative and qualitative measures such as:

- Assessment of energy and demand reductions from participating customers;
- Identification of customer experiences and preferences;
- Assessment of dispatch platform suitability and reliability;
- Assessment of tested customer incentive and acquisition strategies; and
- Identification of demand reduction density and potential effectiveness for deferral of typical network constraints.

4.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2021-2022, total project expenditure to date and the total expected project costs by the completion of the project.

Table 2 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$323,418	$576,779	$1,100,000

4.7 Project Activity and Results

In 2020-2021, Ausgrid agreed to partner with AGL and EnergyAustralia to conduct PTR trials. AGL and EnergyAustralia have been developing their PTR capability as part of an ARENA funded demand response program[2]. AGL and EnergyAustralia are two of the largest retailers in Australia and serve a significant share of Ausgrid's customers. By incorporating AGL Peak Energy Rewards[3] and EnergyAustralia's PowerResponse[4] programs in a single DMIA trial, Ausgrid can expand the project learnings and maximise PTR penetration in nominated locations.

Scheduling a PTR event with the retail partners generally involves providing them with a date, time, and target locations one day before or on the day of the event. The retailers then invite their enrolled customers to participate in the PTR event.

[2] https://arena.gov.au/renewable-energy/demand-response/

[3] https://www.agl.com.au/newcampaigns/peakenergyrewards

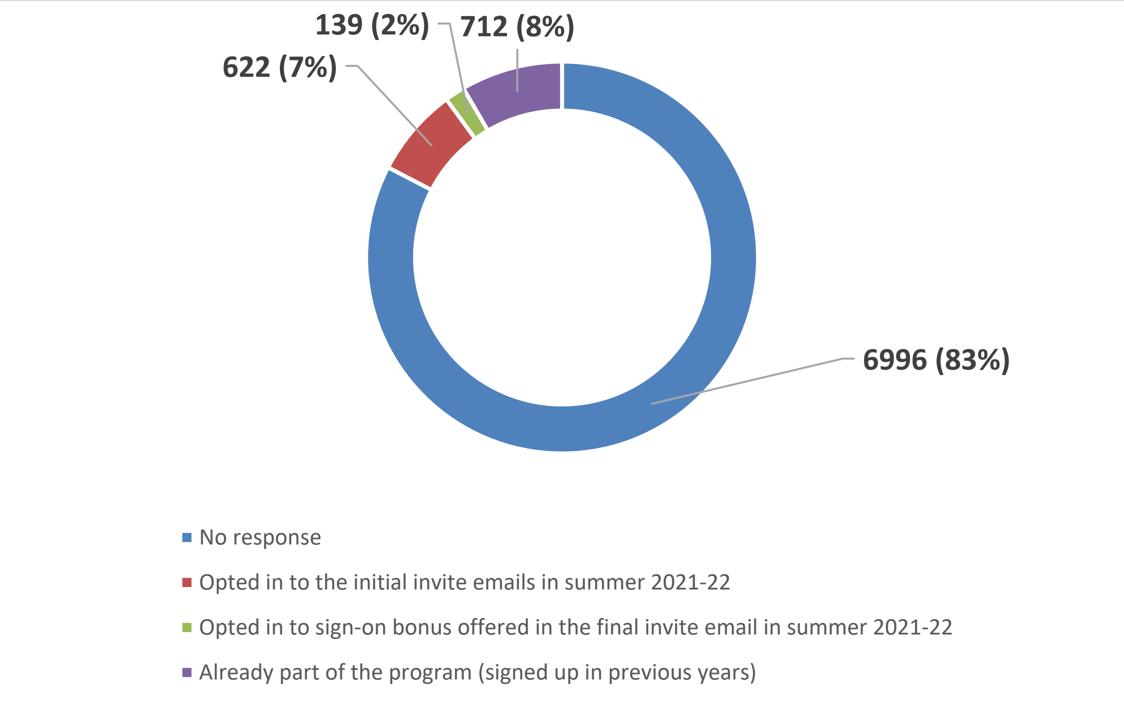
[4] https://www.energyaustralia.com.au/home/electricity-and-gas/power-response

Trial results and activities for 2021-2022 are outlined below:

Customer recruitment

At the request of Ausgrid, AGL ran a recruitment campaign during the summer of 2021-2022 to increase customer enrollment in the program. Emails were sent to eligible AGL customers in the trial suburbs to invite them to join the PTR program. A small monetary bonus was offered to join the program in the final round of email recruitment. The opt-in rate of the recruitment campaign was higher than other recruitment campaigns for demand management trials, which could be explained by a number of reasons including incentives on offer, simplicity of the concept and being able to participate without installing any additional equipment (refer to Figure 3 below for more information).

Figure 3 - Results of AGL's recruitment campaign



A recruitment campaign was not necessary for EnergyAustralia's PTR program as most of the eligible customers were already part of the program. This is because EnergyAustralia applies an opt-out method of recruitment, which automatically include eligible customers in the program and inform them to opt-out if they wish to be excluded. While the opt-out method of recruitment results in a higher number of customers in the program, the PTR event results demonstrate that they are not all active participants (see Table 7).

A smart meter is needed to participate in the PTR program, which is a relatively small requirement for participation compared to other demand management programs. Considering the number of customers with smart meters and the potential for further increases in smart meter installation, there are opportunities to involve a significant portion of customers in the PTR program. It is important for Ausgrid and its partners to continue to explore ways to recruit customers in the program.

Customer participation

Table 3 shows customer participation in the PTR program and the potential increase in participation especially if there is an increase in smart meter penetration. In 2021-2022 Ausgrid expanded the trial to include additional suburbs in the Newcastle and Hunter regions, which are representative of residential areas where near to mid-term forecast indicate potential local network investment.

Table 3 - Customer enrolled in the PTR program by project suburb

Suburbs	Total Customers	Total smart meter customers	Enrolled in PTR program	Percentage of total customers participating in PTR
Aberglasslyn	2390	1188	214	9%
Arcadia Vale	638	169	24	4%
Balmoral	282	78	21	7%
Beecroft	3431	1135	202	6%
Bellbird	974	421	90	9%
Bellbird Heights	335	109	11	3%
Berry Park	71	17	3	4%
Bolwarra	557	262	50	9%
Bolwarra Heights	1180	548	101	9%
Boolaroo	996	397	49	5%
Booragul	623	162	22	4%
Breakfast Point	2587	494	43	2%
Buttaba	470	142	25	5%
Cabarita	876	203	28	3%
Cameron Park	3459	1839	324	9%
Castle Hill	1280	512	523	41%
Cessnock	7165	2189	357	5%
Cherrybrook	6288	2440	383	6%
Chisholm	1636	1184	198	12%
Cliftleigh	942	686	140	15%
Coal Point	813	207	47	6%
Edgeworth	3001	847	133	4%
Fishing Point	493	147	23	5%
Fletcher	2654	1511	304	11%
Gillieston Heights	1854	838	135	7%
Hamlyn Terrace	3236	1822	310	10%
Lakelands	538	189	34	6%
Largs	752	291	50	7%
Lorn	678	244	37	5%
Louth Park	340	215	35	10%
Maitland	1819	397	35	2%
Maitland Vale	124	82	18	15%
Millers Forest	155	46	6	4%
Mortlake	690	171	20	3%
Oakhampton	77	14	6	8%
Oakhampton Heights	47	17	3	6%
Pelton	35	11	1	3%

Rathmines	1005	262	44	4%
Rutherford	5705	2097	300	5%
Telarah	1172	332	60	5%
Thornton	4533	1984	324	7%
Wadalba	1559	703	122	8%
Wangi Wangi	1487	326	55	4%
Woongarrah	2035	1095	174	9%

Baselines

PTR performance is determined by comparing a customer's actual energy consumption with a prediction of what would have been used (baseline) if the PTR event had not occurred. There are many different baseline methodologies in use in Australia and overseas. EnergyAustralia has adopted the CAISO10[5] methodology developed by the California Independent System Operator for their demand response programs. AGL implements their own process based on historical weather data and loads. The PTR results presented in Table 5, Table 7 and Table 8 below were calculated using each respective retailer's baseline methodology.

Ausgrid's baseline method consist of aggregating demand from participating customers and comparing the profile to another similar climate day at an aggregate level. For example, the analysis of the event on 01/06/2022 uses 02/06/2022 (a similar weather day) as the baseline to estimate the demand reduction from the PTR event (see Figure 6 and Figure 8).

Implementing an appropriate baseline for residential customers, particularly at an individual customer level, can be challenging due to highly variable factors such as weather, customer behaviour and solar output. It is important for the industry to continue to develop a robust baseline methodology which is effective for residential customers

Event selection

Dispatch events were selected to coincide with days when electricity demand was expected to be high for the local network. As the maximum annual demand for Ausgrid's local network can occur in summer or winter, both summer and winter event days were selected.

Table 4 – Event days and corresponding temperature for 2022

Date	Time	Retailer partner	Cessnock Max Temperature (°C)	Cessnock Min Temperature (°C)
28/01	16:30 - 19:30	EnergyAustralia	31.3	17.4
01/02	16:30 - 19:30	EnergyAustralia	34	17.9
09/02	16:00 - 19:00	EnergyAustralia	31.7	11.8
10/02	16:30 - 19:30	EnergyAustralia	34.3	13.4
01/06	16:30 – 19:30	EnergyAustralia	14.7	7.9
28/01	16:30 - 19:30	AGL	31.3	17.4
01/02	16:30 - 18:30	AGL	34	17.9
09/02	16:00 - 18:30	AGL	31.7	11.8
10/02	16:30 - 18:30	AGL	34.3	13.4
17/02	16:30 – 18:30	AGL	34.9	13.5
01/06	17:00 - 19:00	AGL	14.7	7.9
19/07	17:00 - 20:00	AGL	14.4	2.8

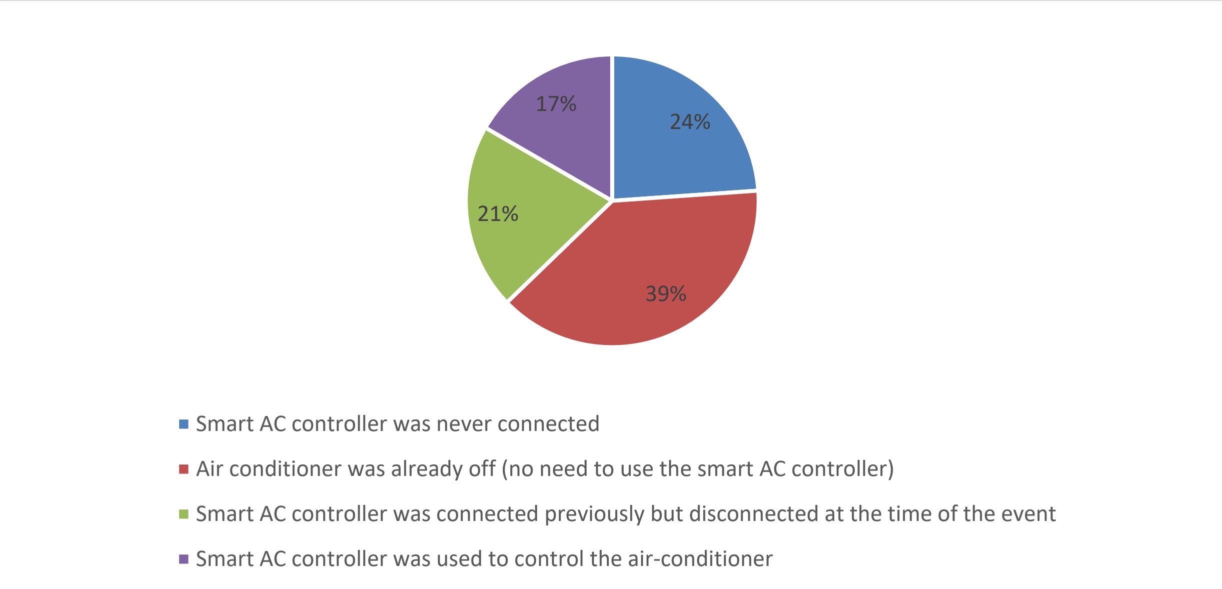
[5] https://www.energyaustralia.com.au/sites/default/files/2020-11/201120_PR_Baseline_Calculation_Doc.pdf

Automatic Demand Response

During the summer of 2021-2022, customers that were enrolled in AGL demand response program were offered a smart AC controller (Sensibo Sky) that enabled the customer's air-conditioner to be controlled by AGL during demand response events. Customers were required to set up and connect the smart AC controller using their WiFi. Once setup and connected, AGL used the smart AC controller to switch off the participant's air-conditioner during a PTR event. The customers were able to override the smart AC controller at anytime and switch the air conditioner back on.

On average approximately 6% (around 35 customers) of the total participants in each PTR event had a smart AC controller. Figure 4 shows that on average there was an opportunity to use the smart AC controller for 17% (approximately 6 customers) of the customers with smart AC controller for each event. For the rest of the customers with smart AC controller, the air-conditioner was already switched off or the smart AC controller was not connected and set up for control. For 45% of the customers with smart AC controller, the device was either never connected or previously connected but disconnected at the time of the event. These figures suggest that greater engagement with customers may be required to set up the smart AC controller. AGL has decided to discontinue this program and further investigation is required to understand customer's response to automatic demand response.

Figure 4 – Results for customers with smart AC controller during the summer 2021-2022 events[6]



Customer response for PTR events with AGL

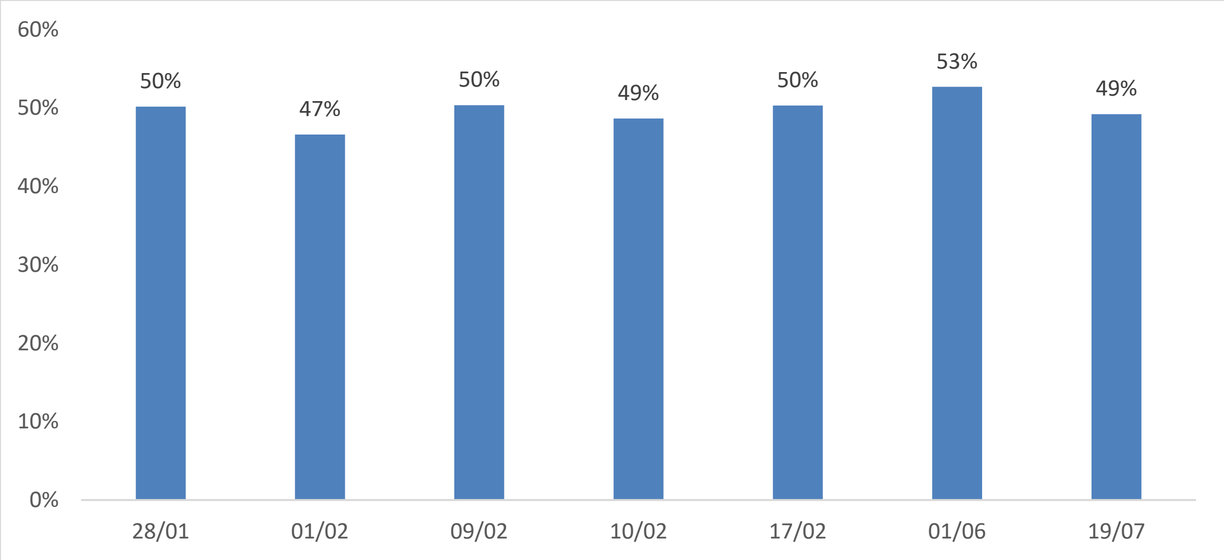
PTR event notification process for AGL was as follows:

1. An invite SMS on the day of the event
2. Event start SMS at the beginning of the event
3. Event end SMS at the conclusion of the event

AGL customers were asked to respond with an opt-in message to participate in the demand response event. The participants were rewarded based on achieving targets of 10% and 30% reduction from the baseline. Figure 5**Error! Reference source not found.** below shows that the participation rates for the customers were relatively consistent across the events in 2022.

[6] Based on status at the start of the event

Figure 5 - Percentage of AGL customers that participated (opt-in) in the PTR events with AGL in 2022



The results for 2022 demand response events are presented in Table 5. Similar to the previous year, on average a larger reduction is observed for the summer events compared to the winter events. While the average reduction for each participant is lower than previous year, due to the significant increase in participants the total reduction is significantly higher, which demonstrates the importance of participation rate.

Table 5 - PTR event results for AGL

Dates	Time	Total number of enrolled customers invited to participate	Participants	Average reduction for participants (kWh/customer)
28/01	16:30 - 19:30	1043	523	3.49
01/02	16:30 - 19:30	1307	609	0.74
09/02	16:30 - 18:30	1323	666	2.63
10/02	16:30 - 18:30	1324	644	2.28
17/02	16:30 -18:30	1336	672	1.33
01/06	17:00 - 19:00	1399	737	1.11
19/07	17:00 - 20:00	1297	638	1.86
Average		1289	641	1.9

Table 6 - Comparison between 2022 and 2021 results for AGL

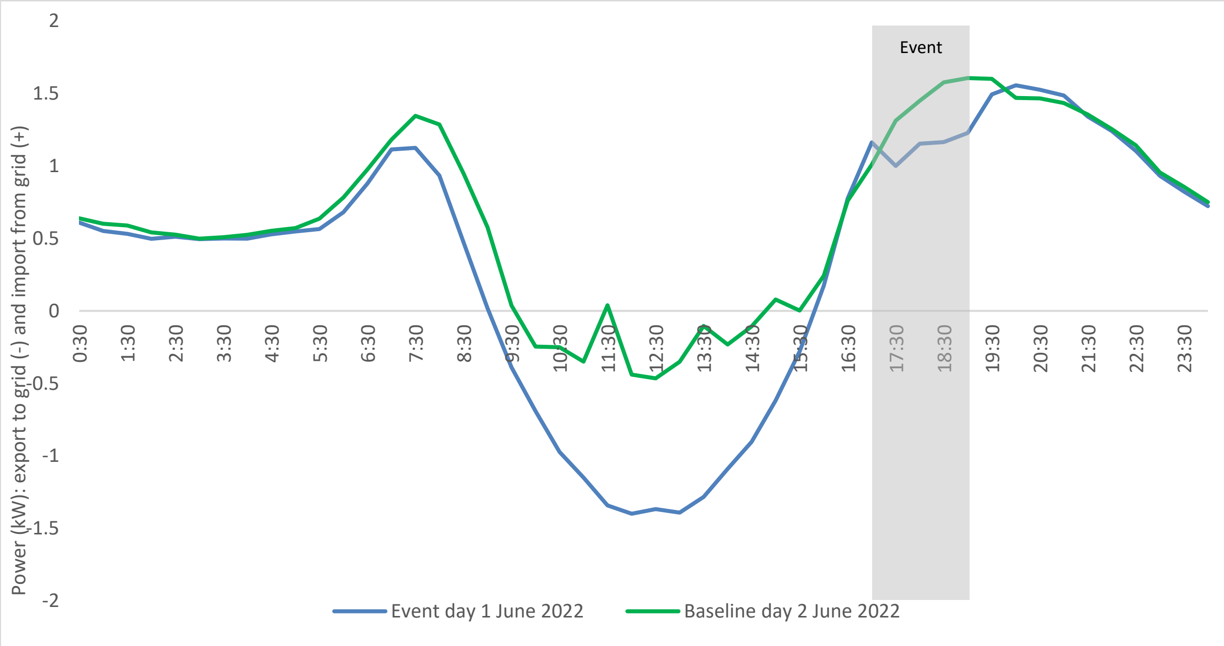
Year	Participation rate (customers/event)	Average reduction (kWh/customer)	Total reduction (kWh/event)
2021	204	2.4	490
2022	1289	1.9	2450

As mentioned earlier, we used a day-matching approach for the baseline comparison, which involves aggregating energy profile of all participating AGL customers and comparing it to the matching day selected on the basis of similar climate conditions. As the bulk of household energy use is associated with heating and cooling, it is the weather conditions that are the primary driver of changing energy use in the home. This approach assumes that unique variations average out when assessed in a large enough population. An event day on 01/06/2022 has been compared with a baseline day of 02/06/2022. A maximum temperature of 14.7°C was recorded at Cessnock Airport on event day on 01/06/2022, while a maximum temperature of 14.9°C was recorded for the baseline day on 02/06/2022.

Figure 6 below shows that for the AGL customers, the comparison of the demand profile for the event and the day-matching baseline indicates a good alignment of evening hours outside of the event period of 5pm to 7pm. At the event start time of 5pm, there is a clear variation from the baseline trend which is then maintained throughout the event. This comparison indicates that the PTR event resulted in an average demand reduction of about 0.4 kW across the event time period for all participating customers.

Note that the estimated average demand reduction of 0.4kW when using the day-matching methodology is slightly lower than the average reduction of 0.55 kW per hour as recorded by the Retailer using their baseline methodology.

Figure 6 - Demand profile for AGL participants (opt-in) in the PTR event on 01/06/2022



Customer response for PTR events with EnergyAustralia

PTR event notification process for EnergyAustralia was as follows:

1. Pre-event SMS sent on the day of the event, prior to the event. The aim is to send this message at least 2 hours before the event.
2. Event start SMS a few minutes before the event.
3. Event end SMS at the conclusion of the event.

The customers were asked to respond with an opt-out message to exclude themselves from the event. The customers were rewarded based on their energy reduction ($/kWh). As shown in Figure 7 below, the response rate for the customers were relatively consistent across all events.

Figure 7: Percentage of EnergyAustralia customers that participated (didn't opt-out) in PTR events with EnergyAustralia in 2022

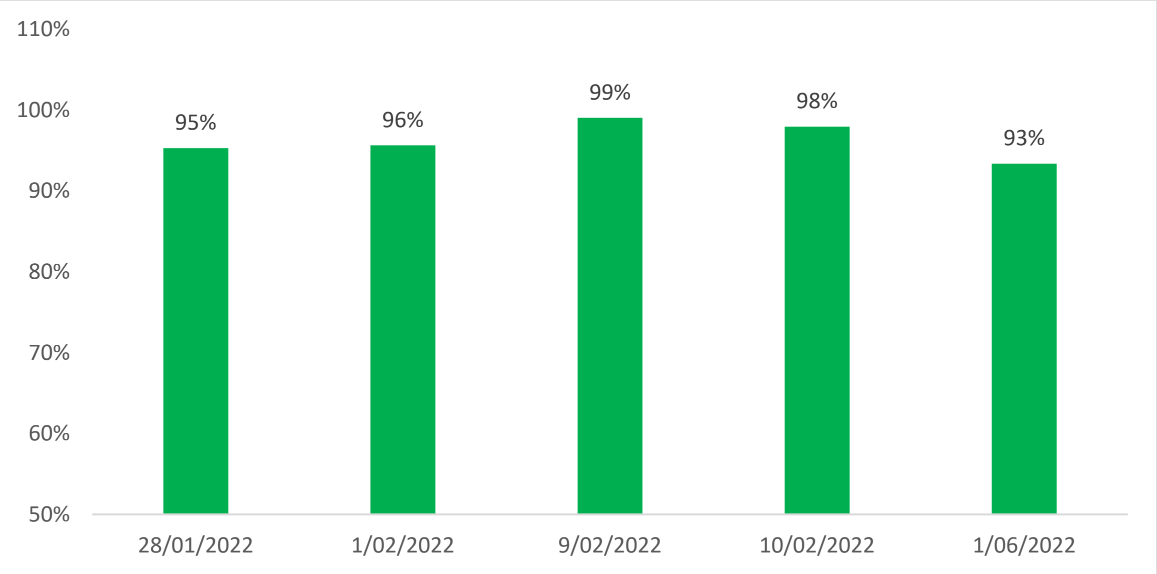


Table 7 - PTR event results for EnergyAustralia

Event Date	Time	Number of enrolled customers invited to participate	Participants (didn't opt out)	Reduction (kW)[7]
28/01/2022	16:30 - 19:30	3078	2933	0.48
1/02/2022	16:30 - 19:30	3068	2934	-0.30
9/02/2022	16:00 - 19:00	2906	2878	-0.18
10/02/2022	16:30 - 19:30	2877	2818	-1.70
1/06/2022	16:30 - 19:30	2087	1949	-0.76
Average		2803	2702	-0.49

Table 7 shows that there were a significant number of non-performing participants. EnergyAustralia's method of recruitment, where customers were automatically included as participants unless they opt-out, results in a mixture of active and inactive customers. The results in Table 7 provide very little information

[7] A positive number represents energy usage reduction while a negative number represents increase in energy usage

about which customers actually responded and therefore the response from active participants. To address this, we have attempted to isolate active customers by defining active customers as those who reduce their consumption by at least 5% based on EnegyAustralia's baseline.

On average 45% of the customers invited for each event were found to have reduced their energy usage by at least 5% (refer to Table 8). This analysis shows that a considerable number of customers were actively participating and achieving significant demand reduction.

Table 8 - PTR event results for EnergyAustralia customers that achieved a minimum of 5% reduction

Event Date	Time	Number of enrolled customers invited to participate	Number of customers with at least 5% reduction in usage	Average reduction for customers with minimum 5% reduction (kWh/customer)
28/01/2022	16:30 - 19:30	3078	1683	2.82
1/02/2022	16:30 - 19:30	3068	1307	3.26
9/02/2022	16:00 - 19:00	2906	1582	2.11
10/02/2022	16:30 - 19:30	2877	1020	1.94
1/06/2022	16:30 - 19:30	2087	801	1.93
Average		2803	1279	2.41

Figure 8 below shows the average demand profile for all EnergyAustralia PTR participants who did not opt out for event day 1/06/2022. Similar to the analysis with AGL, we used a day-matching approach for the baseline comparison, which involves comparing event day with another day with similar climate conditions at an aggregate level. Similar to Table 7, due to blending of active and non-active participants in the group, the lack of a noticeable response indicates that a significant proportion of customers did not actually respond and further, their contribution becomes diluted amongst the population.

Figure 8 - Demand profile for EnergyAustralia customers for event day 1/06/2022

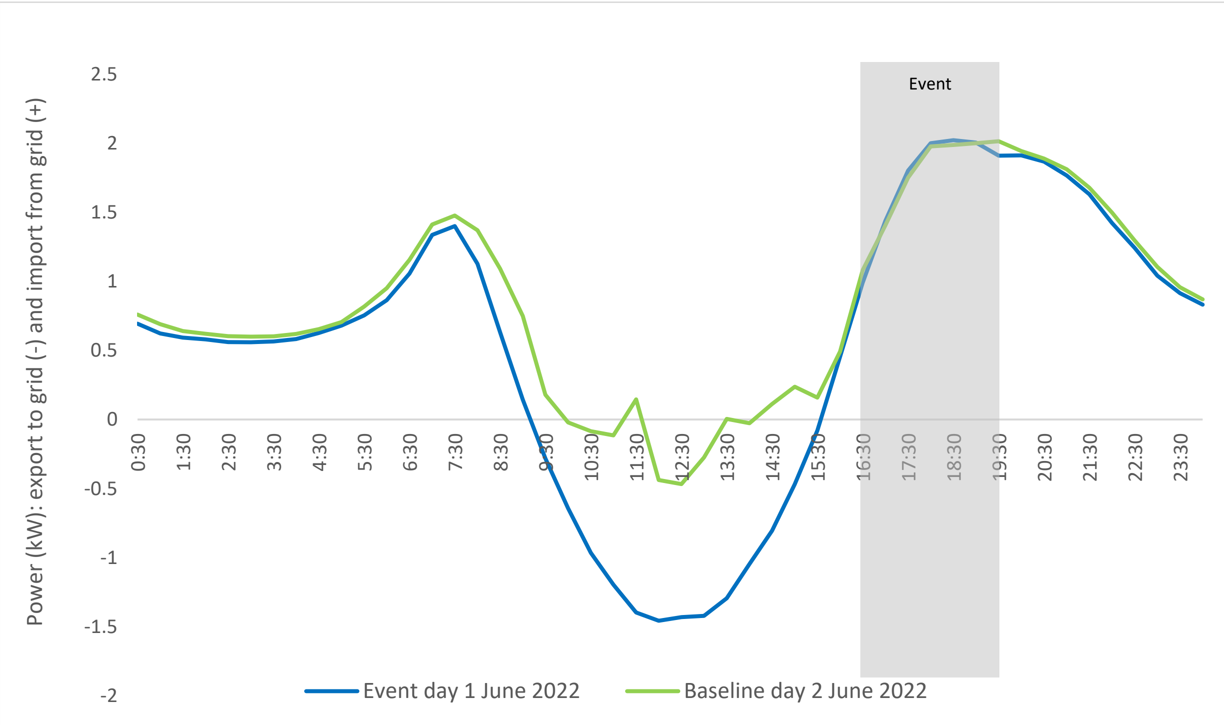
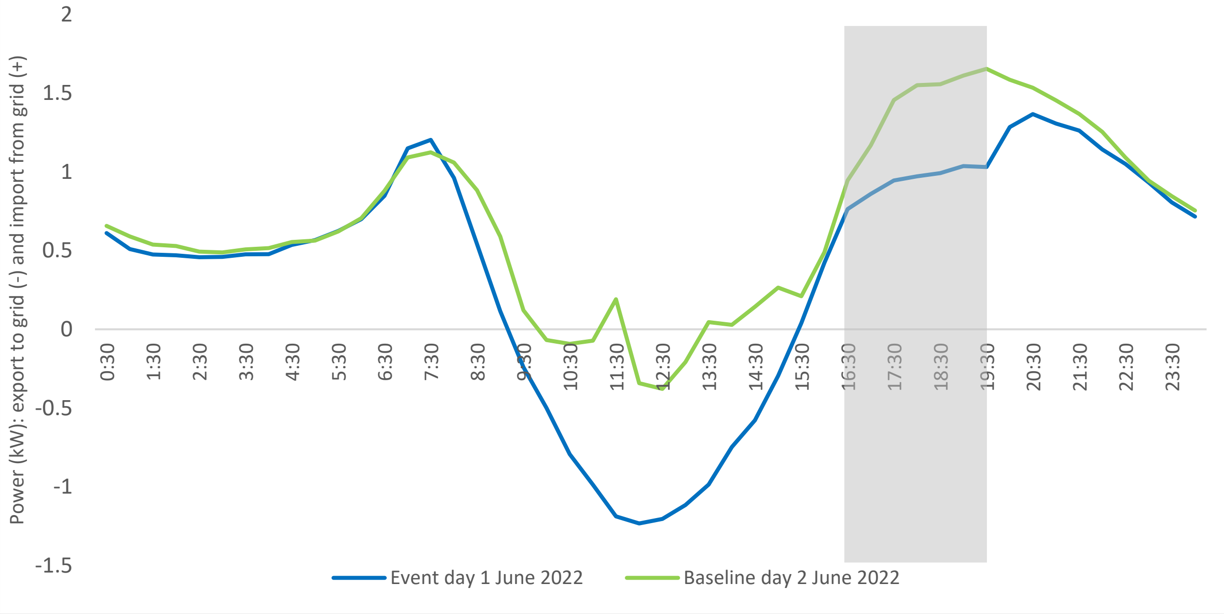


Figure 9 below highlights a noticeable variation in power consumption at the start of the event period for customers who achieved a minimum demand reduction of 5%. Average demand reduction during the event in comparison to the baseline day was approximately 0.5kW, which is slightly lower than 0.65kW per hour reduction recorded using Retailer's baseline methodology.

Figure 9 - Demand profile for EnergyAustralia customers who achieved 5% reduction for event 01/06/2022



Partnership with Retailers

Ausgrid's past experiences with demand response programs have demonstrated that setting up an in-house bespoke demand response program can be costly and customer recruitment can be challenging. Partnering with Retailers have brought many benefits including:

- Sharing of cost components such as IT, administration and customer payments,
- Leveraging participants that are already recruited and managed directly by the Retailers,
- Access to Retailers' experience and capabilities, and
- Utilises the technologies of the future, namely, smart meters and apps

While there are numerous advantages to accessing demand response programs already developed by market participants, there can be restrictions in certain areas. For example, our retail partners have currently restricted the scheduling of demand response events to only business days due to factors such as staff availability and complexity in baselining. As peak demand periods for residential customers can occur on weekends and public holidays, it would be ideal to be able to schedule PTR events on any day of the week. Another restriction relates to technology upgrades whereby on a couple of occasions demand response events did not go ahead due to our Retail partner performing IT system upgrades.

The development of cost-effective and mature demand response products that leverages multiple benefits for market participants will be important for the industry as it transitions to a net-zero future. Ausgrid will continue to work with our Retail partners to explore ways to make the demand response program a viable alternative to network upgrades.

Summary

Key findings from the 2021-2022 results:

- Email recruitment campaign without sign-up bonus resulted in opt-in rate of 7%. Sign-up bonus resulted in additional 2% of customers opting into the PTR program.

- For 45% of the customers with smart AC controller, the device was either never connected or previously connected but disconnected at the time of the event, which suggest greater engagement with customer is required to set up the device.
- There were limited opportunities to use the smart AC controller as in most cases the air-conditioner was already switched off or the device was not connected.
- Approximately 40% of the customers in target trial suburbs have a smart meter. There is an opportunity to significantly increase participation rate with further rollout of smart meters and effective recruitment campaigns.
- While opt-out method of customer recruitment resulted in higher apparent participation rates, there were a significant number of non-performing customers within the group.
- Average demand reduction for active participants ranged from 1.9-2.4 kWh for each event based on Retailer's baseline.
- While the average reduction per participant is lower in 2022 compared to 2021, the average total reduction for each event is higher due to a significant increase in participants, which highlight the importance of increasing participants in the PTR program.
- While an in-house bespoke program may offer greater customisation and control, partnering with Retailers has offered many benefits including access to a large number of already enrolled customers, sharing of costs, and access to Retailer's experience and capabilities.

4.8 Other Information

General information can be accessed from Ausgrid's Demand Management web page from the Innovation Research and Trials link: www.ausgrid.com.au/dm

If you have a specific information request regarding this project to assist in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

5 Electric Vehicle Demand Research

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

5.1 Project nature and scope

The forecast uptake of electric vehicles in Australia is still highly uncertain and the most recent scenario forecasts from the Australian Electricity Market Operator (AEMO) were released in the 2022 ISP Inputs and assumptions workbook. The AEMO estimates that in the NEM (all states except WA and NT) there will be a potential increase from around 26,000 EVs in June 2022 to around 2.2 million by June 2031 in the *Steady Progress* and *Progressive Change* scenarios and as high as 3.1 million electric vehicles in 2031 in the *Step Change* scenario.

If not properly managed, the electricity demand for charging these electric vehicles may lead to significant electricity system infrastructure investments by customers, network service providers and other parties. The additional electricity demand from charging electric vehicles may also provide opportunities to improve load utilisation of existing electricity system assets or assist in balancing supply and demand due to the flexible charging and discharging of the electrical energy storage in vehicle batteries.

This project will explore the future impacts of electric vehicle (EV) charging on the Ausgrid network and the viability and customer response to various demand management interventions.

The first discovery phase of the project involved supporting an ARENA-funded project called Charge Together which was led by EVenergi and supported by other partners including the EV Council, NRMA and the NSW Government. The Charge Together project had three main activity streams that Ausgrid supported including;

- Development of fleet products and tools to assist fleet managers to migrate their fleets to electric vehicles
- Development of private individual product and tools to assist in EV purchasing decisions
- Delivery of a private electric vehicle owners survey to inform network understanding of EV owner preferences

The second phase of the project takes lessons learned from phase 1 activities and extends research and development into two key areas;

- Participation in electric vehicle charging trials with collaborative partners, such as electricity retailers and other parties in the electric vehicle industry.
- Further investigation into the regulatory framework and options for setting and developing network tariffs in the context of electric vehicle charging in the future.

5.2 Project aims and expectations

The key objectives of the project are to:

- Understand and research options for demand management interventions using EV chargers to shift or curtail demand during peak demand periods; and
- Conduct or participate in practical, customer-based electric vehicle charging trials that explore the potential demand management solutions from partnering with customers, retailers, and other EV industry participants.

Other secondary objectives include:

- Sourcing, creating, and collecting activity-based customer EV data; and
- Reviewing and making recommendations on the collection of data on new demand on the network resulting from EV charging.

5.3 How and why project complies with the project criteria

This project aims to build capability and capacity in managing the electricity demand from electric vehicle charging which is forecast to be a significant electrical load in the future. Opportunities exist to manage this demand to reduce electrical infrastructure investments and to potentially use the stored electrical energy to provide network support services.

The modelling and research techniques utilised in the first phase of the project in conjunction with EVenergi involved an innovative bottom-up spatial and electric vehicle typology approach used to estimate and forecast the potential impacts from electric vehicle charging on Ausgrid's zone substations. This involved examining driving and charging data in combination with directly surveying electric vehicle owners to explore their perceptions about their EV usage and charging.

Insights gained from the early adopter EV owner market have provided guidance on the development of demand management options with collaborative partners in Phase 2 and will inform all market participants on the impacts from electric vehicle charging. The lessons-learnt and findings from EV trials will help to assess whether demand response activities with EV owners provide a viable option for demand reductions and provide guidance on EV tariffs.

Other innovative aspects of the project will be explored with electricity retail partners during Phase 2. This will involve exploring the orchestration value of electric vehicle charging for network support services as well as trialling vehicle-to-grid technology for network support services.

5.4 Implementation approach

The project will be conducted in two phases:

<u>Phase 1 - Charge Together project support, led by EVenergi (ARENA-funded)</u>

There are three primary activity streams for this phase of the project that was initiated in 2018-2019 and were mostly completed 2019-2020. Ausgrid supported all activities via in-kind support but principally supported the delivery of an EV owner survey and better understanding of customer preferences and behaviours. The three main activities were:

- The development of a suite of fleet products which can be provided to fleet managers with all the tools necessary to migrate their fleets to electric vehicles.
- The development of a private individual product that will provide individual EV buyers with the tools necessary to make an EV purchasing decision.
- The delivery of a private electric vehicle owners survey to inform network understanding of EV owner preferences and behaviours.

<u>Phase 2 – Electric vehicle charging trials, EV network tariffs and EV industry engagement</u>

The second phase of the project was approved during 2019-2020 with additional project funding and involves the following key activities:

- Partnering with electricity retailers and other electric vehicle industry parties in the development and implementation of collaborative EV customer trials which explore a range of customer, network, electricity retailer and EV industry issues; and
- Engaging an economic consultant to examine the principles of network pricing and develop a network pricing framework that can be used for exploring innovative network tariffs for electric vehicle owners and electric vehicle charging network providers.

5.5 Outcome measurement and evaluation approach

The project outcome measurement will be assessed by evaluating the extent to which the aims and objectives are met as well as meeting the project delivery milestones as outlined in the implementation approach. Expected outcomes from the project include:

- Enhancing our understanding of driving and charging patterns of EV owners by directly surveying electric vehicle owners to explore their perceptions about their EV usage and charging.
- Conducting or participating in one or more industry collaborative electric vehicle charging trials to explore a range of customer, network, electricity retailer and EV industry issues and ensure that distribution network considerations are assessed as part of the trials.
- Development and testing of network tariff options.
- Enhancing our understanding of the potential impacts of electric vehicle charging on demand through development of an electric vehicle typology approach and an assessment of demand management options at a spatial level.

5.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2021-2022, total project expenditure to date and the total expected project costs by the completion of the project. All actual and projected costs are net of any partner contributions.

Table 9 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$73,345	$408,445	$495,000

5.7 Project Activity and Results

5.7.1 Summary of project activity to date

Phase 1 activities were mostly completed during 2019-2020 with the publishing of the final results of the NSW EV owners survey happening during 2020-2021. In addition, the outcomes from the development of the typology based electric vehicle charging planning tool was also published as a case study during 2020-2021.

During 2020-2021, the following Phase 2 activities also commenced or were completed

- Participation as a project partner in the ARENA-funded electric vehicle charging trial being led by Origin Energy. Further information can be found under 'Projects' on Arena's website[8]
- Participation in the technical reference group along with other network companies in the ARENA-funded electric vehicle charging trial being led by AGL. Further information can be found under 'Projects' on Arena's website[9]
- Completion of the electric vehicle network pricing consultancy by HoustonKemp outlining recommendations for electric vehicle tariffs

During 2021-2022, the following Phase 2 activities have been conducted:

- Enhancements made to the EV charging planning tool, informed by the comprehensive customer survey
- Analysis of EV charging data up to May 2022 collected from Origin EV Smart Charing trial
- Communication of the lessons learnt from AGL EV trial with other stakeholders

5.7.2 Update on material changes to the project

There were no material changes to the planned activities during 2021-2022 with Phase 2 activities commencing, in progress or being completed.

5.7.3 Collected results

Phase 1: Electric Vehicle Owners Survey – Final Results

The final results for the electric vehicle owners online survey was released publicly during 2020-2021 and can be found on Ausgrid's website in the Demand Management Innovation and Research section at https://www.ausgrid.com.au/dm.

[8] https://arena.gov.au/projects/origin-energy-electric-vehicles-smart-charging-trial/

[9] https://arena.gov.au/projects/agl-electric-vehicle-orchestration-trial/

Phase 1: Electric vehicle demand planning tool

As reported in the 2019-2020 DMIA annual report a local spatial allocation model was developed to estimate the electrical demand for EV charging using five electric vehicle typologies.

As an outcome of this work, the lead organization on the research project, EVenergi, launched a product called GridFleet in 2021. An Ausgrid case study was published as part of this report[10]. The model was further improved during 2021-2022 period with the continued engagement with Ausgrid.

One of the key outcomes from this component of the project was a greater understanding of how the electrification of the transport sector will create new electricity demand in different locations of the network with materially different characteristics. Electric vehicle charging at workplaces, shopping centres and DC fast charging stations will be quite different in nature to residential home charging for example due to variations in customer types, electric vehicle driving patterns, charging capacity requirements and electricity pricing structures. The spatial location of these EV charging typologies will be a key determining factor in the need for investments in the distribution network as a result of this additional electrical load, with each typology requiring different levels of engagement with customers and the industry to develop cost-effective demand management solutions that can be used to shift demand.

During 2021-2022 this project focused on improving processing efficiency for the power demand model and enhancing forecasting capability. The enhanced capability incorporates an energy model to forecast energy volumes related to EV uptake across the network. This is used to identify the potential impact EV uptake has on different tariff classes and insights were an input to inform the electrical vehicle network pricing study to explore future tariff settings and trials.

Phase 2: Electric vehicle network pricing study

The economic consultant, HoustonKemp, was engaged to provide guidance on the network pricing options that could be explored for electric vehicle charging in future activities. The principal opportunity arising from the uptake of EVs, from a network perspective, is the ability to control or co-ordinate large and flexible loads, thereby minimising the effect on network costs and, at the same time, avoid any loss in amenity for customers with an EV.

The report had two key recommendations with respect to network tariffs;

- to investigate the potential for opt-in locational pricing for stand-alone electric vehicle charge points to encourage better utilization of existing asset capacity and where the incremental network costs are relatively small in a particular location.
- for residential customers, to explore an adapted controlled load tariff to provide improved amenity for electric vehicle owners through options such allowing customers to over-ride the electricity shut-off period for a number of days each year.

The outcomes from this consultancy will be used to inform the strategy and development of efficient network tariffs for electric vehicle charging. Effective network tariffs may have the potential to be used as a cost-effective demand management solution for particular applications and this is planned to be explored further by Ausgrid.

Phase 2: Origin smart charging trial (ARENA)

Ausgrid is a project partner of the Origin EV Smart Charging Trial. Through 2021-2022, the trial successfully installed more than 150 smart charging EV chargers, which were used to test different scenarios of unmanaged, incentivised, and managed charging models with Origin customers. In May 2022 Origin released the ARENA lessons learnt report[Error! Bookmark not defined.] ahead of a full project closure report expected in the next reporting period (2022-2023).

Ausgrid's role has provided input into trial design to shape how the trial explores different elements of EV charging behaviour. This input shaped Ausgrid's understanding of the EV demand impact on the distribution network and how unmanaged and managed charging techniques impact local network assets.

The data captured through the trial has enabled Ausgrid to simulate the impact of managed and unmanaged charging techniques on case study regions of the network at different levels of EV penetration to further qualify how smart charging techniques could be applied for cost effective and local network support.

[10] https://www.evenergi.com/wp-content/uploads/2021/07/Whitepaper-GridFleet-AUS.pdf

The trial is composed of three periods and the description can be seen in the table below. The outcomes are extracted from the ARENA Lessons Learnt reportError! Bookmark not defined..

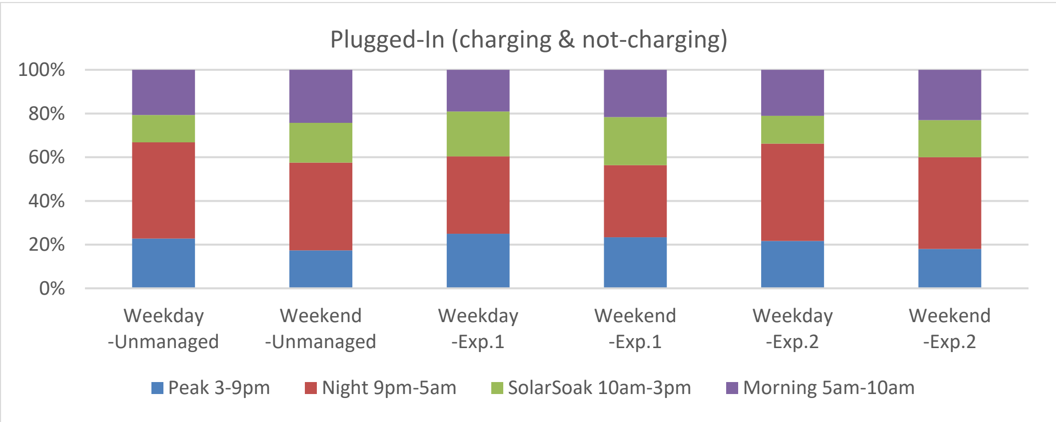
Table 10 - Origin EV Smart Charging trial summary

Trial stages	Description	Periods	Outcomes
Unmanaged - Baseline	No intervention	Prior to 25/07/2021	Peak time charging – 30%; Overnight charging - 38%; Solar Soak charging - 25%
Experiment 1	10c/kWh reward for charging during 10am-3pm and 9pm-5am – Simulated Time of Use (TOU)	26/07/2021 to 26/10/2021	Peak time charging – 10%; Overnight charging - 55%; Solar Soak charging - 31%
Experiment 2	10c/kWh reward for charging during 10am-3pm and 9pm-5am; 25c/day reward for charger being curtailed to 0kW if not opted out	25/11/2021 to date	Peak time charging – 6%; Overnight charging - 55%; Solar Soak charging - 30%

Plugged-In behaviour is consistent

Restricted to the access to the EV charging data of Ausgrid participants only, data of 12 residential participants within Ausgrid network from March 2021 to May 2022 has been collected and analysed. As observed, EV drivers do not plug in their vehicles every day and the vehicles are not necessarily being charged while plugged in. A breakdown of the charger status (Plugged-In or Charging) of Ausgrid participants on an average weekday & weekend is shown in Figure 10.

Figure 10 - EV charger status (Plugged-In or Charging) on an average day



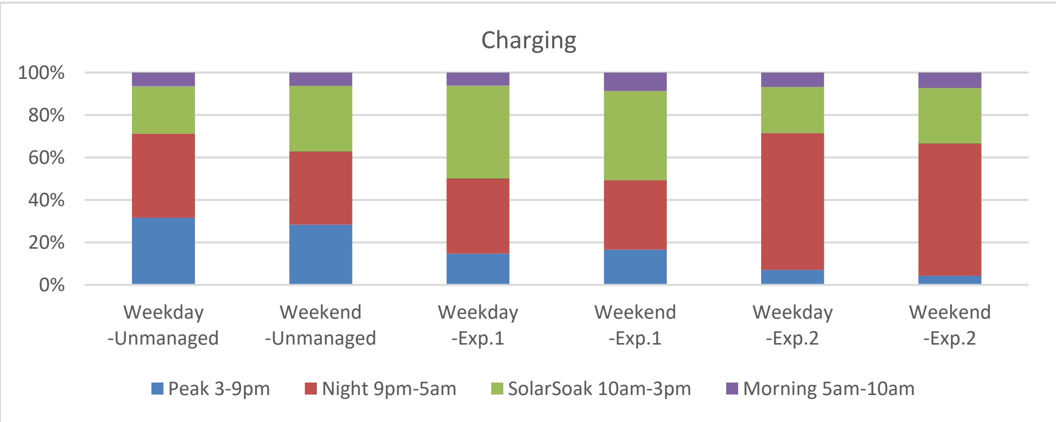


Figure 10 shows that Plugged-In (charging & not-charging) rate at different times of the day is largely consistent across the three trial periods, with Solar Soak having a slightly higher rate on weekends than weekdays. This implies that participants plug in their EVs in a fairly consistent manner impacted by trial incentives. However, for the status of Charging (when charging rate is above zero), the percentage of peak time charging drops significantly in Experiment 1 compared to Baseline Unmanaged level and drops further in Experiment 2. Solar Soak charging increases in Experiment 1. Nighttime charging increases significantly in Experiment 2 due to the chargers curtailed during peak time. The EV charging demand shift is largely in line with the Origin lessons learnt report (Table 10). Ausgrid analysis suggests a higher portion of Solar Soak charging in Experiment 1, which can be explained by Sydney Covid lockdown between July and October 2021.

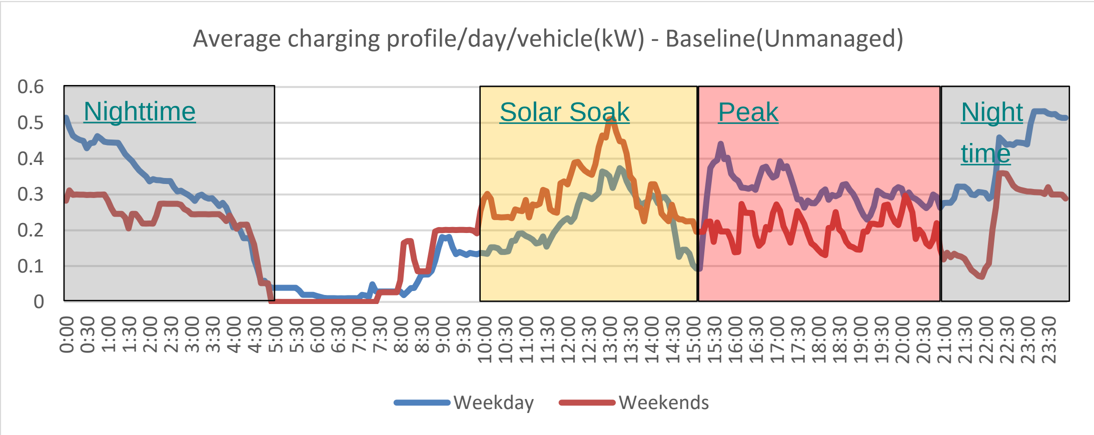
The analysis also indicates that participants are comfortable for their chargers being controlled during peak time (3pm-9pm), with opt out rate less than 2% during Experiment 2.

Charging windows

The data captured by Origin was used by Ausgrid to derive average daily charging profiles per EV customer to contrast the different charging profiles identified across each experiment and also evaluate the EV demand impact of these charging profiles on Ausgrid's network, see Figure 11 to Figure 13.

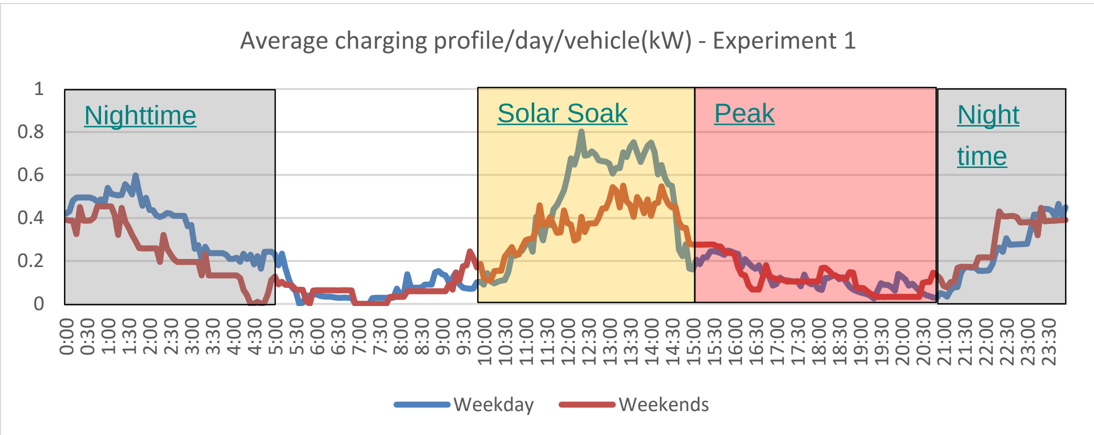
It should be noted that the daily average energy usage from EV charging in the trial is not consistent across three trial periods and lower than Ausgrid internal EV demand forecast. The differences can be explained by Covid impacts and slow transition to EV driving for new EV owners. Participants daily travel distance is impacted at different levels in different periods of the trial. In order to represent a realistic future scenario, the daily energy usage assumed in AEMO ISP2022 is used to calibrate the EV charging profile, with 6.1kWh on a weekday and 5kWh on a weekend day.

Figure 11 - Average daily charging profile per vehicle during Baseline Unmanaged Charging



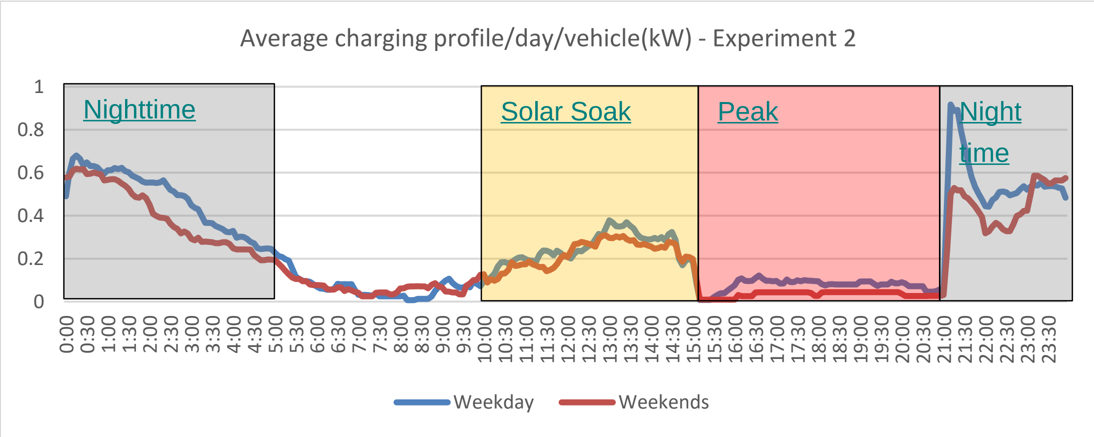
During Unmanaged charging, around 30%/24% of EV charging happened during peak time on a weekday/weekend. Weekday charging is higher in both the peak and nighttime periods compared to weekends, likely due to the greater distance travelled on weekdays and consequently, the level of charging required. Conversely, Solar Soak charging is higher on a weekend (31%) than on a weekday (19%) likely due more EVs being garaged at home on weekends.

Figure 12 - Average daily charging profile per vehicle during Experiment 1



With the introduction of simulated TOU incentive, Peak time charging is reduced to 12% on a weekday. The reduced demand has been shifted to both solar soak period and nighttime period. In line with the analysis shown in Figure 10, Solar Soak charging rate has increased significantly in Experiment 1 exceeding the weekend level which was not the case in the Unmanaged scenario.

Figure 13 - Average daily charging profile per vehicle during Experiment 2



As the chargers curtailed to 0kW charging rate in Experiment 2, Peak time charging is further reduced to 8% on a weekday and 4% on a weekend. Most of the EV charging occurred during nighttime as drivers seem to drive more during the day after Covid lockdown.

It can be concluded that the simulated TOU can effectively shift EV charging demand from peak period to off-peak period. Controlled charging can further increase this shift. However, an artificial peak has been observed immediately after the peak-controlled period ending at 9pm. Methods on staggering this EV charging demand should be considered and appropriate scheduling put in place to avoid these peaks. For example, a charging orchestration scheme could potentially “smooth” out the turn on of EV charging and/or throttle down the charging rate to make better use of the low charging period between 1am and 5am as seen in Figure 13.

Simulated Impact of Future EV Demand on Ausgrid Network

In the AEMO ISP2022 Step Change scenario, EV penetration levels are forecast to exceed 50% by 2039. As of now, the uptake of EVs in Ausgrid’s network is tending to concentrate in certain areas, driven by the early-adopter phenomenon and socio-economic factors. However, as EVs become cheaper over time and more available to the general customer base, uptake is expected to become more uniform. There is considerable uncertainty around the rate of EV uptake and the timing around which parts of Ausgrid’s network may become constrained due to a high EV uptake.

To assess possible impacts of high EV uptake, we have studied two Ausgrid areas by overlaying a 50% EV penetration on the network. Two case study distributors, HP71324/71324L in Muswellbrook and S004755/000001 in Revesby, were identified to simulate unmanaged and managed charging impacts on the low voltage network.

On 20th December 2021, distributors HP71324/71324L recorded a summer high demand (107kW) at 4:40pm where the daily temperature reached 34.8°C on that day. For the purpose of the simulation, we have assumed half of the connected customers (55 NMIs) will charge their EV at home. Figure 14 below shows the demand profile on this day overlaid with the expected demand impact of the simulated 55 EVs.

Figure 14 - Distributor 71324L summer peak assessment - Unmanaged conditions

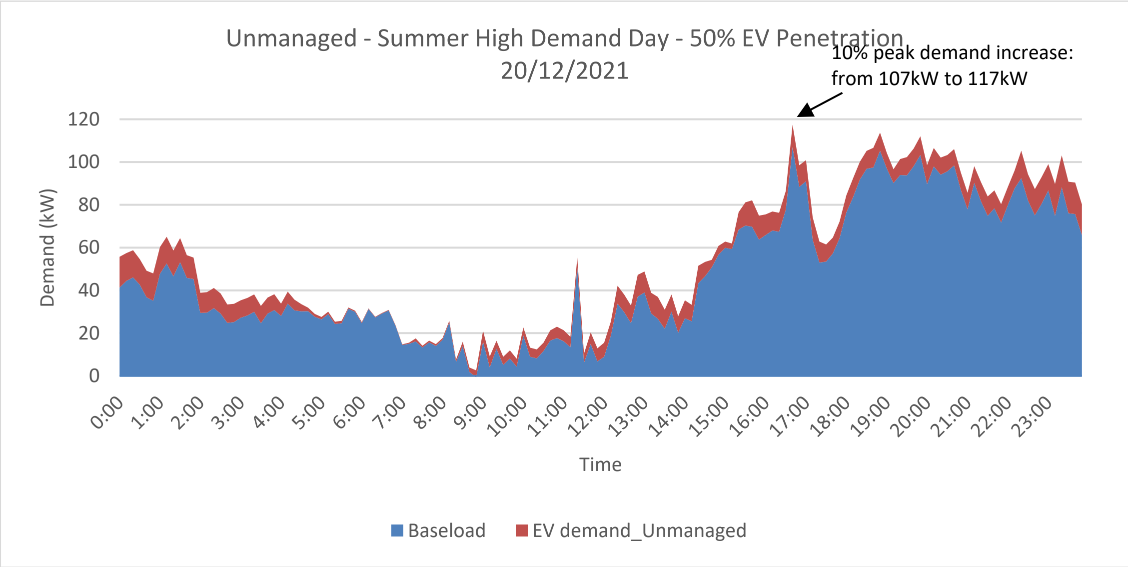


Figure 14 shows that this causes a 10% peak demand increase based on the unmanaged charging behavior, increasing the peak demand from 107kW to 117kW. In Figure 15 below, we use the average charging profile derived from Experiment 1, where customer charging behavior is incentivised through price signals. This shows that customers were incentivised to change their charging behavior. This results in the peak increasing by 3.7% compared with the usual daily peak demand vs 10% increase when charging is unmanaged.

Figure 15 - Distributor 71324L summer peak assessment – Experiment 1 conditions

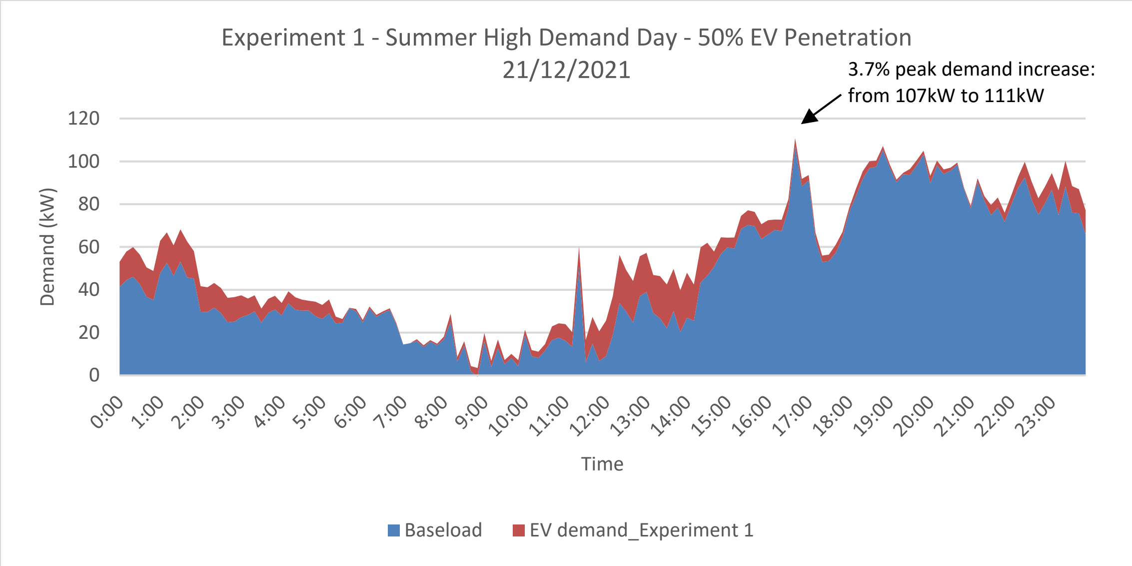


Figure 16 - Distributor 71324L summer peak assessment – Experiment 2 conditions

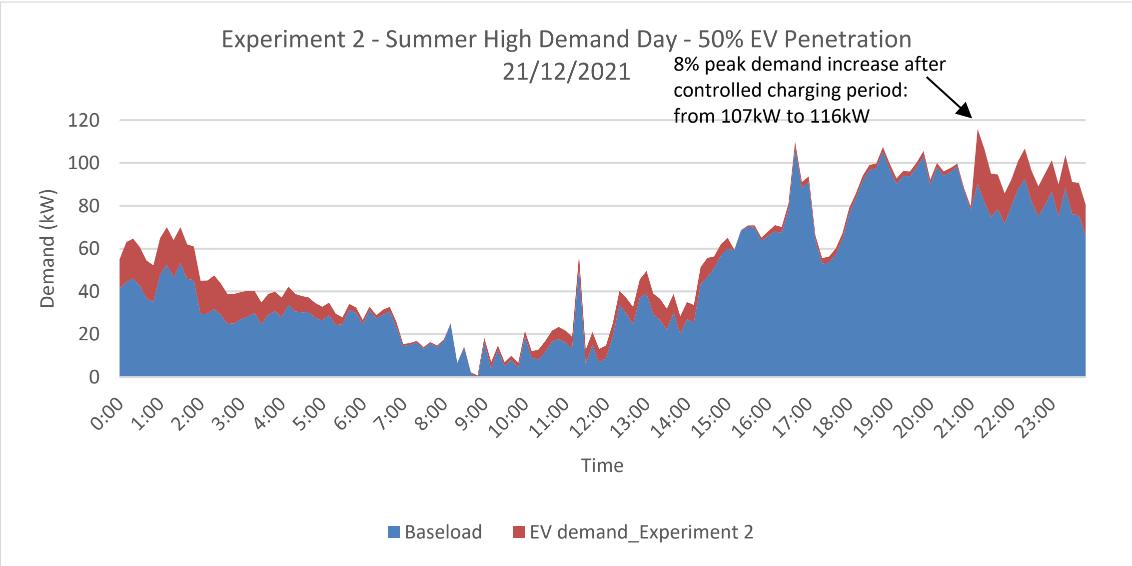


Figure 16 shows the impact of Experiment 2, where Origin controls charging (retailer managed charging). In this example, we observe, a new peak demand (116kW) emerges at 9:10pm. This secondary peak is just 1kW below the unmanaged charging peak in Figure 14 and also represents 8% peak demand increase compared to original daily peak demand. Further work is needed to investigate the orchestration techniques to manage the turn on of charging so to avoid the creation of the artificial peak.

This simulation also highlights the impact of other controlled load as the demand at 10:20pm increases to 107kW, which is equal to the previous baseload peak demand at 4:40pm. This is due to nighttime charging coinciding with hot water heating. This finding reinforces the need for orchestration in EV controlled charging as well as co-optimisation with other controlled load systems such as Hot Water These findings will inform future tariff settings, but also highlight the need for technology providers to consider how controlled EV charging responds to price signals to mitigate artificial peak demand issues.

Solar Soak charging may increase peak demand

Some further analysis was undertaken to explore the impact of EV penetration and Solar Soak charging on a day with less solar generation in the local area.

We applied the Experiment 1 charging profile which has the highest Solar Soak charging rate. The baseload was chosen for distributor S004755/000001 in Revesby on 1^{st} of February 2022 when the daily temperature reached 36^{o}C.

Figure 17 - Distributor S004755/000001 summer peak assessment – Experiment 1 conditions

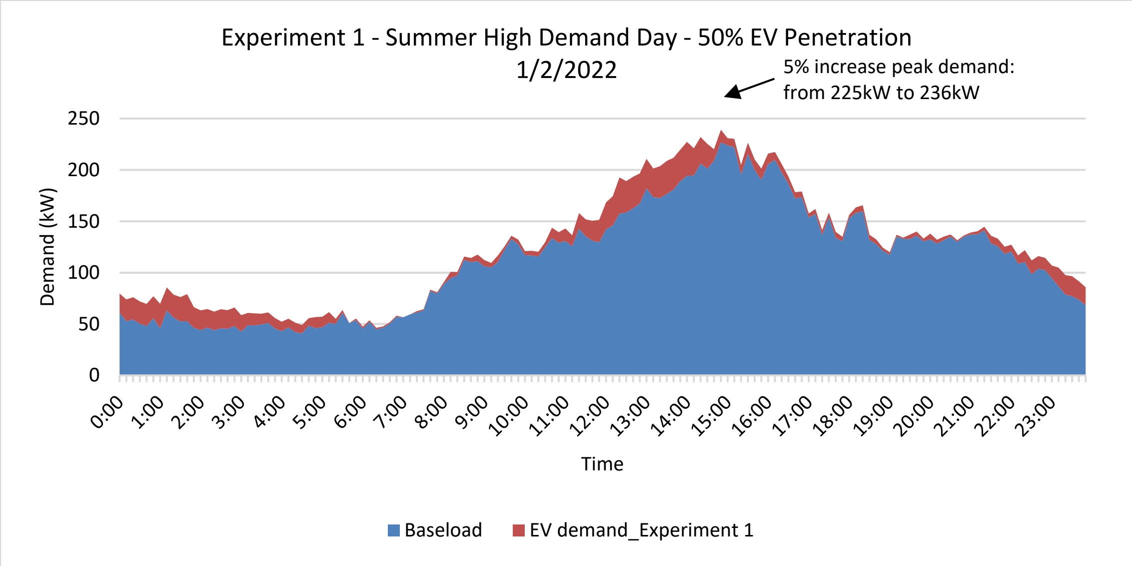


Figure 17 shows that under the simulated 50% EV penetration conditions, the distributor's peak demand increases by 5% compared with normal baseload. The baseload peak demand occurred at 2:50pm, within the incentivised EV charging window. The simulation demonstrates that Solar Soak charging will not always benefit the network at a distributor level. For a distributor with a low level of solar generation, EV tariff needs some special consideration. Alternatively, enabling flexible demand response in EV chargers can also help to alleviate this potential issue.

The project is continuing into 2022-2023 period. A comprehensive dataset will be collected and analysed. Project findings will provide guidance on future products design (e.g. orchestrated controlled charging) and network tariff settings.

Phase 2: AGL electric vehicle orchestration trial (ARENA-funded)

Ausgrid is one of seven network companies on a technical reference group to the AGL EV Orchestration Trial and AGL has published two new Lessons Learnt Report in Sep 2021[11] and Mar 2022[12] respectively. As at March 2022, AGL had signed up 400 participants with 200 smart chargers installed.

The trial comprises three streams:

Residential EV smart charging orchestration – 200 participants who have their charging controlled via a smart charger. This stream is in operation stage and charging data has been collected since Jan 2022.

Emerging charging technologies: vehicle API charging control and Vehicle to Grid. 100 participants have been identified for API charging and controlled charging has been implemented.

Time-of-use (TOU) tariff control group – 100 participants (on TOU tariff) metering data has been collected to assess the effectiveness of a tariff incentive against controlled charging.

Participation in the technical reference group includes helping design the test program for assessing distribution network impacts and orchestration value. Ausgrid is particularly interested in understanding how unmanaged and managed charging of electric vehicles may affect localized electrical demand with the aim of better understanding the value of EV orchestration as a cost-effective demand management solution. The AGL trial will also involve the installation of vehicle-to-grid chargers and V2G network integration aspects are planned to be explored as part of the project.

5.8 Other Information

General information about the Charge Together project can be accessed on Ausgrid's Demand Management web page from the Innovation Research and Trials link: www.ausgrid.com.au/dm

This will be the location where we publish further reports and information on the project.

[11] https://arena.gov.au/assets/2021/09/agl-electric-vehicle-orchestration-trial-lessons-learnt-report-2.pdf

[12] https://arena.gov.au/assets/2022/03/agl-ev-orchestration-trial-lessons-learnt-report-3.pdf

If you have a specific information request regarding this project to assist in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

6 Digital Energy Futures

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

6.1 Project nature and scope

This project is a 3-year research project being led by Monash University in which Ausgrid is a co-funding and in-kind contributor in partnership with Energy Consumers Australia and Ausnet Services. The project has been granted funding from the Australian Research Council due to its innovative combination of research techniques.

The project aims to understand and forecast changing digital lifestyle trends and their impact on future household electricity demand, including at peak times. This will be conducted by employing a range of innovative quantitative and qualitative research techniques that will investigate the behaviours and opinions and make observations of specific customer segments that are of relevance and interest to Ausgrid for better understanding how household customer demand may change in the future.

6.2 Project aims and expectations

The project has 5 key aims and objectives, which are to:

- Objective 1: Understand how Australian household practices (e.g. heating, cooling, entertaining) are changing and likely to change in relation to emerging digital technologies and across different electricity consumer groups.
- Objective 2: Identify emerging future scenarios and principles that will affect electricity sector planning in the near-medium (2025-2030) and medium-far (2030-2050) futures.
- Objective 3: Develop a theoretical and methodological approach to anticipate changing trends in household practices and energy demand, which brings a futures perspective to theories of social practice and digital ethnography.
- Objective 4: Develop an industry-relevant forecasting methodology for tracking and anticipating peak electricity demand, and energy consumption more broadly, that incorporates insights from this future-oriented social science research.
- Objective 5: Develop practical demand management solutions for Australian electricity network businesses to plan for efficient, cost-effective, and reliable networks.

6.3 How and why project complies with the project criteria

This project aims to build demand management capability and capacity in the household customer segment by better understanding households existing and future trends in everyday household energy use practices and how effective demand management solutions can be developed for the household segment.

This research program adopts innovative approaches by applying ethnographic research techniques and sociological theories to investigate how changing social practices will impact on electricity sector planning. Expected outcomes include scenarios and principles for digital energy futures; an interdisciplinary energy demand forecasting methodology; and demand management tools to help the sector meet future residential consumption.

6.4 Implementation approach

The project will take place over 3 years and started in 2019 and will continue through to at least 2022. There are 6 stages to the project that were put forward in the ARC grant proposal:

Stage 1: Digital and energy futures analysis – to inform the ethnographic research and establish trends (Year 1, objective 1)

Stage 2: Digital ethnography with households – with consumer groups in Ausgrid's and AusNet's work areas to generate future scenarios and medium-far futures principles (Years 1 and 2, objectives 1, 2 and 3)

Stage 3: Survey supplement for ECA's annual Energy Consumer Sentiments Survey – (Years 2 and 3) objectives 1, 2 and 3

Stage 4: Scenario innovation workshops – with residential consumers in Ausgrid's and Ausnet's networks to update and extend the scenarios and principles (Year 2, objectives 1, 2 and 3)

Stage 5: Modelling and forecasting development – to cross-analyse, translate, and refine the findings, and develop a forecasting methodology (Year 3, objectives 3 and 4)

Stage 6: Demand management innovation – to identify opportunities in emerging trends that are likely to impact the affordability and reliability of electricity supply for residential customers (Year 3, objective 5)

6.5 Outcome measurement and evaluation approach

The project outcome measurement will be assessed by evaluating the extent to which the aims and objectives are met as well as meeting the project delivery milestones as outlined in the implementation approach.

Expected outcomes from the project include:

- Enhancing our understanding of everyday household practices, how they are changing and how they affect household electricity consumption. (Objective 1)
- Identifying and developing future trends and scenarios in household energy use that can inform forecasting methodologies and electricity sector planning. (Objectives 2 to 4)
- Researching and developing practical demand management solutions in the household customer segment (Objective 5)

6.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2021-2022, total project expenditure to date and the total expected project costs by the completion of the project.

Table 11 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$41,931	$335,148	$410,000

6.7 Project Activity and Results

6.7.1 Summary of Project Activity to Date

Stage 1 (completed): Digital and energy futures analysis

Monash University completed the digital and energy futures analysis which was reported in the 2019-2020 annual report.

Stage 2 (completed): Digital ethnography with households

The recruitment survey for the stage 2 ethnographic fieldwork was conducted in March 2020 and reported in the 2019-2020 annual report.

During 2020-2021, the ethnographic fieldwork was conducted by the Monash University research team and the results were published. Ausgrid provided input, review, and feedback to the Monash research team around the results from the qualitative research.

Stage 3 (completed): Survey supplement for ECA's annual Energy Consumer Sentiments Survey

The changes to the Energy Consumers Australia Sentiment survey was completed during 2020-2021 and the results are expected to be available in 2021-2022. Ausgrid was involved in providing input, review and feedback to the research team and project partners in the development of the new content and questions.

Stage 4:

Development of the research and activities associated with Stage 4 and 5 commenced in 2020-2021 with work expected to be completed in 2022-23.

Stage 5 (in progress):

Development of the research and activities associated with Stage 5 commenced in 2020-2021 with work expected to be completed in 2022-23.

Stage 6 (completed)

Research and activities associated with Stage 6 was completed in 2021-2022.

6.7.2 Update on material changes on the project

The Stage 2 qualitative research was delayed due to the impacts of the COVID-19 pandemic in 2020 and the research techniques used were adapted to go online rather than face to face. All virtual interviews were conducted successfully during the 2020-2021 period.

The Stage 4 customer workshops were completed during 2021-2022 with report to be released October 2022.

The Stage 5 modelling and forecast development commenced in 2021-2022 with completion due in 2022-2023. Appropriate customer research methodologies are still being finalised.

6.7.3 Collected Results

The reports published so far as part of this project can be found on Monash University's website[13].

Results from the Stage 1 desktop research review project were published in June 2020 and can be found at the link above in the report entitled *Digital Energy Futures: Review of industry trends, visions, and scenarios for the home.*

Results from the Stage 2 digital ethnography involving detailed interviews with 72 households was published in July 2021 and can be found at the link below in the report entitled *Digital Energy Futures: Future Home Life*.

Some of the key findings of both reports are brought together and compared in the executive summary of the *Future Home Life* report where the industry predictions and visions from Stage 1 are compared to the research findings from the detailed customer interviews from Stage 2. Key findings were:

- Most households preferred to maintain control over heating and cooling which is at odds with the industry view that smart technologies would manage heating and cooling to deliver savings for both consumers and the energy industry,
- Very few participants showed long term engagement with their energy data and did not change their practices despite awareness of high energy usage which did not align with the industry view that better automation would enable more efficient management of energy, reduced peak demand and reduced energy costs for consumers.
- Energy savings were driven by a more diverse set of motivations than money alone, including education, sharing energy and aspiration towards self-sufficiency. Time of use tariffs unlikely to encourage significant load shifting. On the other hand, the prevailing industry view was that consumers were primarily motivated by financial incentives and time of use tariffs were effective in encouraging load shifting.

Further details can be found in Ausgrid's DMIA Annual Report 2020-2021.

[13] https://www.monash.edu/emerging-tech-research-lab/research/research-themes/energy-futures/digital-energy-futures/reports-and-publications

Results from the Stage 6 Demand Management Innovation were published in December 2021 and can be found at the link below in the report entitled *Digital Energy Futures: Demand Management Opportunities*. The focus of this report was to build upon the *Future Home Life* research and focus on enabling household demand flexibility to respond to grid constraints and shifts in electricity supply. Key findings of the report:

- Building trust and engaging households – Trust is critical to engaging households in demand response and the distributed energy future. Most households do not distinguish between companies involved in energy system, such as Retailers, networks, regulators etc. Trust has been low but has shown incremental improvement. Household participation in DM will depend on the following trust dimensions:
    - The energy system participants including operators and regulators are acting in the best interests of consumers,
    - There is a need for demand response and that it will benefit consumers and electricity system,
    - Demand issues addressed in other ways are not effective or efficient (eg by building more infrastructure or focusing on commercial consumers instead of households),
    - Technologies will work as intended,
    - The electricity sector genuinely supports the transition to renewable energy.
- However, distrust in the energy sector could undermine demand management initiatives. There was a concern that surplus PV exported to the grid boosts energy companies' profits so instead, there was a preference to donate excess energy to more financially constrained households or neighbours so that they might benefit instead. Initiatives to address both minimum and peak demand will need to gain household trust and demonstrate that their participation supports good community, energy system and decarbonisation outcomes. Demand management programs currently achieve low uptake, however, there is an opportunity to utilise more non-monetary approaches to engage a wider range of households,
- Demand management approaches need to be aligned with current household concerns. Diverse strategies will be needed to engage a continuum of people, ranging from those who are enthused about using new technology to those without technology or who have a low level of interest in the energy system. Data from the Energy Consumer Behaviour Survey (ECBS) which included questions informed by the Digital Energy Futures research project, showed that around 35% of households were unfamiliar with their own tariff structure or did not respond to incentives to shift their electricity consumption in response to time of use tariffs. Engagement should address customers' day to day concerns including interests beyond energy to grab attention. Diverse initiatives will incrementally build household awareness and support for demand management as a positive outcome to manage costs and deliver reliable electricity.
- Energy and demand terminology needs to account for the high proportion of English as a 2nd language households within culturally and linguistically diverse communities,
- Incentives, rather than penalties, should frame the design of rewards structures. Rewards that sit outside the electricity tariff structure were found to more likely attract attention and response. Rewards pooled for community benefit may engage households who are unlikely to respond to small financial incentives. Possible ways to incentivise that were suggested were positioning incentives as fun, challenging and/or educational,

6.8 Other Information

General information about the Digital Energy Futures project can be accessed on Ausgrid's Demand Management web page from the Innovation Research and Trials link at www.ausgrid.com.au/dm

If you have a specific information request regarding this project to assist in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

7 Cost Reflective Network Pricing Research

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

7.1 Project nature and scope

Ausgrid has been a leading Australian distribution network in introducing cost-reflective network pricing and introduced residential and small business time of use pricing to its customers on a large scale from as early as 2004. In July 2018, Ausgrid introduced a seasonal time of use network tariff for residential customers and in July 2019 a monthly demand network pricing structure was introduced as the default network pricing structure for customers with new and replacement meters in Ausgrid's network under certain conditions.

As at June 2022, Ausgrid has 156,000 residential customers on demand tariffs and 345,000 residential customers on time of use tariffs, for a combined total of 31% of all residential customers on cost-reflective network tariffs.

The nature and scope of this project is to quantify the peak demand reduction benefits from the introduction of the new cost reflective network pricing to residential customers to better understand the effectiveness of these pricing structures as a possible targeted demand management tool for deferral of network investments. The network pricing structures under study include both seasonal time of use and monthly demand pricing structures and is focused on the residential sector for the first phases of the project. This may be extended to small business customers and the project is split into several phases as detailed in the implementation approach section.

7.2 Project aims and expectations

The aim of this project is to quantify the impact of cost reflective network pricing structures on reducing electricity demand at times of peak demand to develop an understanding of the complementary measures that could be used to increase the effectiveness of these network pricing signals as an effective demand management tool.

7.3 How and why the project complies with the project criteria

This project is targeted at researching and developing demand management capability by better understanding how effective cost reflective network pricing is as a demand management option to reduce long term network costs. The project is considered innovative as it employs analytical and customer surveying techniques not previously implemented to research this topic. In addition, the segment of customers being studied is considered different to other jurisdictions because of the length of time that customer's in Ausgrid's network area have been exposed to time of use network and retail pricing.

7.4 Implementation approach

The project will be conducted over several phases:

<u>Phase 1 – Customer research and surveying</u>

A. Customer surveying

Surveying around 1,000 residential customers and obtaining more detailed information about their appliances, socio-demographics, and retail pricing plans. A follow up survey to these customers may be conducted in subsequent activities to capture a longitudinal aspect to the research.

B. Customer focus groups

Focus group research with a sample of customers from the survey to further explore their understanding of pricing plans, energy-use behaviours, and responses to these pricing signals. Complementary measures would be explored in more depth during this phase. These options are currently being considered in the development of revised plans for the project.

Phase 2 – Demand reduction study and analysis

Detailed study of the impact of cost-reflective network pricing using historical data from interval and smart meter customers exposed to network time of use pricing.

This work is underway with a more detailed scope of works for ongoing activities under consideration. These activities may include monitoring of customer statistics and details of customers who are defaulted onto demand pricing from July 2019.

Phase 3 – Trial program

Trial of complementary measures identified in Phase 1 and Phase 2 that increase the effectiveness of seasonal time of use or monthly demand pricing in reducing peak demand as well as mitigating customer impacts particularly on vulnerable customers.

7.5 Outcome measurement and evaluation approach

A key preliminary outcome being measured is to quantify, where possible, the peak demand reduction effectiveness of the introduction of cost-reflective network pricing across a broad statistically significant sample of Ausgrid customers that have been exposed to these tariffs.

Evaluation of the effectiveness of pricing signals will be performed using a range of surveying and analytical techniques using customer electricity consumption data, control sample comparisons and panel methods.

The primary focus of the project will be to identify the complementary measures that can be used to increase or focus the effectiveness of these pricing signals. To achieve this outcome, a range of customer research and analytical approaches may be required.

7.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2020-2021, total project expenditure to date and the total expected project costs by the completion of the project.

Table 12 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$5,216	$102,091	$250,000

7.7 Project Activity and Results

7.7.1 Summary of project activity to date

The phase 1 survey responses collected in June 2019 were provided to Ausgrid during the 2019-2020 period with collected results reported in the 2019-2020 annual report. During 2019-2020 the project activity also consisted of engaging an analytical consultant to develop the panel method analytical approach to studying the historical half hourly energy consumption data of customers on time of use network price structures. This preliminary piece of work was completed in November 2019 and results were presented in the 2019-2020 annual report.

During 2021-2022 there was no material project activity as outlined in section 7.7.2.

7.7.2 Update on material changes to the project

This project was put on hold for the duration of 2021-2022 due to the Ausgrid network pricing team prioritizing their research focus on trial tariffs related to electric vehicles and a two-way tariff to encourage exports during afternoon/evening peak period and discourage export during the middle of the day.

During 2022-2023 it is planned to conduct further customer research including re-surveying customers with a particular focus on understanding why the customer response to the introduction of cost-reflective network pricing remains low with an estimated peak period reduction of around 2% to 5%. This could be a result of a range of factors including the retail pricing plan structure that customers are exposed to as well as other behavioural factors.

7.7.3 Collected results

Phase 1 customer research

The customer survey conducted in June 2019 resulted in a total of 1100 customer responses where we collected detailed information about household energy sources and use, electrical appliances, energy efficiency, dwelling characteristics, household demographics, retail energy plans and behavioural indicators. The sample was stratified, and weightings were calculated, to allow extrapolation of results to our customer base (e.g. by linking to the ABS census data).

Although preliminary analysis of the survey data was completed further Phase 1 activities were paused during the 2019-2020 year to focus on the demand reduction study.

The project was further paused during 2020-21 and 2021-2022, but further customer research activities are planned to resume in 2022-2023 to better understand why the customer response to cost-reflective network tariffs is as low as 2% to 5% as quantified in the demand reduction study and analysis.

Phase 2 demand reduction study

The results of the quantitative analysis of the customer response to cost reflective network pricing was reported in the 2019-2020 annual report. The results from this preliminary study estimated that the peak demand reduction in the summer peak period for customers that changed from a flat network tariff to a time of use network tariff ranged from 2% to 5% depending on the customer segment. The peak demand reduction in the winter peak period displayed a wider range across the customer segments with counter-intuitive results for small and medium consuming customers but a reduction of around 3% for larger consuming customers.

7.8 Other Information

General information about the Ausgrid's demand management projects can be accessed on Ausgrid's Demand Management web page from the Innovation Research and Trials link: www.ausgrid.com.au/dm

More detailed reports and findings will be released and published for this project as they are finalised and become available.

If you have a specific information request regarding this project to assist in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

8 Community Battery Feasibility Study and Research

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project will be ongoing into the 2022-2023 regulatory year.

8.1 Project nature and scope

This project continues to investigate the potential for locally based community batteries paired with an innovative business model to offer a competitive alternative to traditional local network investment, energy storage capability for market participants and introduce a novel way to markedly improve equitable access to energy storage for customers.

Following the feasibility study, the trial is currently underway in three locations across the region of Sydney and the Hunter - Beacon Hill, Bankstown and Cameron Park.

The trial aims to test the combination of:

- Providing network services to manage peak and minimum demand and power quality issues to avoid or defer traditional network investment;
- Leasing service to a market partner to utilise spare capacity;
- provide frequency control and other grid support services; and
- offer participating customers storage as a service to facilitate self-consumption of excess solar PV energy.

Battery sharing amongst networks, market participants and customers would offer both greater economies of scale and the diversity benefit of a shared asset. Shared storage services can lower costs for networks and the market which lowers costs for all consumers and saves participating customers more than they would if they invested individually. Additional storage capacity also enables increased renewable energy generation and resultant lower emissions.

The scope of this project under the DMIA includes a feasibility study into the concept by investigating the engineering, regulatory and commercial considerations, a customer survey to gauge customer response and attitudes towards the concept and the customer engagement components of the Phase 3 community battery pilot.

8.2 Project aims and expectations

The first phase of the project aimed to assess engineering, regulatory and commercial aspects of the community battery concept within the National Electricity Market context via a feasibility study in the concept.

The second phase of the project aimed to assess the customer response to the concept of a community battery and to better understand customers perceptions, motivations to participate and attitudes towards the concept.

The outcomes of the feasibility study and customer research has now informed the development of a practical trial for the concept in phase three.

As part of Phase 3, the DMIA project continues to explore customer response, perceptions and behaviours as part of the community battery pilot. The main objective of the trial is to test the benefits of stored solar energy to ease network constraints and raise community awareness about the benefits of community batteries.

8.3 How and why project complies with the project criteria

This project aims to explore the viability of an innovative approach to meeting network needs using a blended network / non-network community storage solution. By aligning the interests of networks, markets and customers, a lower cost alternative storage solution could extend the life of local network assets and improve network reliability and power quality. Such blended solutions are uncommon with market participants, customers and networks typically acting individually as market rules and practices create barriers to effective, collaborative solutions.

The project is considered innovative in that this concept is testing how an in-front of the meter battery can be integrated into the electricity market; which has not been explored in detail by Ausgrid or within the National Electricity Market to the best of our knowledge. The engineering, regulatory, commercial and customer considerations are complex, particularly within the framework of the National Electricity Market and the National Electricity Rules and this project seeks to progress the study of this innovative concept for all aspects.

For customers, this research explores a solution which both offers a possible lower-cost alternative to traditional behind the meter storage and a more equitable access to storage technology for customers unable to invest in storage at their homes.

8.4 Implementation approach

The implementation approach for this project was envisioned as 3 possible phases:

Phase 1 – Feasibility study and model business case

The first phase of the project, delivered together with specialist consultants, was to complete a feasibility study and develop a model business case for community batteries as a solution for local network constraints. The scope of work included investigation of the following aspects;

- an ***engineering*** assessment of the network need and conditions in which a community scale battery would be beneficial, including identifying various battery configurations that could be potentially viable and a short list of suppliers that could provide these options;
- an assessment of the current ***regulatory*** framework and identification of any exceptions or waivers that would be required to operate a practical trial of the concept; and
- a ***commercial*** analysis to assess the business case from a project, customer and Ausgrid perspective, determine the key drivers and benefits, and identify uncertainties and risks.

Phase 2 – Customer Research – quantitative survey

The second phase of the project included a quantitative survey of Ausgrid customers. The survey included the following aspects:

- measure consumer needs, motivations and perceptions to store excess solar power in a community battery among solar and non-solar customers;
- measure factors contributing towards purchase of batteries, among current owners and those considering a purchase;
- assess factors impacting consumer experience and performance of current batteries;
- measure profile characteristics of solar, system owners in terms of demographics, household composition and socio-economic factors; and
- ascertain interest levels in future community battery storage solutions (shared assets, subscription models).

Phase 3 – Community Battery pilot

The details and funding of a Phase 3 pilot program was contingent upon the outcomes from Phase 1 and 2 and internal and external review of these outcomes. During 2020-2021, following completion of the phase one feasibility study, a decision was made to progress with a community battery pilot under Ausgrid's Network Innovation program. The community battery pilot has been developed in collaboration with Ausgrid's Network Innovation Advisory Committee (NIAC)[14]. This committee helps guide Ausgrid's network innovation activities and includes customer advocates, research bodies and environmental organisations. The NIAC were presented with the results of the phase one feasibility study and phase two customer research and were supportive of Ausgrid progressing with a community battery pilot.

This DMIA project will continue to fund the customer research and the ongoing customer engagement components of the 2-year customer trial which is part of the community battery pilot.

[14] https://www.ausgrid.com.au/About-Us/Innovation/NIAC

8.5 Outcome measurement and evaluation approach

The outcomes from phase one are a report that investigated and made recommendations about the community battery concept from the perspective of the engineering, regulatory and commercial issues.

To better understand the techno-economic considerations for a community battery as an alternative to network investment, outcomes from the phase one feasibility study considered the following key questions:

1. What are the technical options and costs for a community battery?
2. How do we expect the network conditions/issues to change over time?
3. What network conditions would be suitable for a community battery solution?
4. What is the potential contribution and benefits from Solar PV customer use of the community battery?
5. What are the market and system security benefits from a community battery?
6. What regulatory changes would be required to support the use of community batteries as an alternative network solution?

The outcomes from the phase 2 quantitative customer survey results include a report that provides a summary of customer survey results and insights to better understand customers perceptions and awareness of the community battery concept and potential motivations for participating in a potential community battery pilot.

The learnings from both Phase 1 and 2 have been used to inform the progression of the project to a Phase 3 community battery pilot funded under the Ausgrid Network Innovation program.

As the pilot project, participation in the trial is voluntary. More than 60 customers have participated in the community battery trial across three sites. Since the start of the trial, participating customers have received an average of $14/month as a financial benefit for storing their excess solar generation during the day.

The participants in the trail can virtually store up to 10 kilowatt hours (kWh) per day. Collectively customer have so far stored more than 38MWh of solar energy in the community batteries across the three sites.

Participants have access to a mobile app and an online portal that shows real-time information about how much solar energy they are exporting to the grid, and how much energy they are using.

8.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2021-2022, total project expenditure to date and the total expected project costs by the completion of the project.

Table 13 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$10,438	$495,663	$800,000

8.7 Project Activity and Results

8.7.1 Summary of Project Activity to Date

<u>Phase 1 – Feasibility study and model business case</u>

The project activity for phase one commenced in 2018-2019 with the release of an expression of interest for consulting services, selection of a consultant consortium and commencement of research activities. As part of the research, Ausgrid provided access to detailed network and customer data and access to a wide range of internal subject matter experts (SMEs) to inform and guide the work by the consultants.

During 2019-2020, the feasibility study was completed in February 2020. The study assessed a range of technical, commercial, and regulatory issues and concluded the community battery project initiative could be feasible within as little as 3-5 years. The feasibility report can be downloaded from the community battery project page on Ausgrid's website[15].

Phase 2 – Customer Research – quantitative survey

During 2019-2020, the scope of the customer research was formulated, the procurement exercise completed, and a market research provider selected.

In the third and fourth quarter of 2019-2020, the online survey was designed and developed in collaboration with a market research company and input from stakeholders. The survey was completed at the end of July 2020 and analysis of the results and reporting was completed by the market research company commissioned to conduct the survey by November 2020.

The survey design developed resulted in a targeted letter and email campaign to more than 11,000 Ausgrid customers. The survey design included:

- Existing solar PV customers segmented by annual export volume;
- Existing solar and battery customers;
- Non-solar customers; and
- Solar and non-solar customers in areas identified as representative of Distribution Centres where the community battery solution was potentially viable.

A summary of the key results is provided below in 8.7.3.

8.7.2 Update on material changes on the project

The delivery of the Phase 3 community battery pilot was largely transferred to the Network Innovation program, in collaboration with Ausgrid's Network Innovation Advisory Committee (NIAC). The NIAC was put in place to give customers a role in driving our innovation investment program, guided by an underlying set of innovation principles and their terms of reference[16].

The DMIA funded component of Phase 3 of the trial in 2021-2022 continues to support the customer engagement elements of the trial including activities such as customer engagement communication activities, payment services to customers, ongoing maintenance and support for the customer trial app and other activities relating to the customer experience.

8.7.3 Collected Results

Phase 1 – Feasibility Study

The findings from the Feasibility study confirmed that the community battery concept was likely to be viable under a set of assumptions, constraints and parameters that were supported by analysis of existing network and customer data. For reported results from the feasibility study, refer to Ausgrid's DMIA Annual Report 2019-2020[17]. Ausgrid's Community battery feasibility report can be downloaded from the project research page on Ausgrid's website[18].

Phase 2 – Online Customer Survey

The survey was conducted in July 2020 with just over 900 Ausgrid customers who had solar PV systems or home batteries connected to Ausgrid's network or who were considering installing a solar system within the next two years. The questions in the survey focussed on measuring customers' existing level of knowledge about community batteries and their sentiment, motivation, and barriers towards the concept of taking part in a community battery trial if presented with the opportunity. In addition, profiles of both solar customers and home battery owners were undertaken and presented in the report.

A detailed analysis of the results was completed and finalised by November 2020. The key findings of the online customer survey are discussed in Ausgrid's 2020-2021 DMIA Annual Report and the detailed

[15] https://www.ausgrid.com.au/In-your-community/Community-Batteries/Project-research

[16] https://www.ausgrid.com.au/About-Us/Innovation/NIAC

[17] www.aer.gov.au/networks-pipelines/compliance-reporting

[18] https://www.ausgrid.com.au/In-your-community/Community-Batteries/Project-research

public report containing the results from the survey is available on the project research page on Ausgrid's website[19]

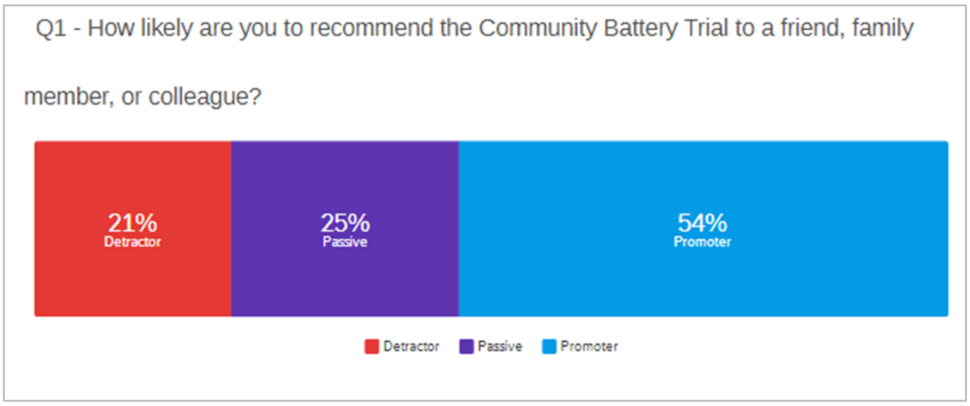
Phase 3 – Community Battery Pilot

As a part of the Phase 3 for the community battery trial program, quarterly surveys were conducted with the existing participants. The first survey was conducted in January 2022 and the second survey was conducted in April 2022. More than 25 trial participants completed the survey sharing their feedback with the team. The questions in the survey revolved around the customer experience of being a part of this innovative trial.

Some of the key findings from the customer surveys are shared below.

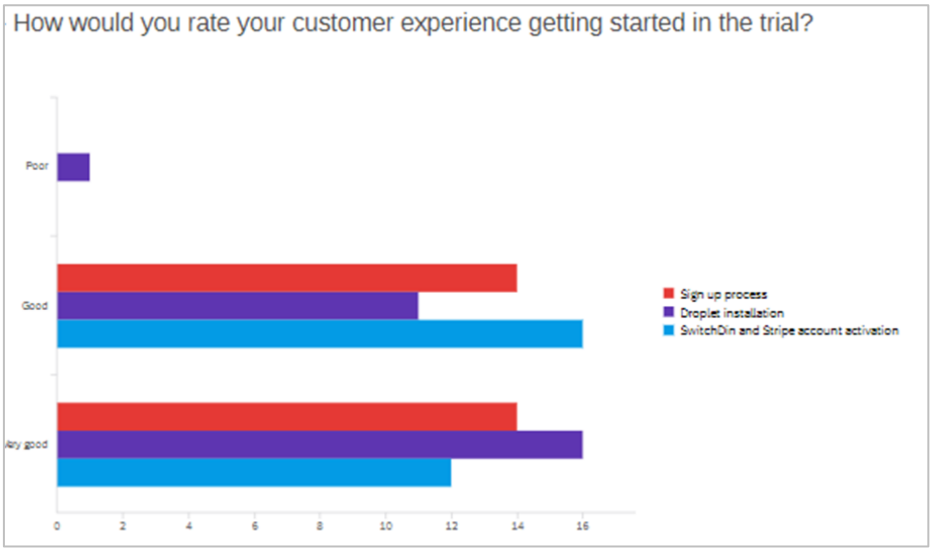
Customers were asked if they would promote the community battery trial amongst their family and friends. More than 50% of the solar customers were excited to be part of the trial and would promote the trial to their family and friends.

Figure 18 – Most customers would promote the project



Customers were able to sign up to the trial at any point during the trial. We asked the participants about their experience in getting started in the trial in reference to the sign-up process, installation of the smart meter called the 'Droplet' and getting started on their online app. 14 out of the 28 customers who participated in the trail rated their experience as being 'very good'. About 57% of the participants rated the experience of the smart meter installation as being 'very good'.

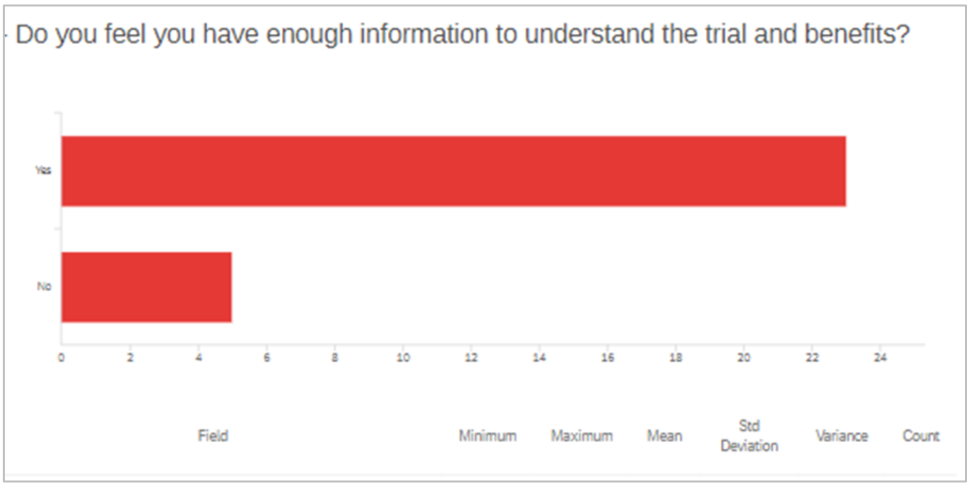
Figure 19 – Most customers had a positive experience



[19] https://www.ausgrid.com.au/In-your-community/Community-Batteries/Project-research

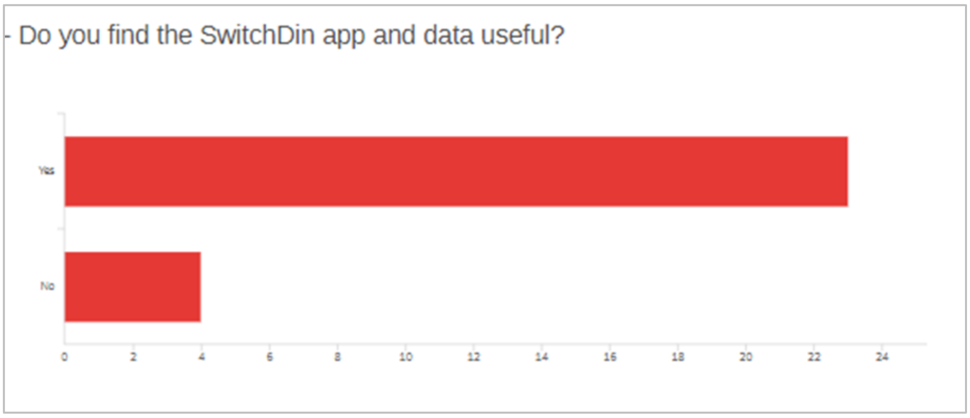
It was important for us to understand how well the trial participants understood the reasons behind the trial and the benefits. The survey found that 23 out of 28 customers were confident that they had the required information and understood the benefits of participating in the community battery trail.

Figure 20 – Customer level of understanding was high



Participating customers have access to a smart measurement app that can be used to access their energy data. The energy data is visible through the app and an online portal that can be accessed during the trial period. About 70% of the customers who participated in the trial found the app and the data very useful.

Figure 21 – Most customers found the SwitchDin app useful



While most of the Phase 3 customer trial is funded separately under the Ausgrid Network Innovation program, customer engagement related components of the project such as ongoing support for customers' experience in the trial, will continue to be the ongoing focus for the project for 2022-2023.

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8.8 Other Information

For further general information about the Ausgrid Community Battery project can be accessed on Ausgrid's website at https://www.ausgrid.com.au/sharedbattery. DMIA research results will be published when available at www.ausgrid.com.au/dm.

If you have a specific information request regarding this project to assist in understanding, evaluating or reproducing this project please contact innovation@ausgrid.com.au.

9 Power2U – Solar and Lighting Incentives Program (Demand Management for Replacement Needs)

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The majority of project activities were completed in 2020-2021 with only a few solar installations occurring in 2021-2022 on participating schools under the Solar My Schools component of the trial. The Project Implementation Approach below is the same as the DMIA 2020-2021 report. The project concluded in 2021-2022 regulatory year.

As part of Ausgrid's funding agreement with co-funding partner, ARENA, a detailed public report covering the latest project results and key learnings has been published on ARENA's website[20]. This report is also available on Ausgrid's DMIA Research and Trials page at www.ausgrid.com.au/dm

9.1 Project nature and scope

This project aims to test the viability of using non-network options to defer or manage the load at risk associated with network investments that involve retiring / replacing aged assets. Around 90% of Ausgrid's capital investment expenditure over the next 5-10 years is related to the retirement / replacement of aged assets and this will be an important project in building demand management capability for this type of application.

This project focusses on developing a solar and energy efficiency incentive program that explores seeking permanent demand reductions that can be attained through a market-led approach. By targeting small geographic areas representative of a network replacement need, this project expands on previous applications of demand reduction by contemplating what is required to defer aged asset replacement. In this instance, the demand reduction must be both geographically located in the service area of a network need, and be capable of delivering demand reduction over a long duration in order to reduce the risk posed by an aged asset failure rather than a network overload and thereby defer the investment required to replace aged assets.

This project is co-funded with the Australian Renewable Energy Agency (ARENA) and the City of Sydney.

9.2 Project aims and expectations

The project originally set out to explore two key objectives:

- Test the effectiveness of incentives to market providers in a targeted geographic area that lead to new installations of technologies that offer permanent demand reductions (e.g. solar power and energy efficiency). This trial is aimed to test whether targeted incentives can create additional customer activity (i.e. above business as usual).
- Study the viability of traditional demand response options to manage load at risk in the event of a network outage. This objective would be more focused on exploring the potential of using customer generation, battery storage, load shedding or other flexible demand response options for longer durations typical of a network outage scenario.

9.3 How and why project complies with the project criteria

This project aims to build demand management capability and capacity by exploring solutions targeted at non-network options that defer or manage the load at risk associated with network investments that involve retiring / replacing aged assets. Using non-network solutions to manage risk from replacement driven investments differs markedly from typical overload risk.

The project aims to investigate an innovative approach to build a portfolio of permanent and temporary load reductions across the daily profile and is considered innovative in that applying demand management solutions to address aged asset related network investments is a new and emerging application of demand management.

[20] https://arena.gov.au/projects/ausgrid-power2u/

9.4 Implementation approach

The project will be conducted in three phases:

Phase 1: Market engagement and provider selection – invite submissions/proposals from market to clarify specific trial operational issues and select preferred project partners. Establish service contracts with market providers and project partners. Completed in 2018-2019.

Phase 2: Initiate and operate trial activities over a period sufficient to allow the market to develop and deliver outcomes (est. 18 to 24-month period). Further details can be found in Ausgrid's DMIA 2020-2021 Annual Report.

Phase 3: Assessment of trial objectives with project partners, reporting and sharing of lessons learned.

9.5 Outcome measurement and evaluation approach

One of the key objectives of the project was to seek to establish what additional uptake of permanent demand reducing technologies, such as solar PV and energy-efficient lighting upgrades, is generated by providing incentives to market providers in targeted geographic areas over a limited period. This would be evaluated by measuring the total take up from the incentive program and comparing to the background and forecast rate of uptake of solar and energy efficiency activities in the target areas estimated in the absence of any incentives.

Other outcomes that were considered included:

- Comparisons between the different approaches to targeting a geographic area. For example, target areas with one market provider versus areas with multiple providers competing for customer sales;
- The effectiveness of differing incentive values provided to market participants;
- Whether the incentive passed onto customers by market providers, whether in full or in part, was considered material to the customer decision-making process to invest in solar and energy efficiency and hence effective as an incentive;
- Whether the incentives provided, and approaches taken, would provide enough material change to the electricity demand in a targeted area to influence a typical network investment decision;
- How cost-effective the demand reductions are on a $ per kW or $ per MWh basis;
- What other market barriers or issues are experienced by the market providers in getting customers to invest in solar or energy efficiency technologies (e.g. premise ownership) and any insights on how to address these barriers; and
- Any other feedback from market providers that may assist in understanding how to improve targeted incentive programs similar to Power2U. This may include why or why not customer sales were made, what worked or didn't work effectively for different customer segments.

The second key objective was to understand whether traditional demand response techniques could be adapted and be an effective part of non-network solution to an aged asset replacement network investment. This was intended to be measured and evaluated by conducting customer research to explore whether demand response techniques could be used to address an outage scenario that might typically be longer in duration.

9.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2020-2021, total project expenditure to date and the total expected project costs by the completion of the project. All actual and projected costs are net of partner contributions. The only expenditure in 2021-2022 were in relation to the installation of 3 solar systems on participating schools.

Table 14 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$4,811	$1,432,048	$1,500,000

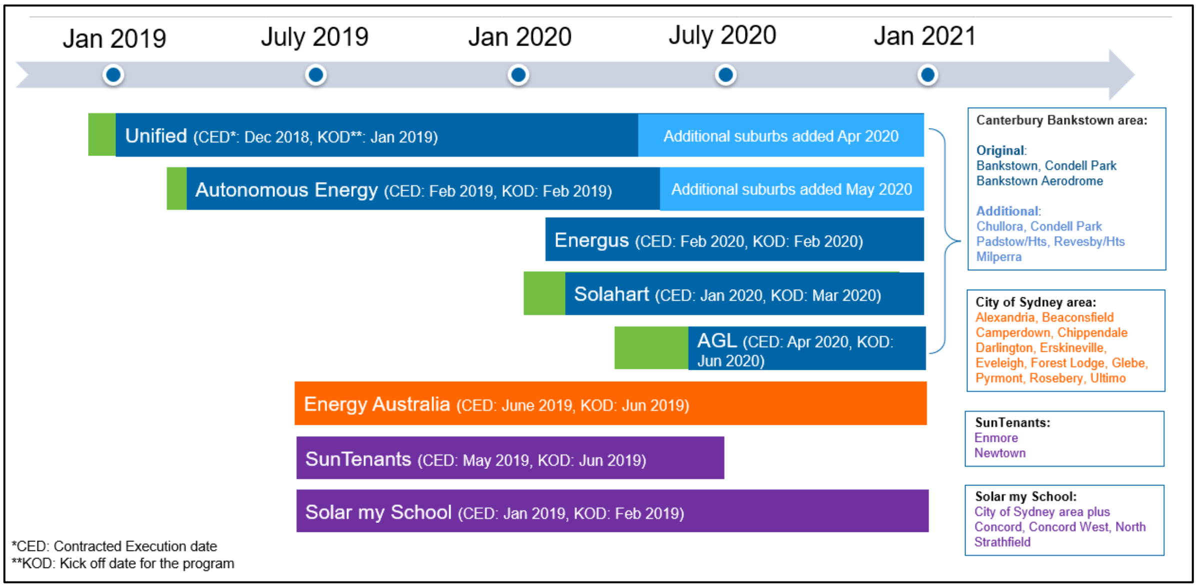
9.7 Project Activity and Results

9.7.1 Summary of project activity to date

Phase 1 - market engagement and provider selection of 8 market providers was completed by 2019-2020. The first 5 market providers had executed their contracts by end of 2018-2019-19, with the remaining 3 entering the program later in the program by end of 2019-2020.

Phase 2 - program activities were mostly conducted between 2018-19 and 2020-21, with the initial 5 market providers commencing their activities in 2018-2019. One of the market providers completed their involvement in the project at the end of this 2019-2020 reporting period. The 3 additional market providers who joined the program later, commenced their activities in the second half of 2019-2020. Of the 7 remaining market providers, all but one completed their committed sales under the program by December 2021, with additional time granted for all committed installations to be completed and verified by 30 June 2021. There were a total of 3 solar systems installed on schools during 2021-2022 due to delays in the gaining approval.

Figure 22 – P2U Program timeline



The various ways that the incentives were structured or promoted by the market providers in their marketing activities to end-use customers included:

- **Solar Subsidies** where the full $250/kW incentive was not passed on. For example,
    - In the residential market for example subsidies were offered at different dollar amounts based on system sizes e.g. to buy a 3kW system the customer could get an additional $450 rebate, or for a 5kW system the customer could receive a $750 rebate). The remaining portion of subsidies assisted in paying for marketing or resourcing costs.
    - Commercial subsidies were also offered on similar but larger scale e.g. rebates of $15,000 was offered on 100kW systems. The general response to subsidy offers at the lower rates helped to start conversations with potential customers. However, the market providers who started at a lower rate were able to shift to a higher level of subsidy towards the full amount. The increase made a significant difference in motivating customers to act and commit to accepting their proposals.
- **Efficient lighting retrofits** where the end-use customers were offered a free extended warranty on the lighting technology or a reduction in cost based on the $ per Energy Saving Certificate (ESC).
- **Limited offers** where the number of offers available was set to cap. One market provider advertised in their letterbox flyer, “offer limited to 50 households only”. However, this did not

appear to resonate that strongly and there was only a modest uplift in solar quotations following these types of incentive offers.

- **Limited time offers** on when installations must be made. One market provider in the Canterbury Bankstown area advertised that to receive the offer for subsidies relating to the P2U program, the installation must be made by 30 June 2020 to create a sense of urgency to motivate customers to commit to accepting proposals.

Phase 3 – assessment of trial objectives, reporting and sharing of lessons learned was substantially complete by the Ausgrid project team at the end of 2020-2021. As part of our funding agreement with ARENA, they required completion of our ARENA knowledge sharing report by April 2021. Consequently, the ARENA funded part of the project in the Bankstown area was wound up at end of 2020 with final installations permitted to end March 2021. This report has since been approved and is now publicly available on ARENA's website[21] or on Ausgrid's website via the Demand Management web page for Innovation Research and Trials at www.ausgrid.com.au/dm.

But while the ARENA funded component of the project in the Bankstown area was required to be completed per ARENA's timeline, the schools and City of Sydney components of the project continued until June 2021. This allowed for the extended assessment and tender timelines associated with new solar installations on NSW State schools, as well as additional time for solar and lighting installations to be completed in the City of Sydney area. Final project activities occurred during 2021-2022 which were the installation of 3 solar systems on schools in the Inner West area. No further activities are anticipated under this project.

9.7.2 Update on material changes to the project

This project has been expanded and extended to fully test the original objectives and in response to early trial results. Notably, Phase 2 project activities took longer to commence than anticipated, and to allow the incentive offer to extend over a period of about 18-24 months, phase 2 activities were extended.

In response to preliminary results and feedback from market providers, the number of market providers operating in trial area two was increased from two to five and the geographic area for this trial area was increased in size.

Also, in response to preliminary results, the incentive level applied to trial area one was increased to align with that offered in trial area two.

As mentioned in the previous section, due to one of the market providers operating in the program's niche school segment, its ability to facilitate delivery of the school installations was heavily influenced by internal decisions by the NSW Department of Education. The Department has made relatively material changes to its tendering, approval, and installation processes during 2020-2021 that impacted the timing of the installation of solar systems for the majority of the schools in the Power2U program. Marketing activities were completed at end of June 2021 with installation of new systems completed by June 2022.

Further details on trial operational changes are found in the knowledge sharing report published on ARENA's and Ausgrid's websites.

9.7.3 Collected results

As mentioned above, the only activity during 2021-2022 related to the installation of 3 solar systems on schools in the program. Tables 16 and 17 per the DMIA Annual Report 2020-2021 have been updated here to reflect these additional solar systems.

[21] https://arena.gov.au/projects/ausgrid-power2u/

UPDATED Table 16 (from DMIA Annual Report 2020-2021) - Power2U Project Solar PV Activity Summary

Provider	Actual sales (kW)			Committed sales (kW)	Totals (kW)
	FY 19/20	FY 20/21	FY 21/22		
A	180	396	0	417	993
B	540	435	0	0	975
C	0	495	0	198	693
D	0	315	0	0	315
E	0	100	0	0	100
F	0	52	0	0	52
G	0	106	66	0	172
Total kW	**720**	**1,899**	**66**	**615**	**3,300**

UPDATED Table 17 (from DMIA Annual Report 2020-2021) - Power2U Project Solar PV Activity by Solar system size

Solar System Size	Business		Residential		Schools	
	Customers	kW	Customers	kW	Customers	kW
0 to 30 kW	29	465	11	66	5	110
>30 to 100 kW	30	1983			1	41
>100 to 200 kW	4	598				
Total	**63**	**3,046**	**11**	**66**	**6**	**151**

All other information is unchanged from the last year's report and is not reproduced here for brevity. For further details, please refer to the DMIA Annual Report 2020-2021.

9.8 Other Information

General information about the Power2U project can be accessed on Ausgrid's Demand Management web page from the Innovation Research and Trials link: www.ausgrid.com.au/dm

If you have a specific information request regarding this project which may assist you in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.

10 Virtual Power Plant (Battery Demand Response)

This project is a continuing Demand Management Innovation Allowance (DMIA) project from Ausgrid's last regulatory control period 2014-2019 into the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2021-2022 regulatory year.

The project concluded in 2021-2022 regulatory year. A full report of the project will be published on Ausgrid's website later in the 2022 calendar year.

10.1 Project nature and scope

Ausgrid's Battery Demand Response (Virtual Power Plant, VPP) trial explores whether battery VPP's can provide reliable and cost competitive sources of demand reductions or voltage support services to defer network investment. This project seeks to show how the grid can integrate with renewables and partner with industry and customers to maximise grid efficiency benefits and reduce costs for customers. This project aims to investigate the potential application of demand response for residential batteries for network support services by engaging with customers with an existing battery system that is VPP capable.

10.2 Project aims and expectations

The three primary objectives of the project are to:

- Test whether customer battery systems offer a technically and commercially viable demand management option.
- Test customer take-up of a network support (demand response) offer whereby customer battery systems are dispatched to align with network needs.
- Investigate and trial the battery dispatch systems from market providers and explore possible integration of battery management platforms or systems within the Distributed Energy Resource (DER) optimisation platform of Ausgrid's Advanced Distribution Management System (ADMS).

Secondary objectives include;

- Better understanding of the types of customer battery systems being installed by early adopters of the technology
- Better understanding of the impacts on maximum demand and energy volume for a customer with a battery system with and without a demand response offer.

10.3 How and why project complies with the project criteria

This research project explores the demand management capability of a battery VPP (Virtual Power Plant) with market providers. Over the course of the trial, the batteries located on customer's premise are dispatched to provide support to the network. Each Ausgrid dispatch event is crafted to explore a research objective in areas such as the delivered reduction in demand on the grid and the performance of Battery Management Systems (BMS). By offering reliable and cost competitive sources of demand reductions or voltage support services, battery VPPs have the potential to help avoid or defer network investment.

Battery VPPs are considered a new and emerging concept and the technology is rapidly evolving. The project is considered innovative in that this is a large scale VPP (multiple MWs of dispatchable capacity) being tested by a distribution network service provider across a range of different battery aggregators, aggregator and customer models and battery manufacturers.

10.4 Implementation approach

The project is planned to be divided into 3 phases to align with the objectives set for the project:

- Phase 1 – Battery customer market research
- Phase 2 – Customer trial over 2 or more years
- Phase 3 – Distributed Energy Resource integration with the Advanced Distributed Management System (ADMS)

Phase 1 of the trial included collation and analysis of information of battery systems connected to Ausgrid's network and an exploration of possible offers and contractual arrangements with a range of different market providers (e.g. battery suppliers, aggregators, and energy service providers). This Phase was completed in 2018-2019.

Phase 2 of the project includes customer battery system dispatch and further development of aggregator partnerships. This Phase was initiated in 2018-2019.

Phase 3 of the project will consider integration of network support dispatch and constraint management into the DER platform of Ausgrid's Advanced Distributed Management System (ADMS). This phase will not be initiated in this trial as Ausgrid's ADMS is currently not available.

10.5 Outcome measurement and evaluation approach

The project will be assessed by evaluating the extent to which the project objectives are met as well as meeting the project delivery milestones as outlined in the implementation approach.

Project activities designed to achieve these objectives include:

- establishing dispatch event schedules which test a wide range of battery and VPP performance including summer and winter peak events and periods of minimum demand;
- collaborating with providers to better understand customer views and preferences;
- analysis of battery performance for dispatch and non-dispatch days across a range of scenarios;
- identification of customer benefit from both VPP dispatch and business as usual battery operation;
- assessment of the impact of retail tariffs on customer benefits;
- comparing battery performance across individual battery types and VPP providers;
- assessing for the option of expanding the number of customer and/or the number of VPP providers;
- collaborating with VPP providers to improve dispatch performance and trial innovative battery management techniques to better align battery dispatch performance with network needs; and
- comparing resultant VPP performance and costs, adjusted for any possible future improvements, against representative network needs to determine the viability and cost effectiveness of the solution.

10.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2019-2020, total project expenditure to date and the total expected project costs by the completion of the project.

Table 15 - Project Costs

Budget Item	Actual project costs 2021-2022	Total project costs as at end of June 2022	Total expected project costs
Total project costs (excl GST)	$241,676	$1,102,559	$1,180,000

10.7 Project Activity and Results

10.7.1 Summary of project activity and collected results to date

Ausgrid's partnership with Reposit Power[22] marked the beginning of the customer trials with hundreds of customers combining to form a 1MW (megawatt) VPP. In 2019-2020, Ausgrid completed an open tender process to add new VPP providers to the trial, which received 11 responses from the market. As part of the process, Evergen[23] and ShineHub[24] were selected to join the trial. Ausgrid's VPP fleet currently

22 https://www.repositpower.com

23 https://www.evergen.com.au

24 https://www.shinehub.com.au

consists of approximately 750 battery customers. . With multiple fleets and providers and a range of battery types in the trial, Ausgrid is able to compare different elements to identify how the various providers and batteries perform within a VPP.

The project activities have not been planned to align with an area of the network with an investment need. The project is designed to build capability and capacity and explore efficient demand management mechanisms with market providers.

For results from earlier years, please refer to content from earlier AER DMIA reports on the AER's website[25] and published VPP reports on Ausgrid's website[26]. A summary table of dispatches completed during the trial has been provided below.

Table 16 – Dispatch details

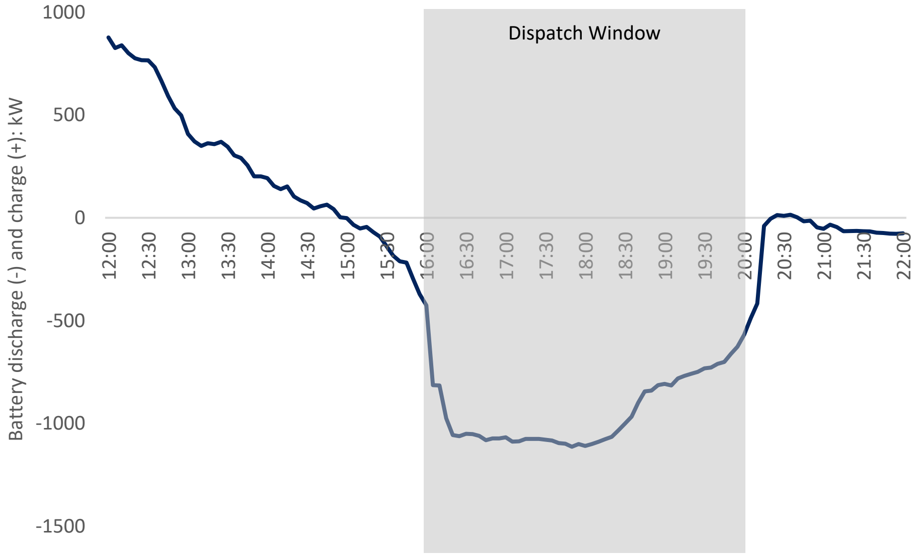
	FY19	FY20	FY21	FY22
Energy Dispatched (MWh)	7	12	61	62
Approximate fleet size (No. of Customers)	237	350	750	750
Event days[27]	12	42	69	64

Results from the 2021/22 activities are as follows:

Summer dispatch

Figure 23 shows a VPP dispatch on 10 February 2022 with approximately 670 batteries involved across Ausgrid's network. This was one of the largest dispatches conducted in the trial with over 3.7MWh of total energy discharged during the 4-hour event with all three VPP providers involved. The reduction in energy output for the last hour of the dispatch event was due to one of the fleets unexpectedly running out of power. Further exploration into achieving consistent output is discussed in the next section.

Figure 23 - VPP Dispatch on 10 Feb 2022



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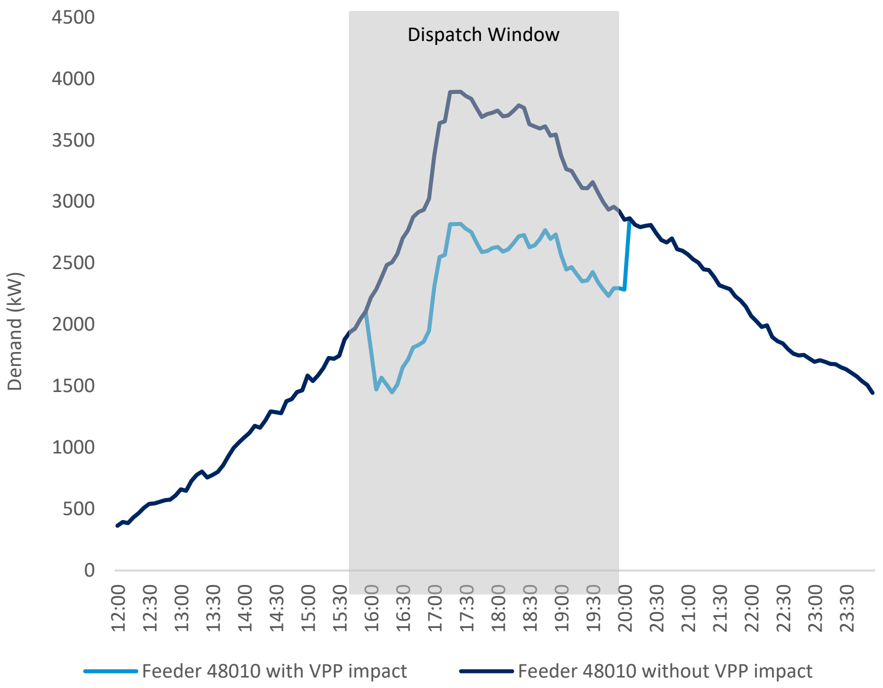
[25] www.aer.gov.au/networks-pipelines/compliance-reporting

[26] www.ausgrid.com.au/Industry/Our-Research/DMIA-Research-and-trials

[27] While the vast majority of event days tested dispatching energy, feed in management was tested with a small group of batteries for 20 days.

Figure 24 demonstrates the projected demand reduction that could be achieved if all 670 batteries were connected to 11kV feeder 48010 on Telarah Zone Substation. The dispatch in Figure 23 would reduce the peak demand on 11kV feeder 48010 by over 1MW.

Figure 24 - Projected impact of VPP dispatch on 11kV Feeder 481010 for the dispatch on 10 Feb 2022



This 11kV feeder 48010 was part of Ausgrid's Gillieston Heights Demand Management RFP published in 2019, in which Ausgrid invited non-network option providers to propose demand reduction initiatives to address capacity constraints in the area (see Table 17). The dispatch in Figure 23 would have been sufficient to address the capacity constraint in 2021-2022. This demonstrates that with a sufficiently sized fleet, VPPs have the potential to address network constraints. There are approximately 1600 customers connected to the 11kV feeder, which means 40% of the customers would need to own a VPP battery to match the size of the VPP dispatch on 10 February 2022. This requires a significant increase in battery uptake on the feeder.

Table 17 - Annual forecast capacity constraint on 11kV Feeder 48010 for Gillieston Heights RFP in 2019

Measure	Year 2021-2022	Year 2022-2023	Year 2023-2024
Capacity Constraint (kW)	914	1448	1981

Optimising power output

Figure 25 and Figure 26 below show dispatches where the discharged power significantly declined during the final 25-40% of the dispatch window. The fleet continued to discharge power after the dispatch event, which indicates that there were batteries in the fleet that had the capacity to deliver additional power during the dispatch window. For this particular fleet, the dispatch instruction with a target output is sent to each battery prior to the event. No further instructions are sent during the event. In cases where some batteries are unable to deliver their target power during the event, no updated instructions are sent to other batteries to deliver additional power to make up for the shortfall, which results in a decline in overall fleet output.

Figure 25 – Dispatch on 25 May 2022 with fleet 1

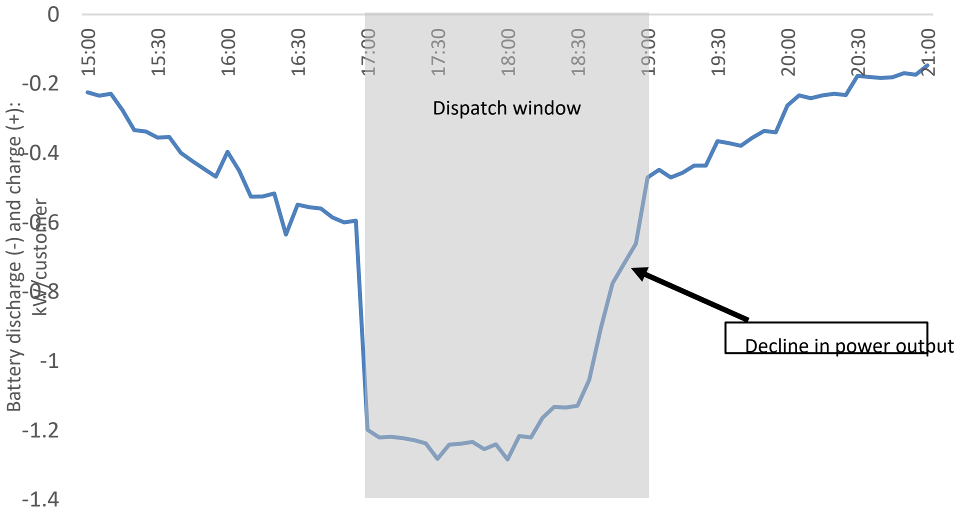


Figure 26 – Dispatch on 30 May 2022 with fleet 1

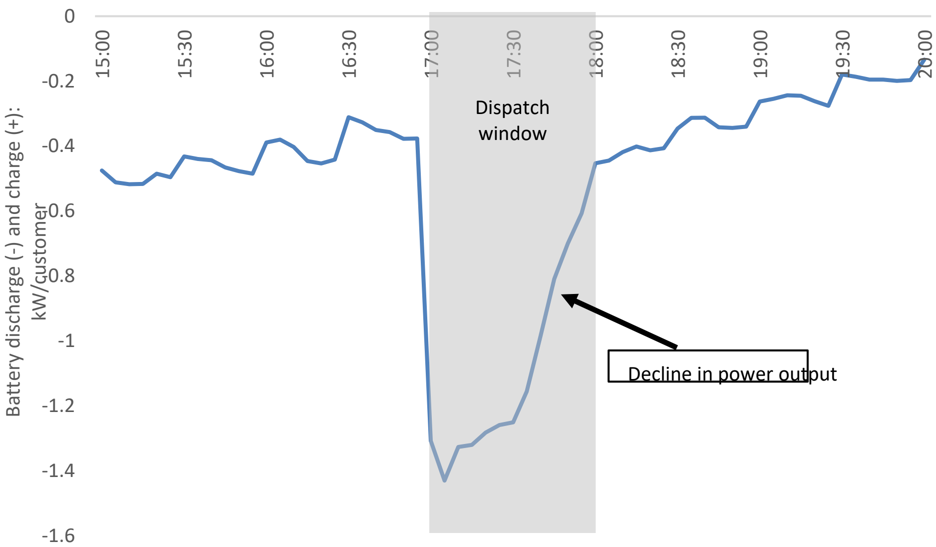


Figure 27 and Figure 28 show dispatches for two other fleets where updated dispatch instructions are sent constantly throughout the dispatch window. Where there are batteries that are unexpectedly unable to deliver the required amount of power, updated dispatch instructions are sent to other batteries for additional power output to make up for the shortfall, which enables the fleet to deliver relatively constant amount of energy and meet the overall target power output. This type of dispatch requires a reliable communication network so that new dispatch instructions can be constantly sent to the batteries.

Figure 27 – Dispatch on 17 Feb 2022 fleet 2

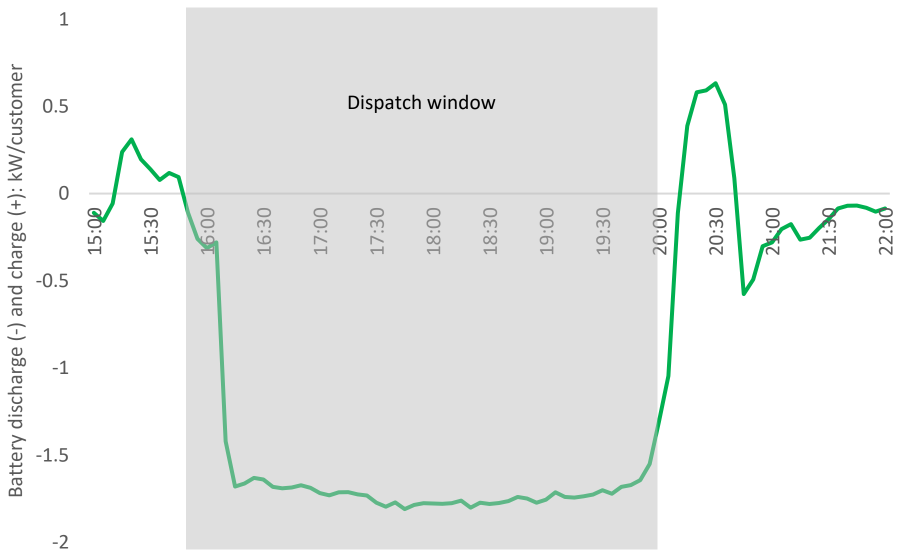
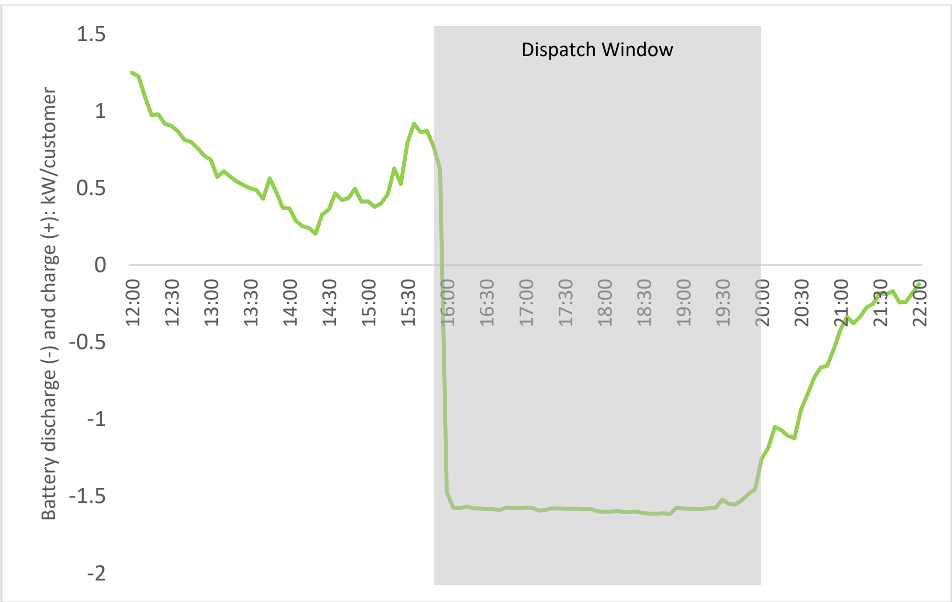


Figure 28 – Dispatch on 16 Jun 2022 with fleet 3



Template dispatch

The previous charts (Figure 27 and Figure 28) show dispatches where the aim is for the VPP fleet to discharge constant power throughout the event, which allows for better predictability of the energy output. One of the issues with this type of constant dispatch is that the output is unlikely to match the load profile as load profiles are usually not constant.

For the first time in the trial, template dispatch was tested in the summer of 2021-2022 (see Figure 29 and Figure 30). The objective of this type of dispatch is to discharge VPP power in a particular shape that resembles a typical load. The output shape for the dispatch is set by the user prior to the event. In comparison to a constant dispatch, this type of discharge allows for the discharge profile to better match the load profile. However, the template shape is not dynamically updated throughout the event therefore the shape of the output and the actual load profile are unlikely to exactly match, and in many cases could be significantly different.

Figure 29 – Template dispatch on 31 May 2022

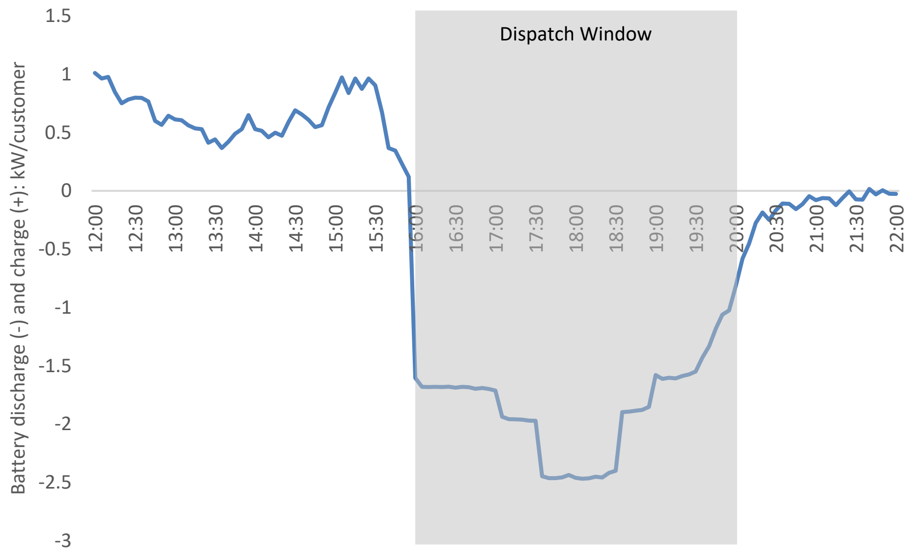
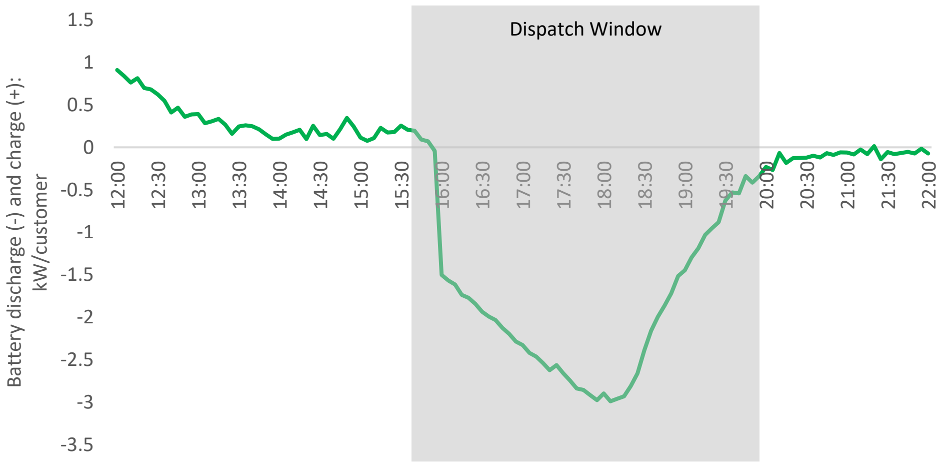


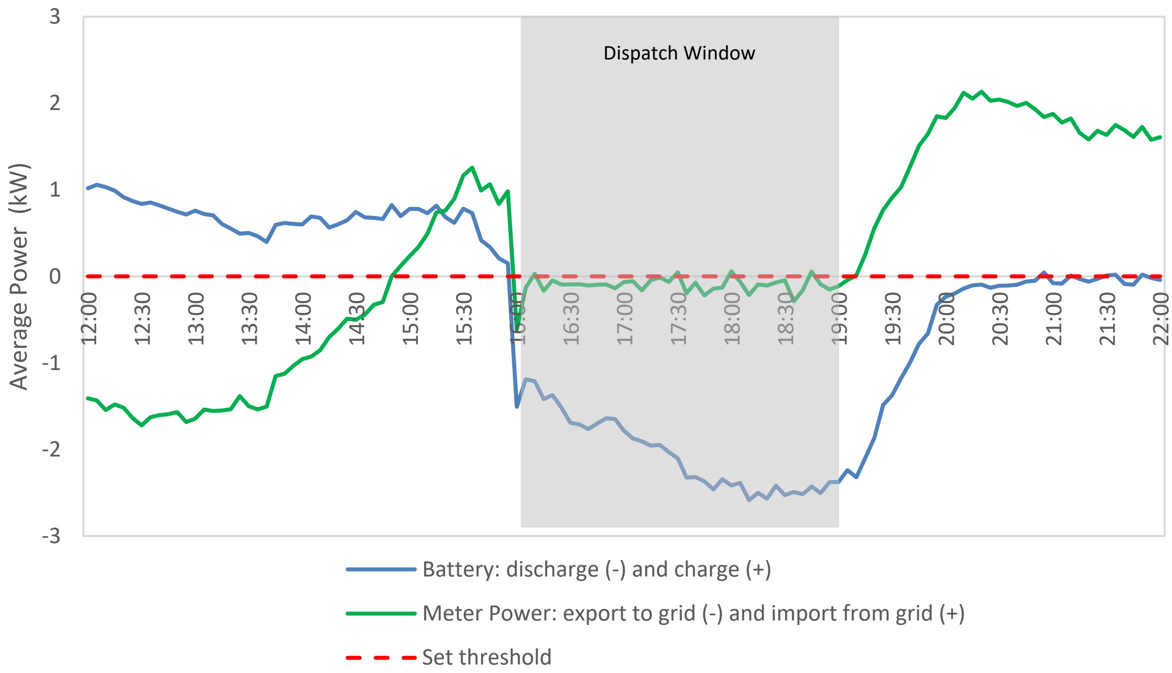
Figure 30 – Template dispatch on 28 January 2022



Dynamic dispatch

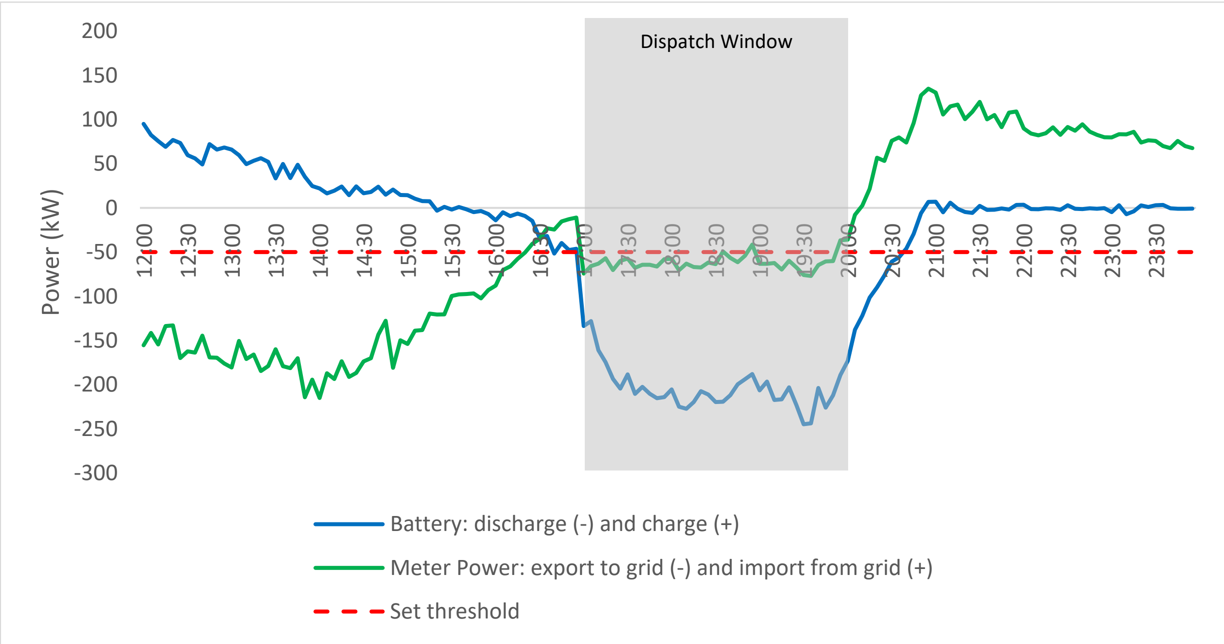
A dynamic dispatch is where the dispatch power of the VPP is constantly adjusted to ensure that overall load at the meter point is below a certain threshold set by the user. Dynamic dispatch was tested for the first time in 2020-2021 and Ausgrid has continued to test this feature. Figure 31 shows a dispatch where the load threshold is set to zero and the VPP fleet discharges power to match the load so that there is zero import from the grid. This type of dispatch could assist with capacity constraint on the network by setting a threshold that is within the capacity of the constrained asset.

Figure 31 - Dynamic dispatch on 1 June 2022 with load threshold of zero at the metering point



The threshold can also be set so that there is a net export at the metering point for times when the network requires additional power. Figure 32 demonstrates a dispatch where minimum net export of 50kW is requested and the output is adjusted to ensure this net export is delivered during the event. One of the advantages of this type of dispatch include better match between VPP output and the load. One of the possible issues with a dynamic dispatch is that there are greater communication requirements as the VPP fleet is dynamically responding to feedback from the load or network.

Figure 32 – Dynamic dispatch on 16 September 2021 with threshold set to minimum export of 50kW



Feed in Management

High voltage conditions can occur on the network during minimum demand periods when load is low and solar export is high. With high growth in solar connections, instances of high voltage conditions are increasing. A customer's solar power system may be interrupted or reduced in output where local network voltages are high. There are a number of network solutions that can be implemented to address these high voltage conditions. To explore alternative methods of addressing high voltage issues, Feed in Management (FiM) functionality is being explored to test its reliability and efficacy. Both gross and net FiM were tested during the trial. Net FiM restricts solar generation to supply customer load and limit the net export to a set value. For example, net zero FiM event would restrict solar generation to supply only the load and limit net export to zero. Gross FiM turns off all solar generation regardless of the load.

In October 2021, Ausgrid invited 29 VPP customers with suitable FiM technology to participate in the FiM trial, which resulted in four customers opting into the trial. Figure 33 and Figure 34 show the results of a net zero export FiM event scheduled between 11am-1pm on 3 November 2021. There was no response from in solar output as the systems were not configured appropriately. Consequently, no changes to the voltage profile was observed (see Figure 34)

Figure 33 - Net zero export FiM event on 3 November 2021

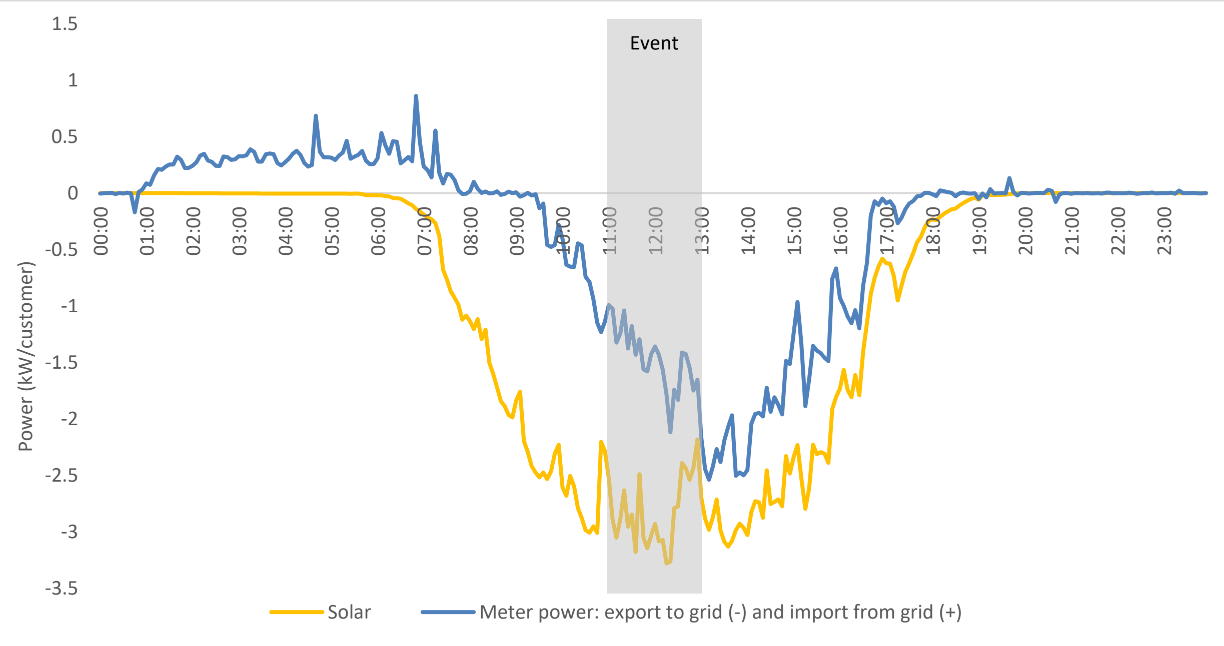
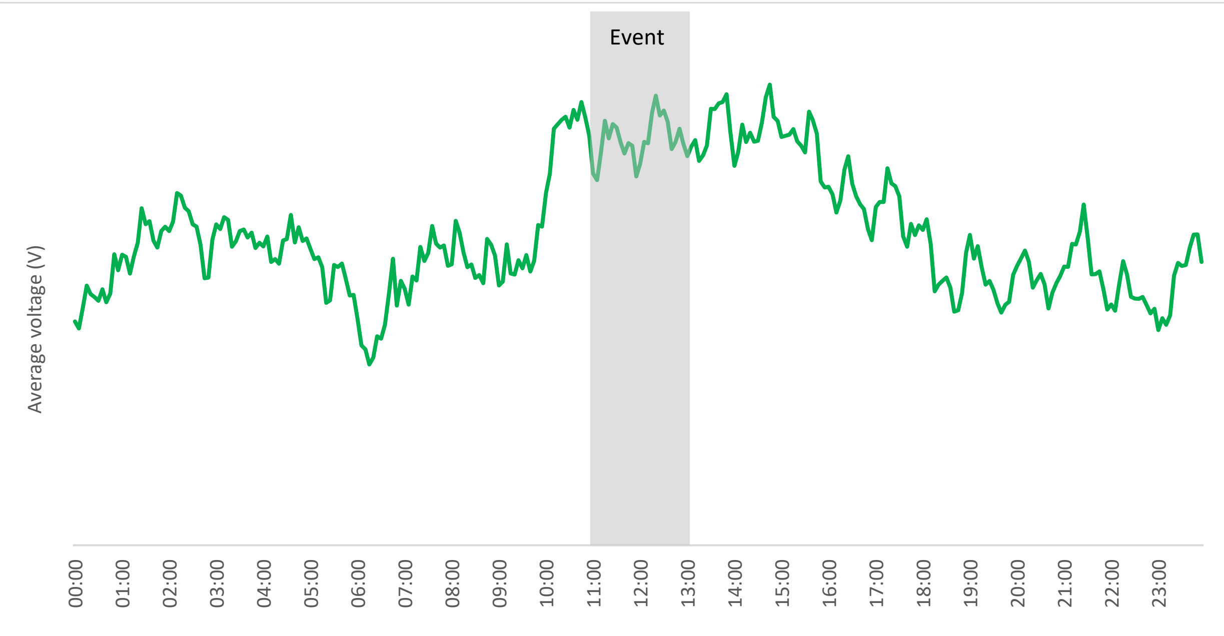


Figure 34 - Voltage profile for net zero export FiM event on 3 November 2021



After appropriate configurations were set up, another net zero export FiM event was tested on 15 November 2022 between 11am-3pm (see Figure 35). Ideally there should be net zero export at the metering point between 11am-3pm. Figure 35 shows that solar output was curtailed and the net export was reduced but still resulted in some export to the network during the event. According to Figure 35, there was a reduction in average voltage level during the FiM event.

Figure 35 - Net zero export FiM event on 15 November 2022

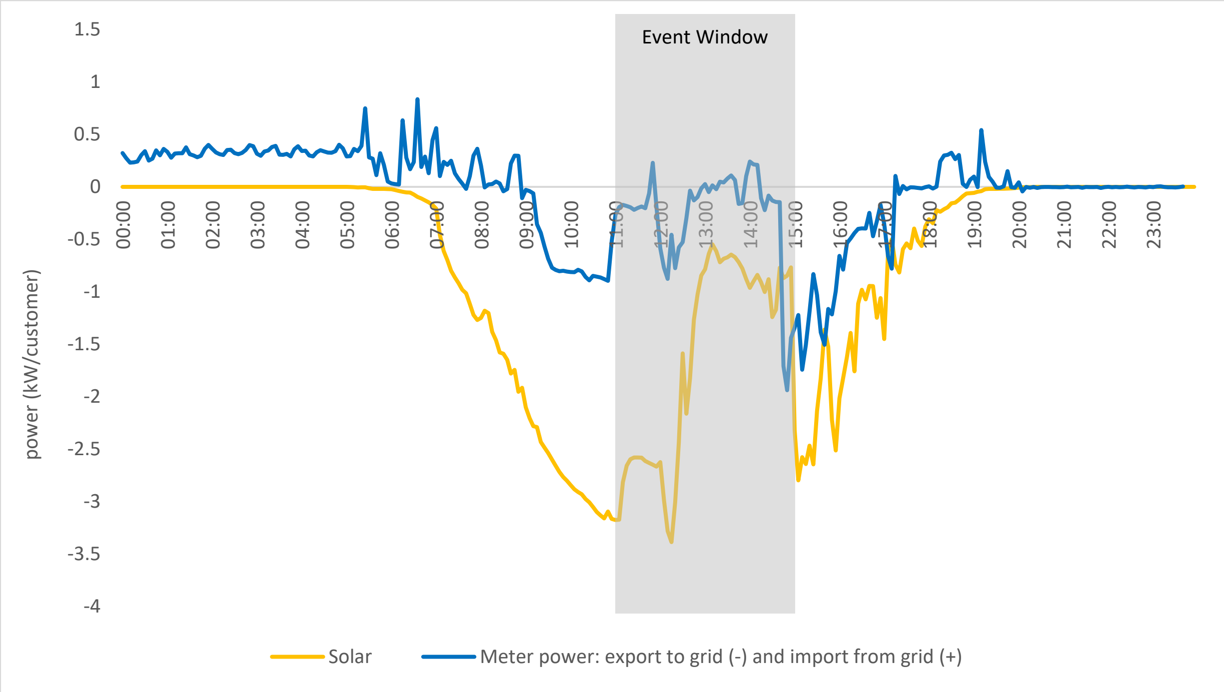


Figure 36 - Voltage profile for customers participating in net zero export FiM event on 15 November 2022

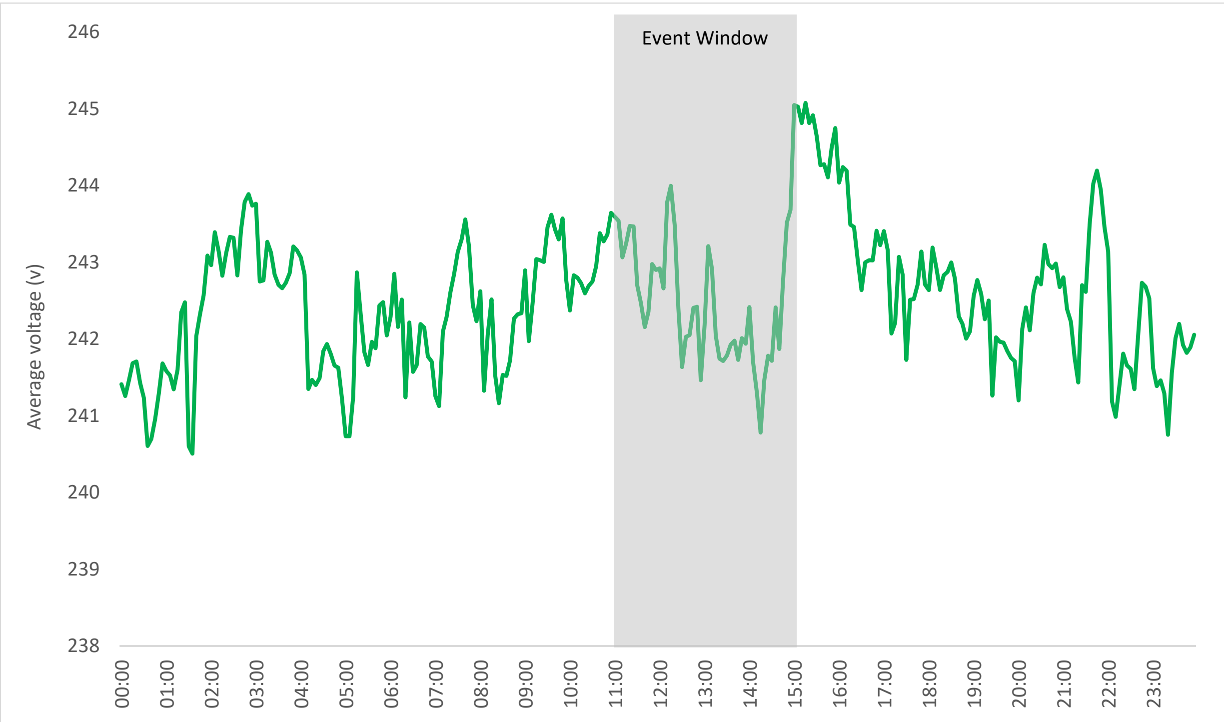


Figure 37 shows a FiM event where net zero export was mostly achieved for the duration of the event window. Corresponding voltage profile shows a decrease in voltage during the event (see Figure 38).

Figure 37 - Net zero export FiM event on 17 November 2022

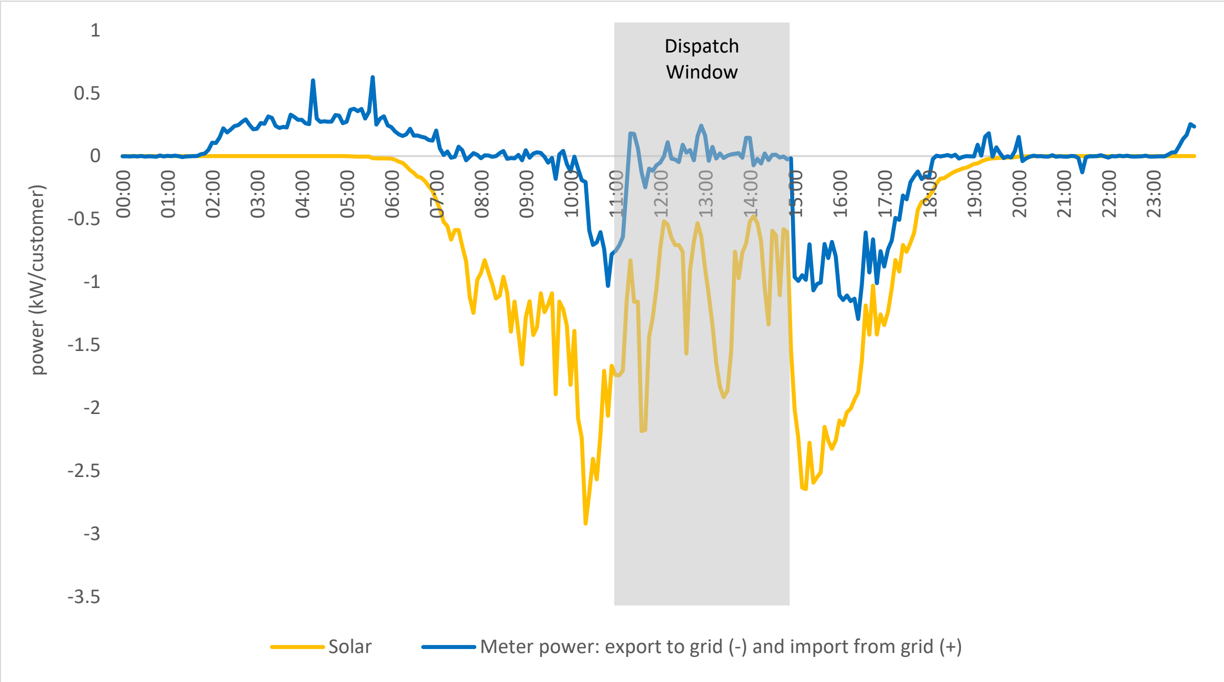


Figure 38 - Voltage profile for customers participating in net zero export FiM event on 17 November 2022

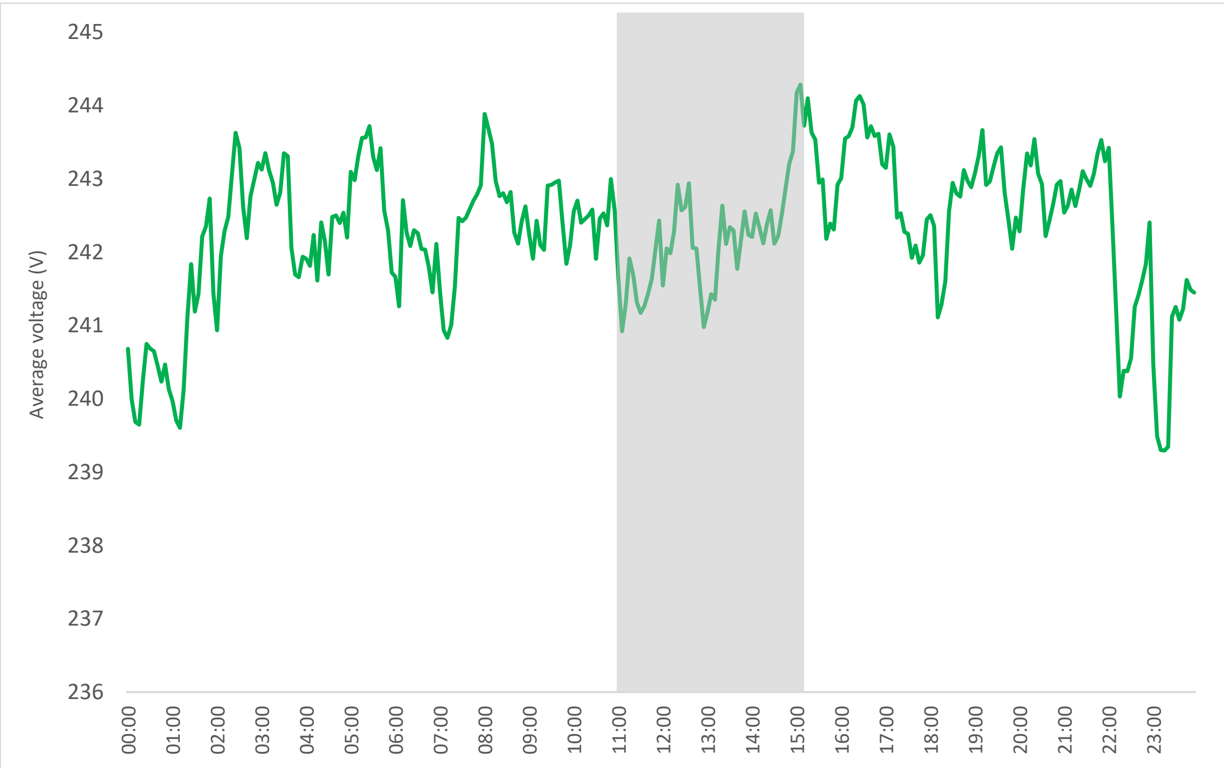


Figure 39 shows gross FiM event where solar production was stopped between 12-1pm, which resulted in the customer having to import energy from the grid. The corresponding voltage profile show a clear noticeable reduction in voltage (see Figure 40).

Figure 39 - Gross FiM event on 18 November 2022

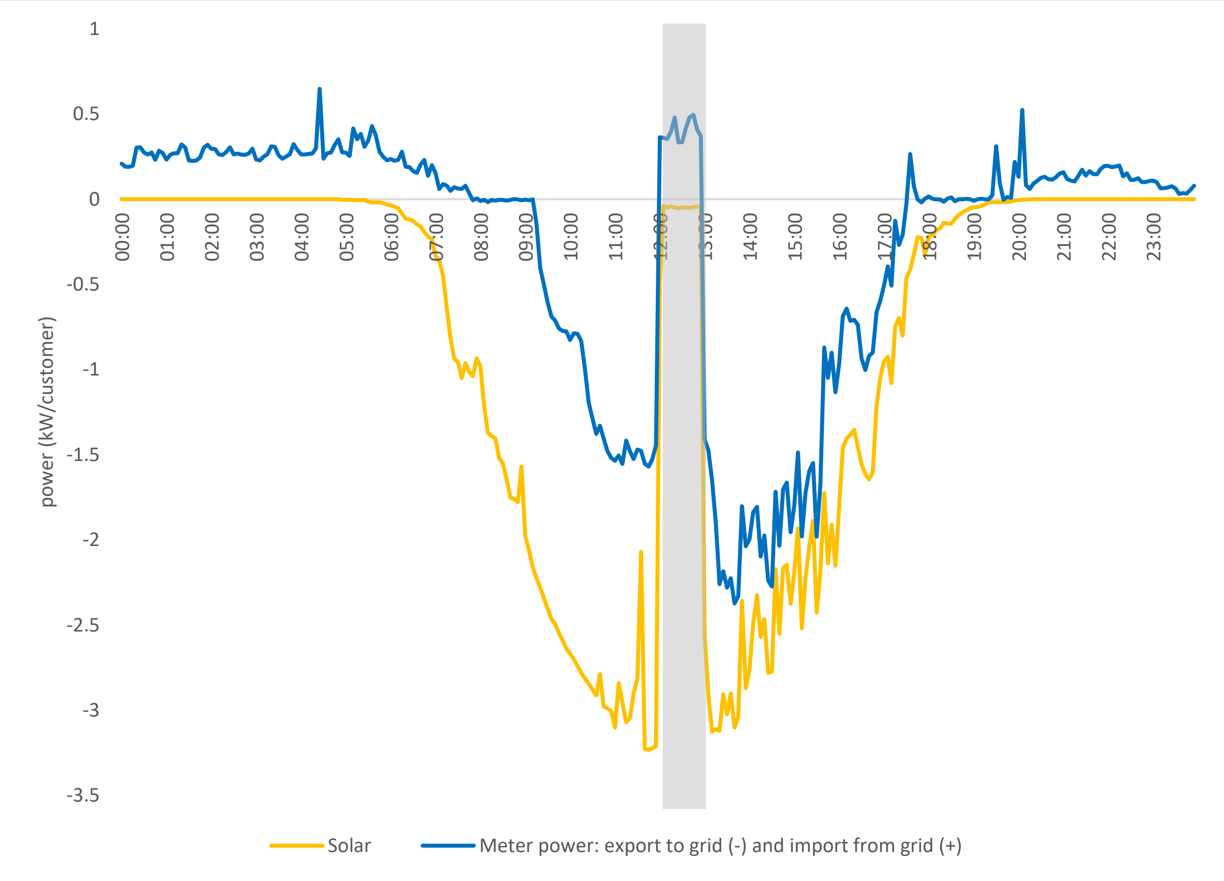
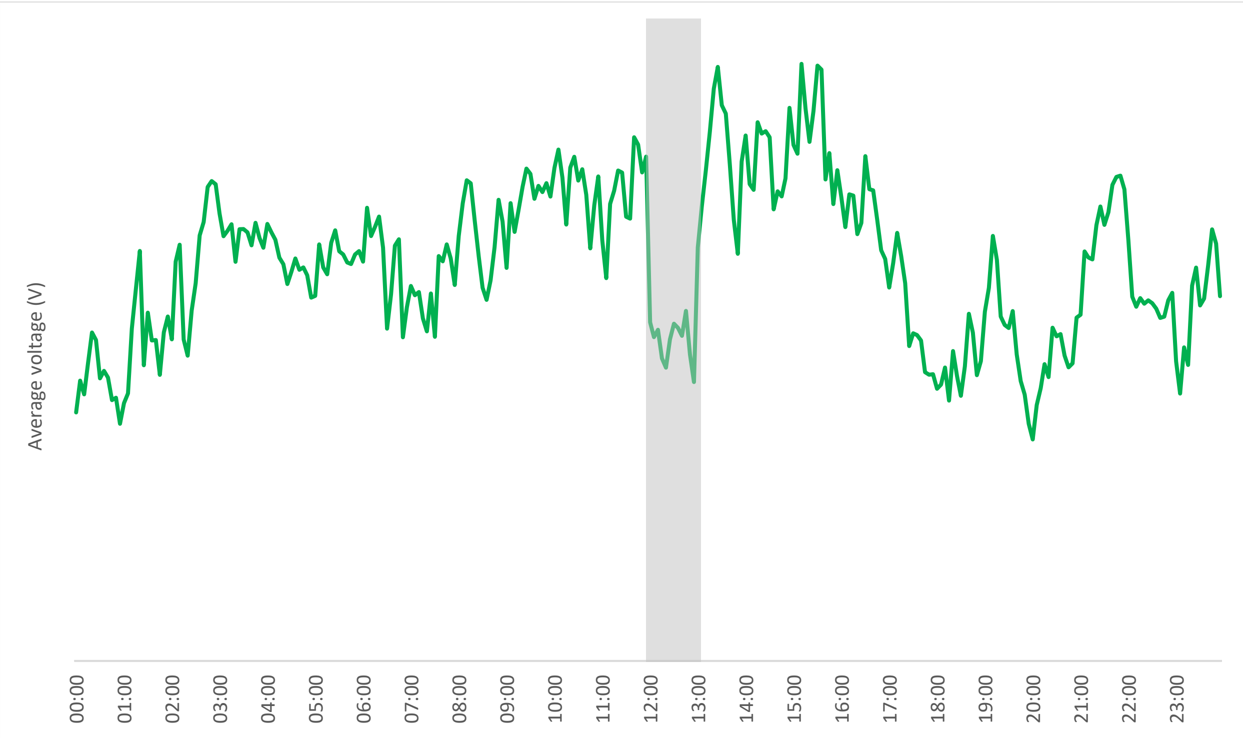


Figure 40 - Voltage profile for gross FiM event on 18 November 2022



Summary

Key findings from the trial results in 2021-2022 include:

- A battery VPP has the potential to address network constraints and offer an alternative option to a network upgrade. A significant increase in battery uptake is likely required to set up a VPP fleet large enough to meet a particular local network constraint.
- VPP dispatches can be optimised by sending updated instructions during the event to adjust for shortfalls from some batteries in the fleet.
- A template dispatch that discharges VPP power in a particular shape to resemble a typical load can provide better match between discharge and the load profile in comparison to a constant output dispatch. The output shape of the discharge profile is unlikely to exactly match the load profile if the output shape is set prior to the dispatch and is not dynamically updated throughout the event.
- Dynamic dispatch that constantly monitors the load and controls the VPP output to match the load allows the network to control the total load at the metering point. This type of dispatch requires constant communication with the VPP fleet.
- Both gross and net export FiM can help lower voltage during minimum demand days. However net export FiM is preferrable as the solar can still supply the house load.
- Net FiM is more complex and difficult to achieve compared to gross FiM as the algorithm must constantly adjust the solar output to supply the house load but limit export to the set threshold.
- Gross FiM can add costs to the customer's bill as it stops all solar production, which can result in the customer importing energy from the grid.

10.8 Other Information

General information about the VPP project can be accessed on Ausgrid's Demand Management web page from the Innovation Research and Trials link: https://www.ausgrid.com.au/Industry/Demand-Management/Power2U-Progam/Battery-VPP-Trial.

If you have a specific information request regarding this project which may assist you in understanding, evaluating or reproducing this project please contact demandmanagement@ausgrid.com.au.