Demand Management Innovation Allowance Mechanism

Annual Compliance Report, 2022-2023

September 2023

Demand Management Innovation Allowance Mechanism

Annual Compliance Report, 2022-2023

September 2023

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 2022-2023 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; **[Section 2.2]**
b) a list and description of each eligible project on which the allowance was spent; **[Section 2.1]**
c) a summary of how and why each eligible project complies with the project criteria; **[Section 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 **[Section 3 to 12]**:
    i) the nature and scope of each eligible project or program,
    ii) the aims and expectations of the eligible 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 eligible project:
        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. **[Section 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: **[Section 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 2022-2023 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
Completed Projects as of 30 June 2023		
Battery Demand Response (Virtual Power Plant)	This project aimed to investigate the potential application of demand response for residential batteries for network support services by engaging with customers with an existing battery system. It also explored whether battery VPPs can provide reliable and cost competitive sources of demand reductions, load management or voltage support services to defer network investment.	This research project explored the demand management capability of a battery VPP (Virtual Power Plant) with market providers. Battery VPPs are considered a new and emerging concept and the technology is rapidly evolving. The project was innovative in that it was a large scale VPP (multiple MWs of dispatchable capacity) being tested by a distribution network service provider across a range of different battery aggregators, customer models and battery manufacturers.
Electric Vehicle Demand Research	This project explored 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 aimed to understand the possible electricity demand impacts from electric vehicle charging on network assets and then participated in EV trials that investigated the potential demand management options for addressing future network investment needs.	This project aimed 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 was a 4-year research project led by Monash University and in which Ausgrid was both co-funding and an in-kind contributor in	This project aimed to build demand management capability and capacity in the household customer segment by better understanding households existing and future trends in everyday

Project	Description	How and Why Project meets DMIAM Criteria
	partnership with Energy Consumers Australia and Ausnet Services. The project aimed to understand and forecast customers' changing digital lifestyle trends and their impact on future household electricity demand, including at peak times.	household energy use practices and how effective demand management solutions can be developed for the household segment. This research program adopted innovative approaches by applying ethnographic research techniques and sociological theories to investigate how changing social practices will impact on electricity sector planning.
Ongoing Projects as of 30 June 2023		
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 or reduce the need for longer term network infrastructure upgrades.	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 leverage the roll out of smart meters and collaboration with electricity retailers.
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	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.

Project	Description	How and Why Project meets DMIAM Criteria
	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.	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.
Project Edith Customer Payments	Project Edith has three primary objectives: 1. To test and demonstrate the effectiveness of managing network capacity through dynamic network pricing in a growing two-sided market. 2. To highlight and inform key areas in operationalising this model. 3. To engage and share insights within industry. The rapid demonstration phase sets out to meet these by developing an end-to-end dynamic pricing system and enrolling customers from participating customer agents (electricity retailers or aggregators) to test outcomes. This DMIA project establishes a mechanism for reconciliation payments to participating customer agents.	Project Edith is exploring the effectiveness of dynamic network pricing to improve utilisation of distribution networks. If found effective, these price signals can reduce network costs to manage the impacts from minimum and maximum demand based on current and future trends, as well as improve customer outcomes such as reducing the need for curtailment of solar exports and unnecessary network upgrades. Importantly, achieving these outcomes will be primarily by effecting the behaviour of CER. This project is critical research to ensure Ausgrid, other DNSPs and AEMO can identify how effective dynamic pricing signals are at influencing CER and consequently the future NEM. The DMIA funds payments to participating retailers to reconcile the difference between each customer's network tariff and the tested Edith tariff. This enables the testing of Edith as an off-market tariff for the purpose of allowing a lean and iterative research approach that could not have been achieved with an on-market sub-threshold trial tariff. Furthermore, this approach enables participation with an aggregator who is not registered as the customer's retailer but has an agreement to control customer assets for demand management purposes. This is the first trial of its kind in Australia. Dynamic Network Pricing can specifically target emerging issues that are widely regarded as key risks in our transition to a net zero, distributed energy system.

Project	Description	How and Why Project meets DMIAM Criteria
Project Edith CSIP-Aus Specification Extension	This project proposes to develop, build and test an extension to the currently published version of the CSIP-Aus API (Common Smart Inverter Profile – Australia, Application Programming Interface), that being version 1.1 dated June 2020. This extension is needed in order to provide the functionality required to communicate the dynamic network prices to customer agents (retailers and aggregators) in Project Edith. CSIP-Aus is being adopted by DNSPs across the NEM for the communication of dynamic operating envelopes (including flexible exports). The outcomes of a successful dynamic network service is expected to include increasing market participation opportunities for CER, increasing network utilisation, as well as enabling customers to provide more efficient demand management support services based on two-way dynamic pricing rather than direct procurement.	This project will build technology to communicate pricing signals that will support Project Edith. If found effective, these pricing signals can reduce network costs to manage the impacts from minimum and maximum demand based on current and future trends, as well as improve customer outcomes such as reducing the need for curtailment of solar exports and unnecessary network upgrades. This will involve measures designed to reduce both peak demand and minimum demand scenarios. In the absence of real-time communication of dynamic network prices, customer agents would not be able to optimise these vital network capacity signals. Enabling this by extension of the CSIP-Aus API not only provides an effective method of dynamically managing network capacity, it does so in a way that will allow a consistent integration across different DNSPs in the NEM and therefore minimises costs to participants. This is to our knowledge the first implementation of dynamic network pricing functionality in an API intended for CER communication.
Barriers to Electrification Study	This project aims to build Ausgrid's understanding of the impact of decarbonisation through electrification. The research will identify electrification pathways and explore how different social, economic and technical customer barriers may impact different customer segments. A greater understanding of electrification will support electricity networks to explore how and when novel and innovative demand management techniques or smart and flexible technology solutions might facilitate the efficient addition of new electrical loads to the grid. The project is critical foundational research and is expected to support future network expenditure savings, lower average network charges per customer and effective prioritisation of future	This research will explore how Ausgrid can build new or original demand management capability and capacity through nascent demand-side technology or demand management techniques that support customer decarbonisation through electrification. The project incorporates findings from primary and secondary research including external stakeholder consultation and will be innovative in evaluating how national and international examples of new demand management techniques or technology could be developed or used on Ausgrid's network in the relevant market context. The study is focussed on emerging electrification trends across all customer segments to understand the impact of adopting new technology and the various customer segment and demographic considerations that must be considered. The project will support wider industry learning and knowledge sharing to support customers in overcoming barriers to

Project	Description	How and Why Project meets DMIAM Criteria
	innovative trials for demand-side technology or demand management tariff and non-tariff interventions to enable efficient integration of new customer load and electrification.	electrification and available smart or flexible solutions that could support integrating new load efficiently over the long-term.
C&I Thermal Load Flex	Ausgrid is seeking to assess the effectiveness of thermal load flexibility of C&I customers (thermal flex) in localised areas of Ausgrid's network. Large loads such as supermarkets, shopping centres and refrigerated distribution centres could potentially offer a material quantum of load flexibility under both peak demand and minimum demand conditions. These loads are substantial in scale and commonplace in the community. The project will explore whether they can potentially offer an economic and reliable source of load flexibility.	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 3rd party organizations leveraging their relationships with C&I customers and equipment installed at customer sites that enable load flexibility. The project is innovative in testing new market provided flexibility solutions for commercial customers which has not been explored on the network to date and will inform how Ausgrid could leverage and integrate this new demand management capability and capacity over the long-term including evaluating opportunities, challenges and performance of providing this load flexibility.

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 2022-2023 regulatory year on a total of eight ongoing projects with a total of $929,332 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). Note the overall total spend in prior years are for all projects in that year and so project totals in column may be less than the overall total for year.

Project	Project status at end of June 2023	Incurred project costs 2019-2020 (excl GST)	Incurred project costs 2020-2021 (excl GST)	Incurred project costs 2021-2022 (excl GST)	Incurred project costs 2022-2023 (excl GST)
Hot Water Load Control	Ongoing	$0	$14,296	$65,752	$20,804
Peak Time Rebate	Ongoing	$40,786	$193,488	$323,418	$400,099
Electric Vehicle Demand Research	Complete	$202,134	$33,722	$73,345	$103,817
Digital Energy Futures	Complete	$174,565	$105,610	$41,931	$24,037
Community Battery Feasibility Study and Research	Ongoing	$267,578	$58,670	$10,438	$12,474
Battery Demand Response (VPP) Trial	Complete	$290,314	$355,410	$241,676	$29,763
Project Edith Rapid Demonstration - Customer Payments	Ongoing	$0	$0	$0	$5,037
Project Edith CSIP-Aus Specification Extension	Ongoing	$0	$0	$0	$166,294
Barriers to Electrification Study	Ongoing	$0	$0	$0	$162,222
C&I Customer Thermal Flexibility	Ongoing	$0	$0	$0	$4,785
TOTAL		**$1,348,147**	**$1,181,951**	**$766,587**	**$929,332**

2.3 Statement on costs

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

1. are not recoverable under any other jurisdictional incentive scheme,
2. are not recoverable under any other state or Australian Government scheme, and
3. 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 Demand Management Innovation Allowance (DMIA) project was 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 2022-2023 regulatory year. The project will be ongoing into the 2023-2024 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 over 350,000 customers that are actively using controlled load, 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 3 to 6 GWh, which is equivalent to around 300,000 to 600,000 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 been an increase in the number of customers that have a load control device in the smart meter. Over 120,000 customers now have 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 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$20,804	$100,852	$315,000

3.7 Project Activity and Results

3.7.1 Summary of project activity to date

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

Overview of project activities carried out in the regulatory year of 2021-2022:

- 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.

Overview of project activities carried out in the regulatory year of 2022-2023:

Controlled Load Research

- Following the successful trial carried out in the preceding 2021-2022 regulatory year, the ES7 Network Price Guide was updated to include new controlled load switching times, which enabled the solar-soak option for OP1 customers.
- As part of making this ES7 change, Ausgrid has conducted further research activities to study the potential impact of the change on customers and the Ausgrid network, which included the development of a data simulation tool to model the electric hot water tank performance. This simulation tool is designed to be flexible to incorporate a range of tank sizes, weather conditions and other relevant factors to evaluate different hot water tank performance parameters.
- Following the changes to ES7, Ausgrid has also been working with retailers to explore the implementation of the new solar-soak option. Initial testing of the solar-soak option has taken place with a sample of customers.
- As the solar soak option enables a second operation window during the day, we also aimed to estimate the impact of this second window on heat losses and customers' electricity bills. More details of Ausgrid's findings are outlined in Section 3.7.2.1.
- Ausgrid has also conducted research activities to estimate the potential impact of reducing the randomisation period of OP1 customers from 3 hours to 1 or 2 hours. The randomisation period is the time between the scheduled "ON/OFF" time and when the individual relays actually switch on/off. Findings are outlined in Section 3.7.2.2.

Heat Pump technology research

- As adoption of other water heating technology has increased, including Heat Pumps, Ausgrid has also conducted preliminary research on the impact of heat pumps and their performance to customer and network outcomes for demand management.
- Preliminary scoping work was carried out to identify key priorities for future research to understand the impacts of different Hot Water technologies, customer uptake and understanding the costs and benefits with consideration to availability of flexible loads compared to the performance or suitability of heat pumps to provide load flexibility or energy efficiency.
- As part of further research planned for following years, Ausgrid will explore customer and industry research that will increase our understanding of how heat pumps are commonly installed, their energy performance and develop a greater understanding of customer preferences between different Hot Water technologies, in particular as gas is likely to be replaced over time.

SolarShift Research Project

- In 2022-2023, Ausgrid joined SolarShift project (part of RACE for 2030)[1] as an industry partner. This 2-year research initiative, led by UNSW in partnership with Endeavour Energy, Solar Analytics, NSW Office of Energy and Climate Change (OECC), and Energy Smart Water (ESW), will explore coordinated control and operation of Domestic Electric Water Heating Systems (DEWH) for soaking up excess solar generation.
- By collaborating with the SolarShift team, Ausgrid aims to better understand the potential of load control as a demand management solution and develop strategies on how Ausgrid, retailers, market participants and customers can work together to optimise the operation of the load control system for the benefit of all stakeholders.
- SolarShift team is currently developing optimal algorithms for hot water load control and a tool that the customers can use to assess economic and environmental benefits of investing in different hot water systems.

[1] https://racefor2030.com.au/project/solarshift-turning-electric-water-heaters-into-megawatt-batteries/

3.7.2 Project Research Findings

The focus of the research activities was to estimate the impact of modifying the controlled load switching times on customers and the Ausgrid network. This includes the changes adopted in the updated ES7. Specifically, we focused on three research activities: (i) estimate the impact of a second operation window on heat losses and customers' electricity bills, (ii) study the impact of reducing the randomisation period of OP1 customers, and (iii) estimate the potential of OP1 customers to absorb the energy exported by solar PV systems.

3.7.2.1 Heat losses study

The operation of electric resistance hot water tanks was modelled to assess the impact of a second operation window (i.e., the tank can switch on at night & during the day) on heat losses and customers' electricity bills. The operation of hot water tanks is influenced by multiple factors, such as weather conditions, hot water usage profiles, tank technical specifications, etc. The model was built based on relevant Australian standards (i.e., AS/NZS 4234 2021, AS/NZS 4692.1 and AS/NZS 4692.2), manufacturers' technical information and academic research to consider these factors.

The model was used to simulate the solar-soak operation of 250L, 315L and 400L electric hot water tanks. Under this option, the hot water tanks can switch on at night (e.g., between 10pm- 7am), and during the day (e.g., between 10am and 5pm). Four hot water draw profiles were adopted to simulate daily hot water usage based on available literature and the AS/NZS 4234 standard. The normalized hot water draw profiles are shown in Figure 1.

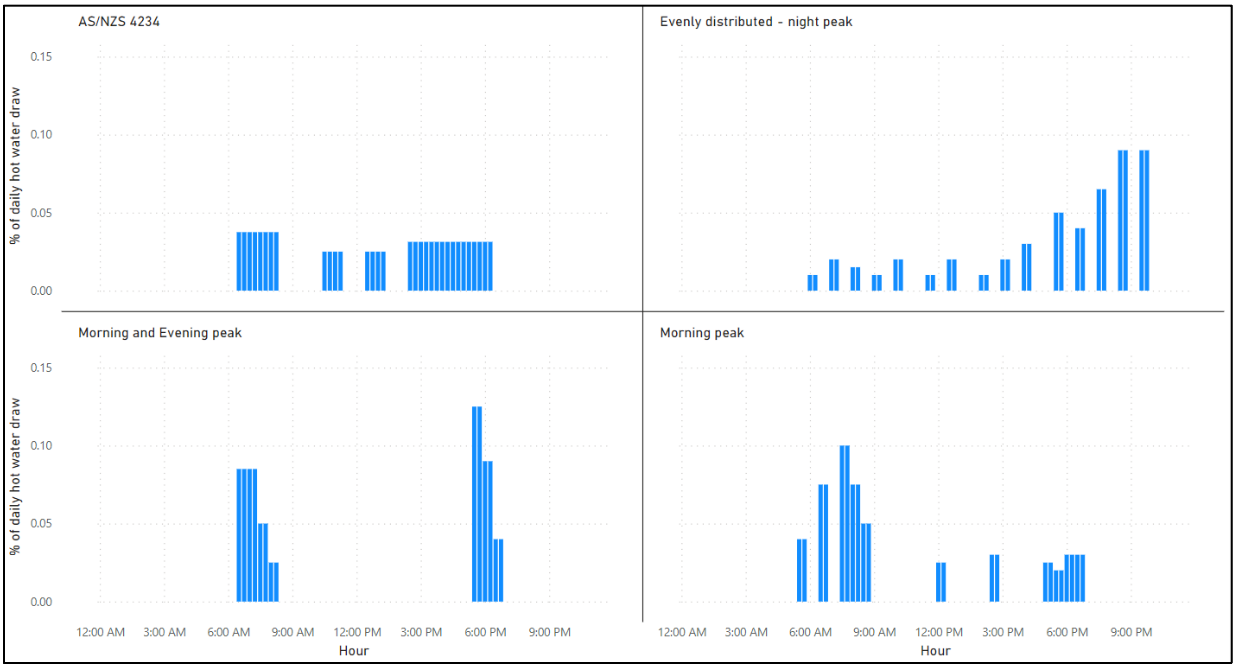


Figure 1 - Normalised hot water draw profiles.

We also estimated the heat losses of operating an electric hot water tank under a solar-soak option to evaluate the impact of a second operation cycle. This incorporated a comparative analysis against the off-peak operation, which was considered the baseline scenario. The results revealed that the solar-soak option might imply a small increase in the daily heat losses, potentially leading to an additional 3-5% increase in the annual electricity bill.

Figure 2 shows this corresponds to an approximate yearly extra cost of 10-24 AUD for the simulated scenarios. Figure 2 also shows the night peak scenario has almost no extra costs, as it considers low hot water usage throughout the day, resulting in small temperature drops in the tank, and the water was mainly heated at night. Nevertheless, other simulations revealed that when daily hot water consumption increases, this scenario also incurs additional billing costs. It is worth noting that this study assumes that customers do not have installed solar systems to supply their hot water tank load during the day.

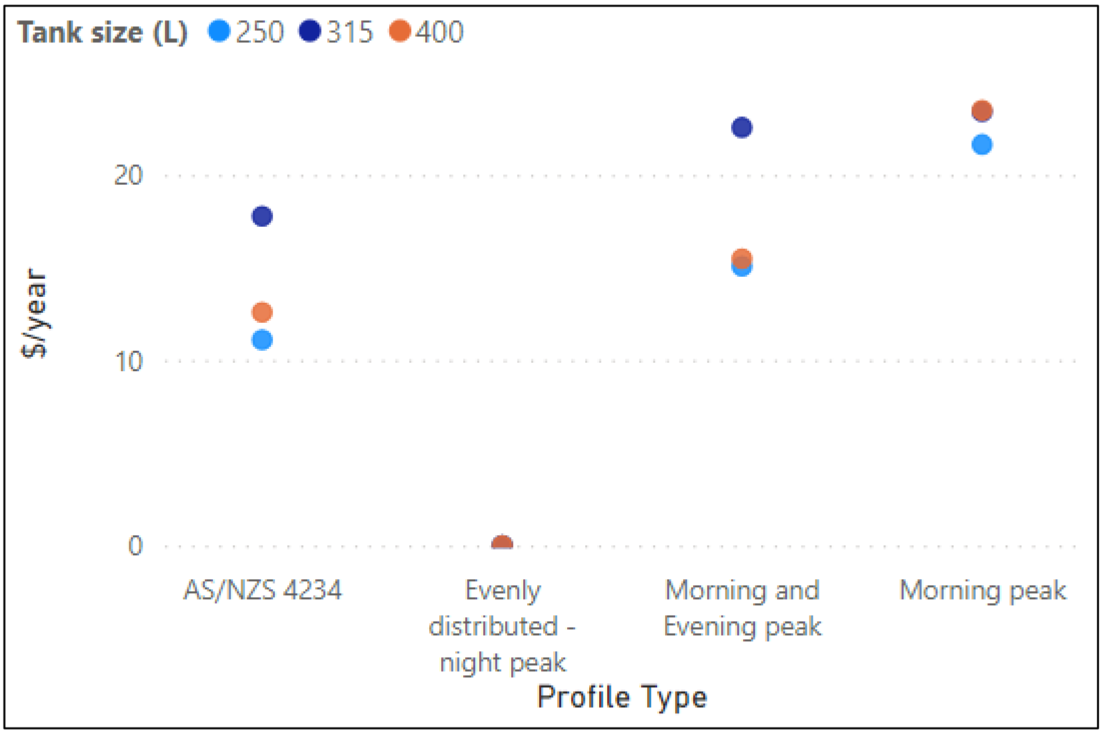


Figure 2 - The simulated costs of operating electric hot water tanks under a solar-soak option.

The model was also used to assess potential billing changes for the customers who participated in the project trial during 2021-2022, in which the solar soak operation was tested. Figure 3 shows the additional annual costs for different tank sizes and power ratings. In summary, the average additional costs vary between 6 and 25 AUD, resulting in an approximate 12% increase in the electricity bill over a year.

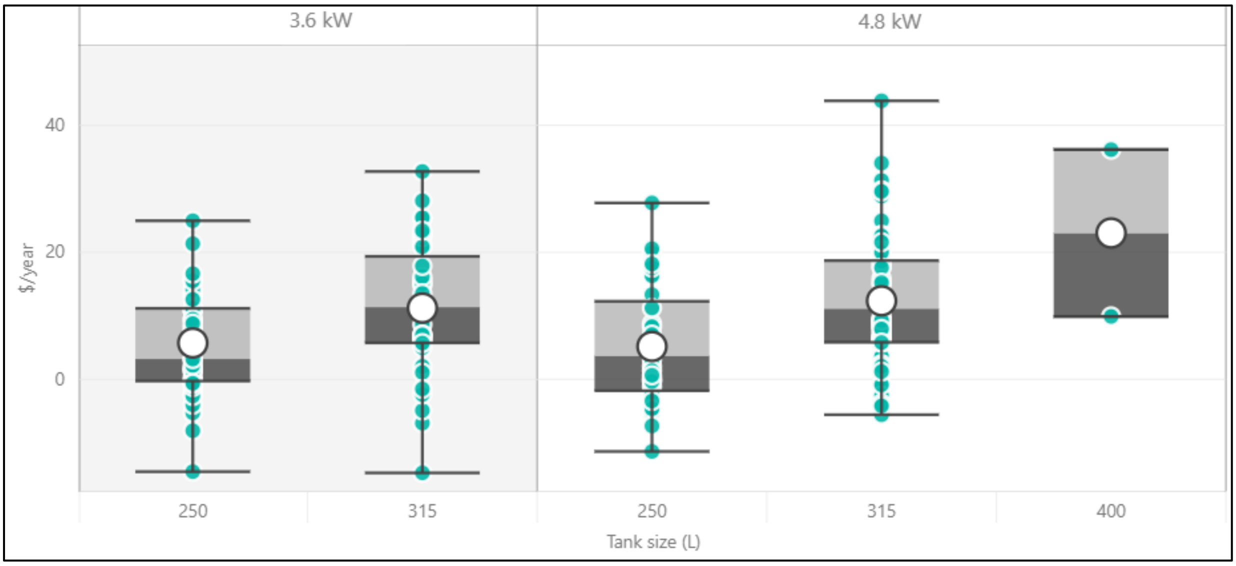


Figure 3 - Box plot diagram illustrating the estimated additional billing costs of the solar-soak option compared to the off-peak option, considering the hot water usage profile defined in AS/NZS 4234. The left-side boxes represent the 3.6kW rating tanks, while the right-side box plots represent the 4.8kW rating tanks.

The findings from this research activity revealed the potential financial implications on customers' electricity bills when transitioning from the one charge cycle off-peak option to two charge cycles (overnight and solar-soak). However, it should be noted that this is a preliminary study, and a comprehensive analysis requires further examination and testing of the solar-soak operation's impact on both customers and Ausgrid's network.

The next step in the 2023-2024 regulatory year is to expand the analysis using more real-customer data and modelling the operation of other technologies, such as air-sourced hot water heat pumps. Additionally, the research activity aims to investigate the potential impact of adopting solar-soak and heat pumps on network demand.

3.7.2.2 Randomisation period study

As part of the ongoing engagement and collaboration activities with relevant stakeholders, electricity retailers presented an inquiry regarding the possibility of reducing the current three-hour randomisation window of OP1 customers in Ausgrid's ES7 Network Price Guide. To answer this question, we estimated the potential impact of shorter randomisation windows on the network, especially in terms of any potential increase in peak value. In particular, our study considered a sample of around 94,000 OP1 customers and tested one- and two-hours randomisation windows. A three-hour window was also estimated as a control variable to compare against the actual settings and validate our analysis.

Figure 4 shows the estimated load profiles of the OP1 customers comparing the three randomisation windows. For this sample, implementing a one-hour randomisation window results in a 37% growth in the peak value (i.e., from 219MW to 299MW). Likewise, a two-hour window leads to a 17% increase (i.e., from 219MW to 257MW). Moreover, the control simulation (i.e., three-hour window) appears to align with the actual data. From these results, we can conclude that a three-hour randomisation window reduces the maximum demand by 80MW compared with the one hour randomisation.

To complement this analysis, Figure 5 shows the average peak value growth of changing from three-hour randomisation (i.e., actual settings) to one- and two-hour randomisation periods. Notably, implementing a one-hour randomisation window would lead to significant effects, causing the OP1 load peak value to surge by approximately 37-68%, equivalent to a range of 77-86 MW. Likewise, adopting a two-hour randomisation window would induce an increase of about 17-27%, corresponding to 36-41 MW.

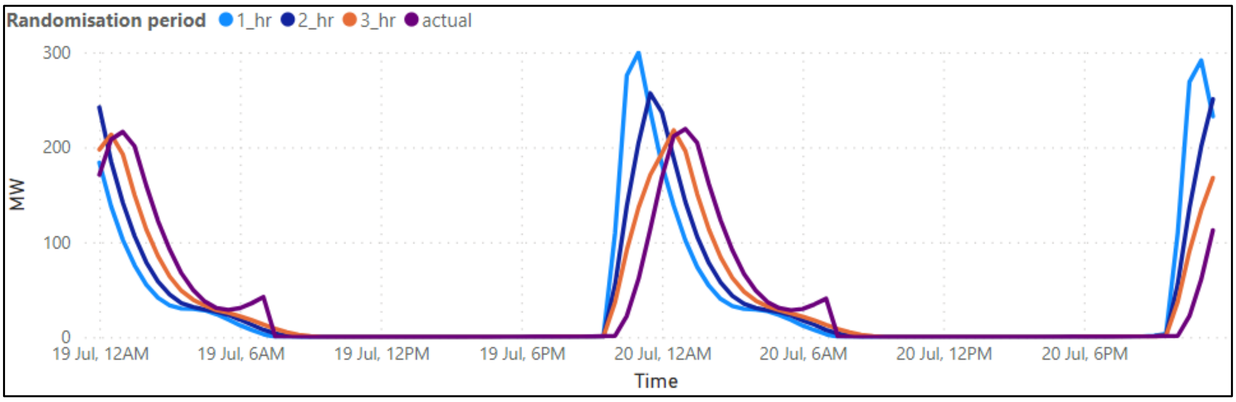


Figure 4 - Results of testing one- and two-hour randomisation periods. The line plots represent the load profiles of around 94,000 OP1 customers under one hour (light blue), two hours (dark blue), three hours randomisation periods (orange) and actual load profile (purple). Note that we analysed all days in 2022 and this plot only shows an example of our results (19 and 20 July 2022).

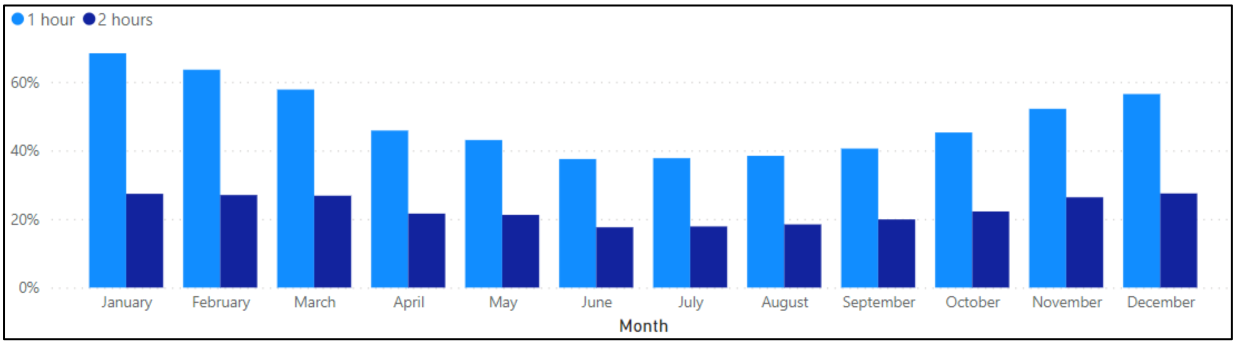


Figure 5 - Average increase in peak values of the one-hour (blue light) and two-hour (dark blue) randomisation periods compared to actual load data.

The findings from this study revealed how changing the randomisation windows settings impact the peak load associated with OP1 customers. We will continue this analysis by assessing the impact on specific zones of our network.

3.7.2.3 Solar-soak study

To complement the analysis presented above, we estimated the impact of shifting OP1 customers from off-peak operation to the double charge solar-soak operation. In particular, our interest was to estimate the potential of OP1 load to absorb the energy exported by PV systems into the network. Figure 6 shows the average load profile of all OP1 customers and PV customers exports in the network. We compared these values by calculating the ratio between the OP1 load the PV exports. The results show that during the solar-soak window, the total OP1 load represents almost 50% of the solar exports for most of the intervals within the solar-soak window. We also estimated the percentage of daily energy absorbed by OP1 customers across the year, as shown in Figure 7. The findings indicate that, on average, OP1 has the capacity to consume 35% of solar exports. This proportion fluctuates throughout the year, with winter months exhibiting the highest absorption rates (~50%). The shoulder months also display a notable figure of approximately 40%, potentially mitigating emerging challenges related to minimum demand.

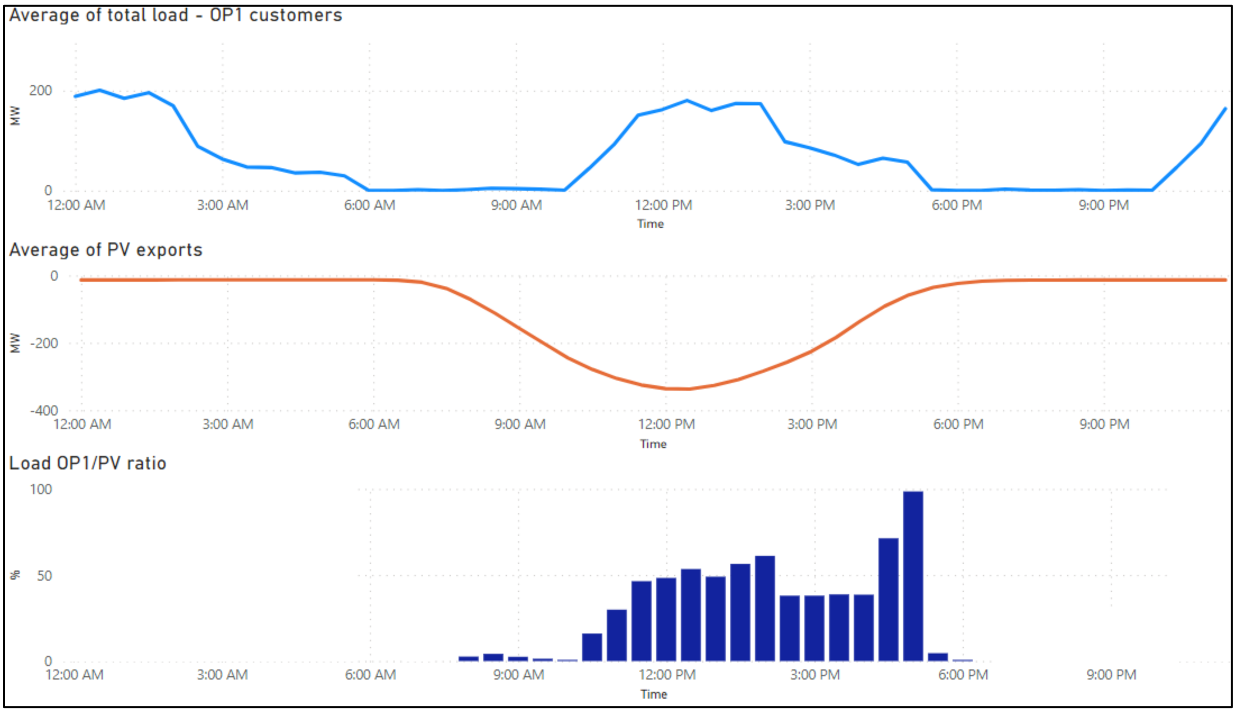


Figure 6 - Average load profile of OP1 customers (light blue), average PV customer exports to the network (orange) and ratio comparing the load and PV exports (dark blue bars). These plots show the average profiles considering the data of shoulder months (i.e., April, May, September and October 2022).

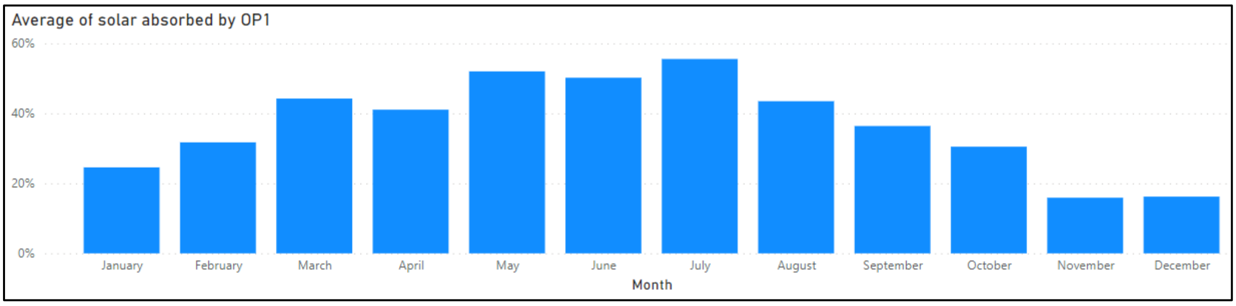


Figure 7 - Percentage of daily PV energy exports absorbed by OP1 customers.

These results confirm the meaningful potential of OP1 load to absorb solar exports and enable hosting capacity for more connections of PV systems to the network.

The next step in the 2023-2024 regulatory year is to expand the analysis using more real-customer data, focus on specific network zones and modelling the operation of other solar-soak windows (e.g., earlier start time, or two solar-soak windows, etc.) and the randomisation periods.

3.7.3 Update on material changes to the project

There were no material changes to the planned activities during 2022-2023. Planned Phase 1 and Phase 2 project activities were commenced, in progress or completed as outlined.

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

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 2022-2023 regulatory year. The project will conclude at the end of August 2023.

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 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 trialled 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 took place across 2 phases. The first phase of this project included the implementation of collaborative PTR trials with retailers. The PTR events in 2020-2021 confirmed the functionality of the basic retailer PTR process, provided insight into the Retailer customer recruitment strategy and customer demand response and satisfaction.

Phase 1 of the trial 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 focused on exploring how we can increase the density of customer adoption for this solution in the trial areas and to better understand the viability of this solution for network support purposes. Throughout phase 2, phase 1 partnerships with the retailers continued with an increased number of customers.

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 2022-2023, 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 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$400,099	$976,878	$1,050,000

4.7 Project Activity and Results

In 2020-2021, Ausgrid agreed to partner with AGL and EnergyAustralia to conduct PTR trials. Since 2017, AGL and EnergyAustralia have been developing their PTR capabilities[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.

Baselines

The energy reduction for each event is determined by comparing the participant's actual energy consumption with a prediction of what would have been consumed (baseline) if the demand response event had not occurred. EnergyAustralia has adopted the CAISO10 methodology[5] developed by the California Independent System Operator for their demand response programs. AGL implements its own baseline process based on historical load and weather data.

[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

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

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. Energy companies are encountering issues such as false negatives, where customers that genuinely changed their behaviour are not being recognised by their baseline methodology as having reduced their consumption.

With an increasing number of residential customers having rooftop solar, and a material share of PTR customers having solar, calculating an accurate baseline for solar customers is both challenging and important. The need for a robust and standardised baseline methodology that is effective for residential customers will be important in ensuring that PTR and other demand response programs continues to develop as a valued solution for customers, networks, and retailers.

Comparison between the two programs

Table 3 shows different approaches taken by the two retailers.

Table 3 - Comparison table for AGL and EnergyAustralia's PTR programs

Program Component	AGL	EnergyAustralia
Recruitment	**Opt-in** Customers must actively sign up to the program. For the events, the customers must respond to the invite SMS to be considered a participant	**Opt-out** Customers are automatically enrolled into the program and must actively opt-out to be excluded. For the events, the customers are assumed to a participant if they do not respond to the invite SMS.
Customer Reward	$5 for meeting Target 1 (10% reduction from the baseline) $10 for meeting Target 2 (30% reduction from the baseline)	$1 for reduction + $2/kWh reduction from the baseline
Baseline	Internal baseline using weather and historical data	CAISO 10[5]

Trial results and activities for 2022-2023

Locations

Ausgrid scheduled PTR events across 44 suburbs in 2022-2023, with over 4,200 customers enrolled in the program as of June 2023. Approximately 55% of the customers in the target suburbs do not have a smart meter, which indicates that there is a large potential for increasing participation rate with a higher uptake of smart meters.

Figure 8 - Suburb locations of demand response participants

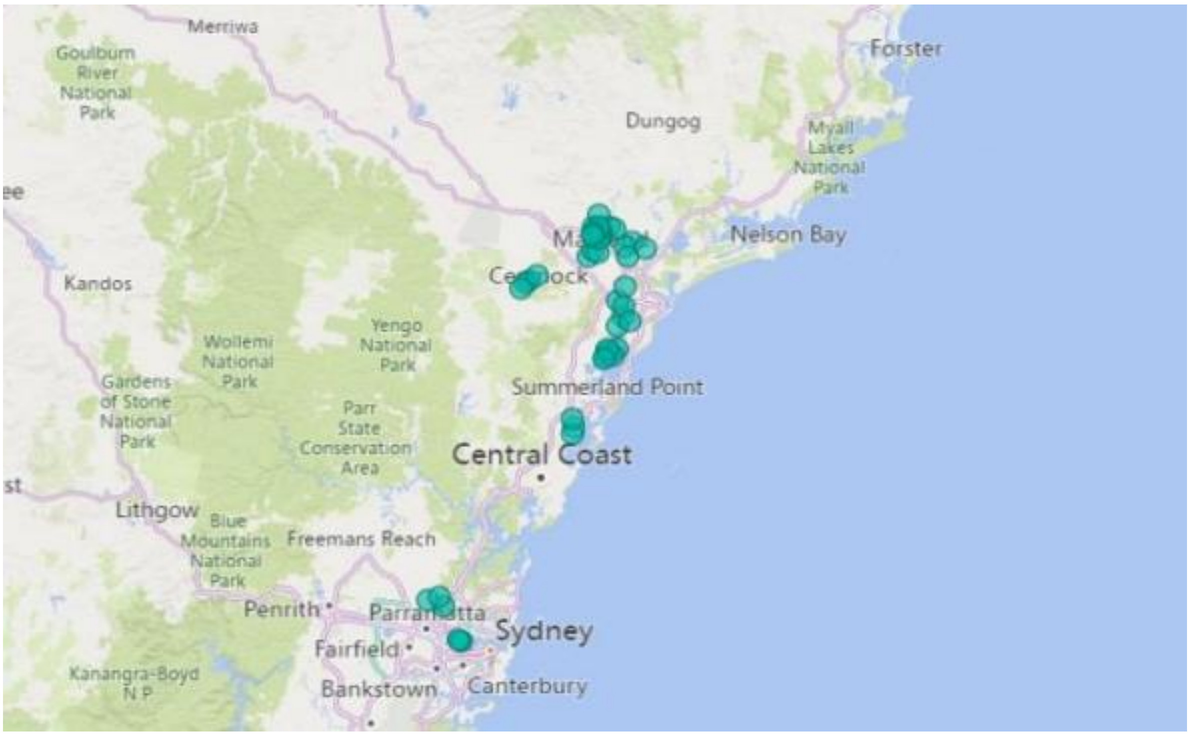


Table 4 - Customer participation rate by project suburb for the demand response program in Jun 2023

Suburb	Total Customers	Total smart meter customers	Total Registered (both retailers) in the program	Total Registered (both retailers) customers as percentage of total customers	Total Registered (both retailers) customers as a percentage of smart meter customers
Oakhampton Heights	47	19	4	9%	21%
Maitland Vale	131	90	17	13%	19%
Lakelands	537	211	35	7%	17%
Fletcher	2712	1691	267	10%	16%
Castle Hill	1280	593	96	8%	16%
Aberglasslyn	2409	1309	202	8%	15%
Bolwarra	564	304	47	8%	15%
Bolwarra Heights	1181	622	91	8%	15%
Wadalba	1442	763	111	8%	15%
Bellbird Heights	330	124	19	6%	15%
Balmoral	284	103	15	5%	15%
Coal Point	806	282	42	5%	15%
Millers Forest	154	52	8	5%	15%
Chisholm	1847	1455	203	11%	14%
Cliftleigh	991	771	107	11%	14%
Cameron Park	3569	2133	304	9%	14%
Hamlyn Terrace	3281	1970	276	8%	14%
Woongarrah	2077	1231	171	8%	14%
Gillieston Heights	1876	993	136	7%	14%

Suburb	Total Customers	Total smart meter customers	Total Registered (both retailers) in the program	Total Registered (both retailers) customers as percentage of total customers	Total Registered (both retailers) customers as a percentage of smart meter customers
Largs	764	341	48	6%	14%
Fishing Point	492	181	26	5%	14%
Telarah	1167	388	54	5%	14%
Louth Park	372	263	34	9%	13%
Bellbird	1101	600	79	7%	13%
Cherrybrook	6280	2786	369	6%	13%
Beecroft	3422	1409	185	5%	13%
Rathmines	1010	344	44	4%	13%
Wangi Wangi	1492	450	57	4%	13%
Thornton	4592	2266	274	6%	12%
Cabarita	869	232	28	3%	12%
Lorn	677	275	31	5%	11%
Rutherford	5787	2509	271	5%	11%
Cessnock	7158	2591	294	4%	11%
Boolaroo	1006	467	48	5%	10%
Berry Park	70	20	2	3%	10%
Edgeworth	3074	1088	105	3%	10%
Breakfast Point	2583	526	52	2%	10%
Buttaba	471	182	17	4%	9%
Arcadia Vale	640	223	20	3%	9%
Booragul	617	211	19	3%	9%
Pelton	35	13	1	3%	8%
Maitland	1767	451	31	2%	7%
Oakhampton	76	17	1	1%	6%
Mortlake	687	187	10	1%	5%

Event days

There were 13 PTR event days during 2022-2023. These events were selected to coincide with periods when electricity consumption is expected to be high due to high summer or low winter temperatures.

Table 5 - Event days in 2022-2023

Date	Day type	Time of invite notification	Time	Retailer	Cessnock Max Temperature (°C)	Cessnock Min Temperature (°C)
18-Jan-23	Weekday	24 hrs prior to the event	16:30-19:30	EnergyAustralia	33.9	13.7
3-Feb-23	Weekday	24 hrs prior to the event	16:30-19:30	EnergyAustralia	32.6	15
17-Feb-23	Weekday	24 hrs prior to the event	16:30-19:30	EnergyAustralia	35.5	13.5
20-Feb-23	Weekday	On the day of the event	16:30-19:30	EnergyAustralia	33.6	17.2
7-Mar-23	Weekday	24 hrs prior to the event	16:30-19:30	EnergyAustralia	36.9	22.1
16-Mar-23	Weekday	24 hrs prior to the event	16:30-19:30	EnergyAustralia	36.5	15.4
17-Mar-23	Weekday	24 hrs prior to the event	16:00-19:00	EnergyAustralia	32.7	12.3
19-Jul-22	Weekday	On the day of the event	17:00-20:00	AGL	14.4	2.8
18-Jan-23	Weekday	24 hrs prior to the event	16:30-19:30	AGL	33.9	13.7
25-Jan-23	Weekday	24 hrs prior to the event	16:30-19:30	AGL	31.6	17.4
4-Feb-23	Weekend	On the day of the event	16:30-19:30	AGL	28.6	15.5
11-Feb-23	Weekend	On the day of the event	16:30-19:30	AGL	37.3	13.8
18-Feb-23	Weekend	On the day of the event	17:00-19:00	AGL	38.6	14
20-Feb-23	Weekday	On the day of the event	16:30-19:30	AGL	33.6	17.2
7-Mar-23	Weekday	24 hrs prior to the event	17:00-19:00	AGL	36.9	22.1
12-Jun-23	Public Holiday	24 hrs prior to the event	17:30-19:30	AGL	21.2	2.1

Weekend and Public Holiday Events

With the exception of a public holiday event in 2021, the retailers have restricted us from scheduling events on weekends and public holiday during the first two years of the trial due to factors such as limited availability of support staff and IT systems on weekends and public holidays.

We tested weekend events for first time in the trial in the summer of 2022/23 and a public holiday event for the second time in the trial in the winter of 2023. It was important for us to test weekends and public holiday events as peak demand days can occur on any day of the week, not just weekdays. Table 6 shows that the participation rates were similar between weekends and weekdays, with a lower average reduction for weekend events.

Table 6 - Comparison between weekdays and weekend events with AGL for 2021-22 and 2022-23 events, event notification was sent on the day

Day Type[6]	Time of Invite notification	Average Participation	Average Response (kW/customer)
Weekends	On the day	52%	-0.59
Weekday	On the day	51%	-0.76

There was a slightly lower participation rate and a higher reduction for the participants for the King's Birthday Public Holiday event when compared to weekday events (see table below).

Table 7 - Comparison between King's Birthday Public Holiday and weekday events with AGL for 2021-22 and 2022-23 events

Day Type	Time of Invite notification	Average Participation	Average Response (kW/customer)
Public Holiday	24 hours before	52%	-0.83
Weekday	24 hours before	54%	-0.77

Drawing a firm conclusion is challenging due to the limited testing of weekend and public holiday events. However, it is promising that the participation rates and energy reductions on weekends/public holidays were comparable to weekdays. Further investigation is needed to address challenges associated with weekend/public holiday events.

Advance event notification

During the initial two years of the trial, the event invite SMS was sent on the day of the event. In 2023, an additional SMS notification was sent 24 hours before the event for some of the events. The impact analysis for events in 2021-2022 and 2022-2023 revealed a slightly higher participation rate for events with 24-hour advance notification. Further, the events with the 24-hour advance notification saw a higher average reduction.

For consistency and to minimise variability between different day types, only weekday events were included in the figures in Table 8. Although firm conclusions are challenging to draw due to varying customer performances, this area should be further explored especially as the survey results indicated that approximately half the respondents would require a 24-hour advance notification to participate (see Figure 23 in Survey Results section).

Table 8 – Comparison between sending the invite notification 'the day before' vs 'on the day' for weekday events in 2021-2022 and 2022-2023 (a negative number represents a reduction in consumption)

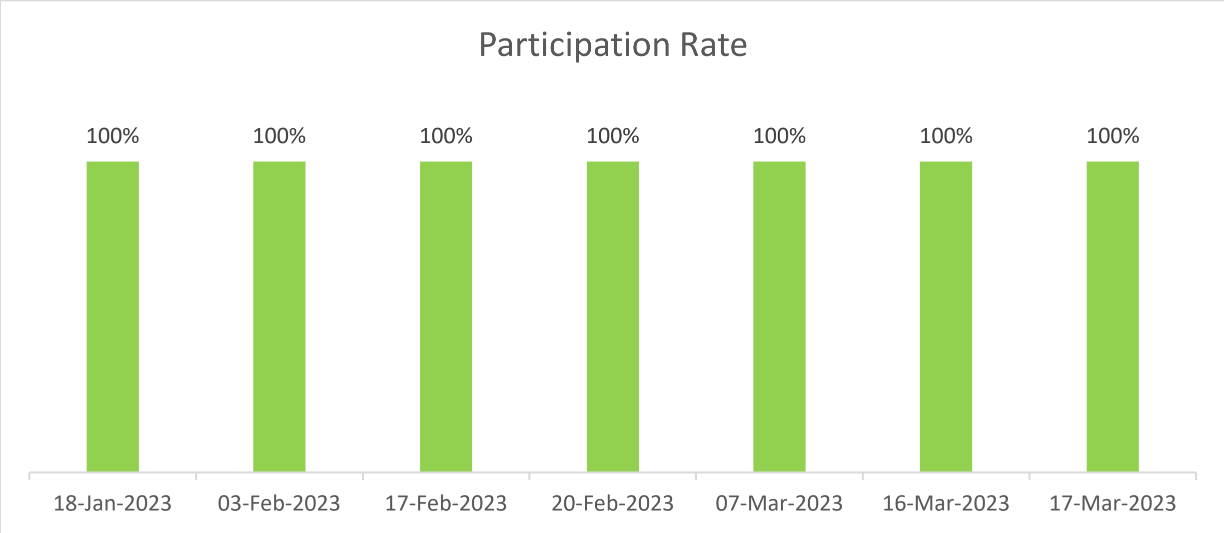
First notification sent	AGL		EnergyAustralia		
	Participation Rate	Response from participants – Opt-in (kW/customer)	Participation Rate (didn't opt out)	Response from participants – did not opt out (kW/customer)	Response from active participants that achieved min. 5% reduction (kW/customer)
24 hours prior	54%	-0.77	100%	0.16	-1.06
on the day	51%	-0.76	96%	0.18	-0.78

[6] The AGL event on 4 Feb 2023 was excluded from the figures because it was a relatively mild summer day where the maximum temperature was 28.6°C, which doesn't represent a typical peak summer day. We scheduled the event solely to test weekend event capabilities.

EnergyAustralia Results

Figure 9 below shows the participation rate for EnergyAustralia events during the summer of 2023. EnergyAustralia employed an opt-out method of recruitment, which means a customer is considered a participant if the customer doesn't actively opt-out by responding to the invite. The participation rate of 100% means that no customer opted out of the event.

Figure 9 – Percentage of EnergyAustralia customers that participated (didn't opt out) in the demand response events in the summer of 2022-2023



As shown in Figure 10**Error! Reference source not found.**, not all of these 'participants' actively reduced their consumption. On average, during most event days, the 'participants' increased their energy consumption compared to the baseline.

Figure 10 - Average response (kWh/customer) using EnergyAustralia's baseline, a positive number indicates increased consumption and a negative indicates reduced consumption during the events

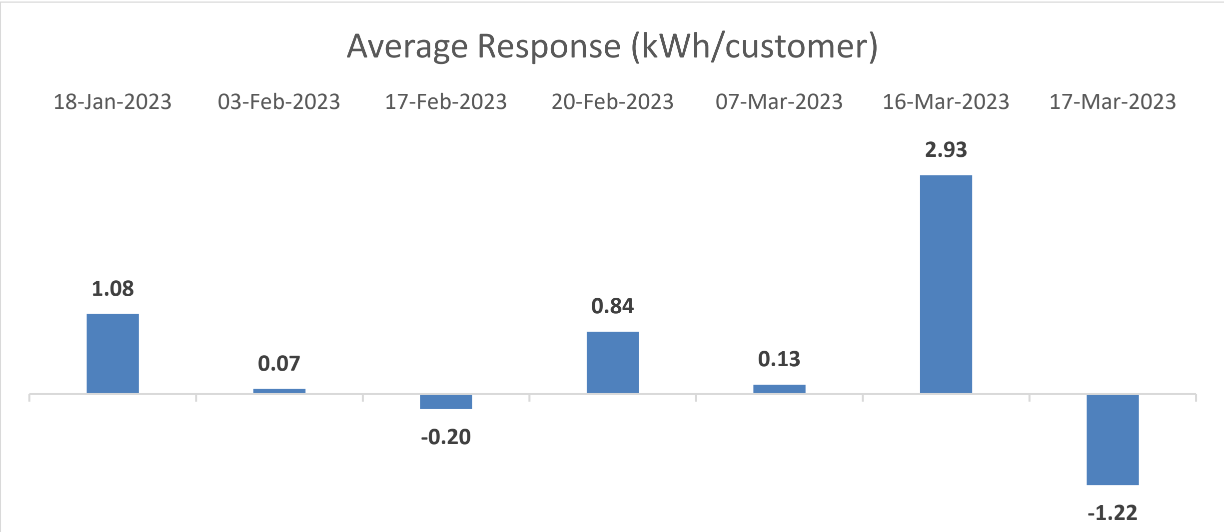
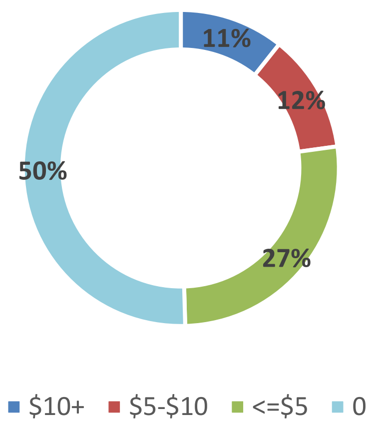


Figure 11 following further highlights that a significant number of customers are not an active participant, with approximately 50% of the customers not receiving a reward.

Figure 11 - Reward summary for EnergyAustralia events in 2023



To uncover a meaningful rate of participation and response, we applied a 5% threshold value to estimate the level of active participation. As highlighted in Figure 12, approximately 46% of the invited participants achieved a minimum of 5% reduction in their consumption and correspondingly,

Figure 13 shows that, on average, a reduction of 3.07kWh was achieved by the estimated active participants.

Figure 12 - Percentage of EnergyAustralia participants (did not opt-out) that achieved a minimum of 5% reduction

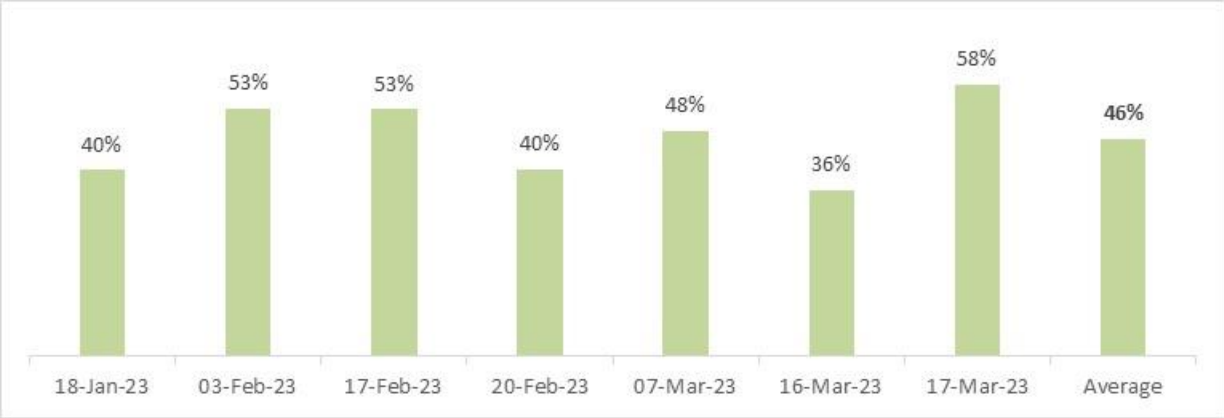


Figure 13 - Average response per event (kWh/customer) for customers that achieved at least 5% reduction in relation to EnergyAustralia's baseline, a negative number indicates reduced consumption during the events

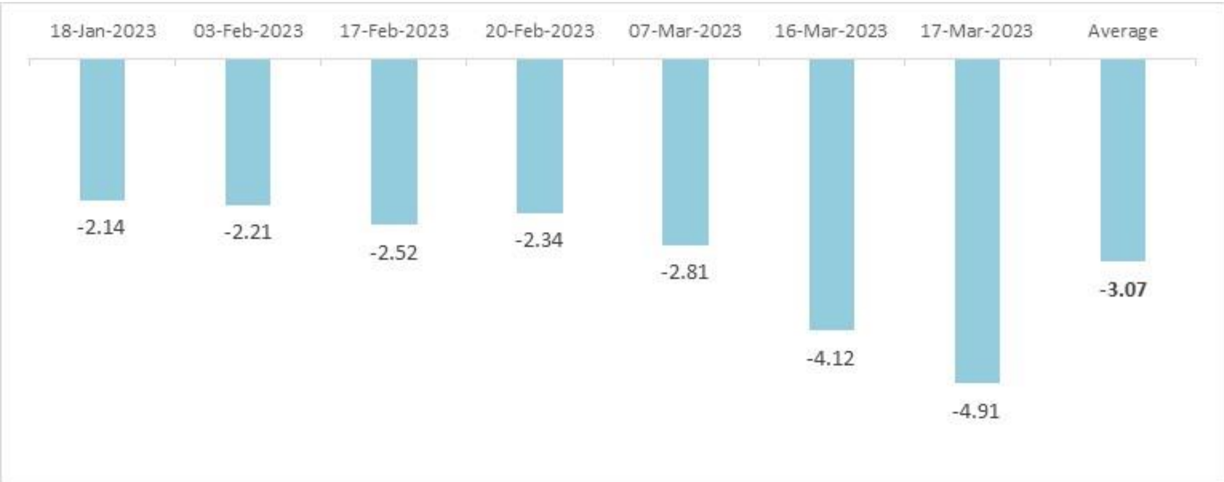
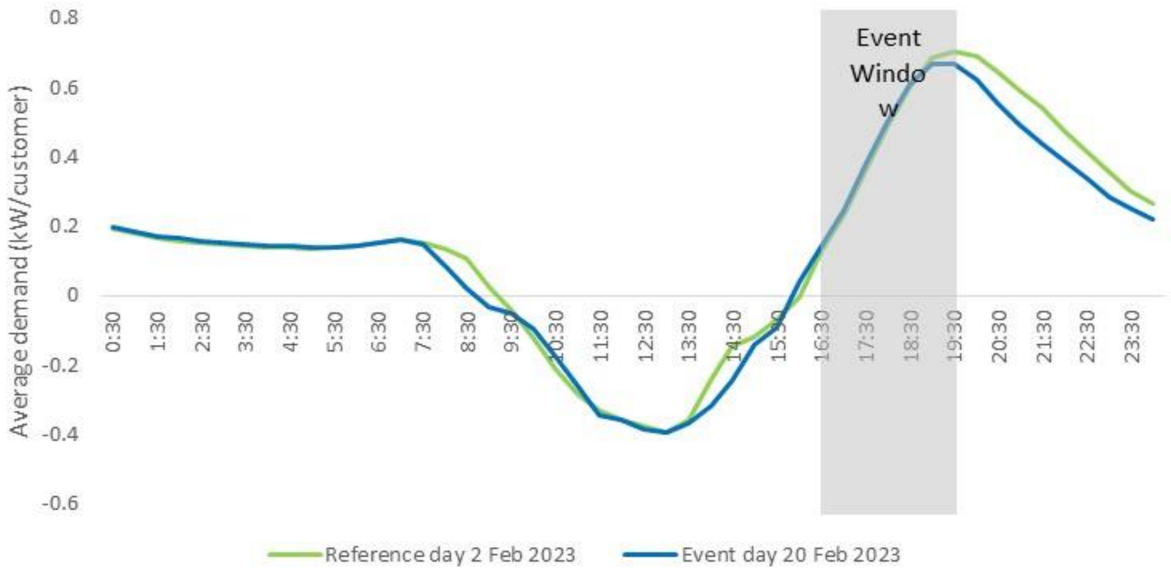


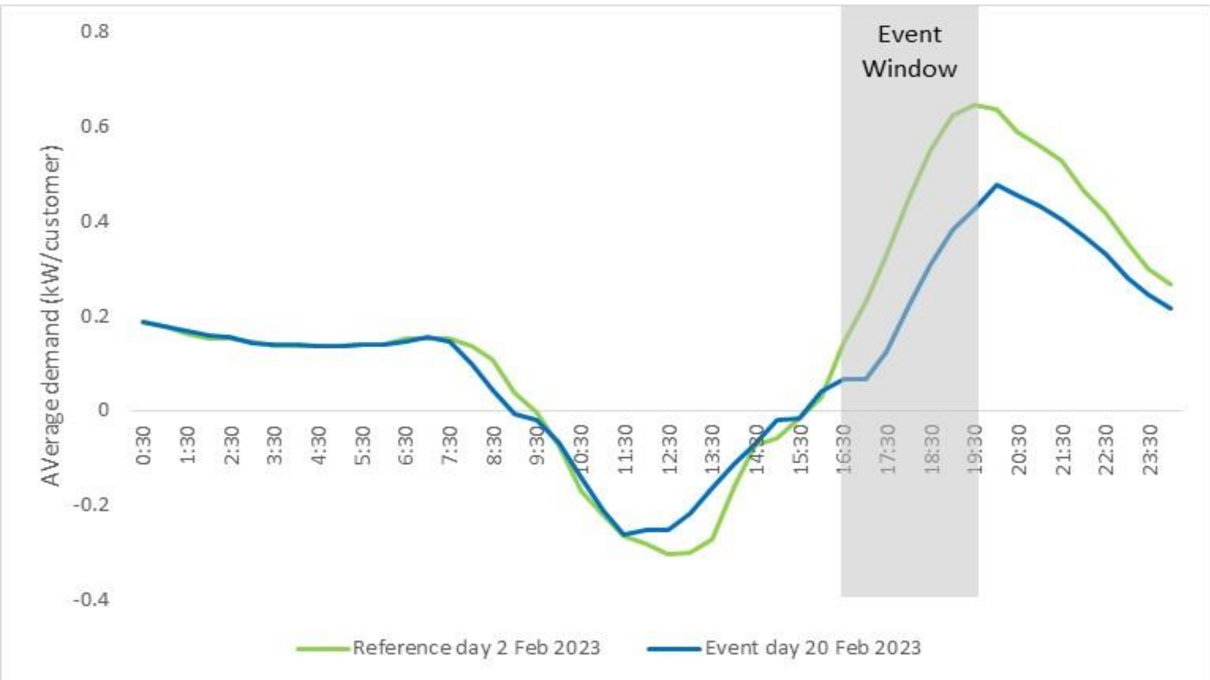
Figure 14 shows the average demand profile for EnergyAustralia participants for the event day on 20 February 2023. To measure and illustrate the impact of the demand reductions on the event days, we applied a day-matching approach to choose a reference day, selected based on similar climate conditions. Note that the day-matching approach was not used to calculate customer's reward. As expected, without adjusting for estimated participation, there is no noticeable response due to the blending of active and non-active participants.

Figure 14 - Demand profile for EnergyAustralia participants (did not opt out) for the event day on 20 Feb 2022



After adjusting for estimated non-participation using the 5% threshold as above, Figure 15 shows there was a noticeable reduction on the event day in comparison to the reference day. It should be noted that the apparent temperature was lower in the evening of the event day, both during and after the event, in comparison to the evening of the reference day. This likely played a role in the lower energy usage observed during and after the event. However, a noticeable change in demand around the start of the event suggests that a significant portion of the customers were actively trying to reduce their energy demand.

Figure 15 - Demand profile for EnergyAustralia customers who achieved at least 5% reduction for event 20 Feb 2023



AGL Results

Figure 16 shows that the participation rate remained relatively constant throughout the year. In contrast, the average reduction per customer fluctuated between different events. As expected,

since all participants opted themselves into the events, on average, reductions were observed for all the events (see

Figure 17).

Figure 16 - Percentage of AGL customers that participated (opt-in) in 2023

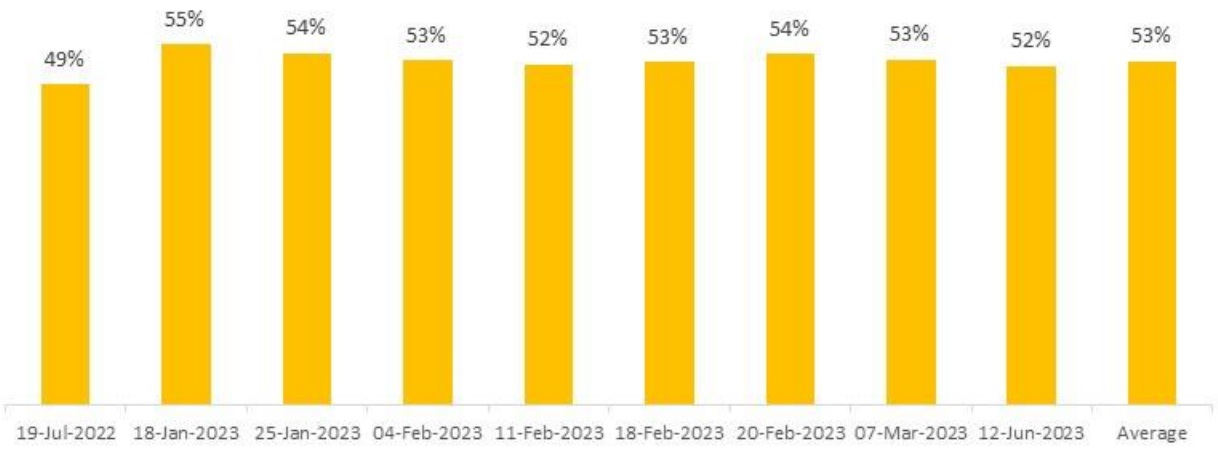


Figure 17 - Average response per event (kWh/customer) using AGL's baseline, a negative number represents a reduction

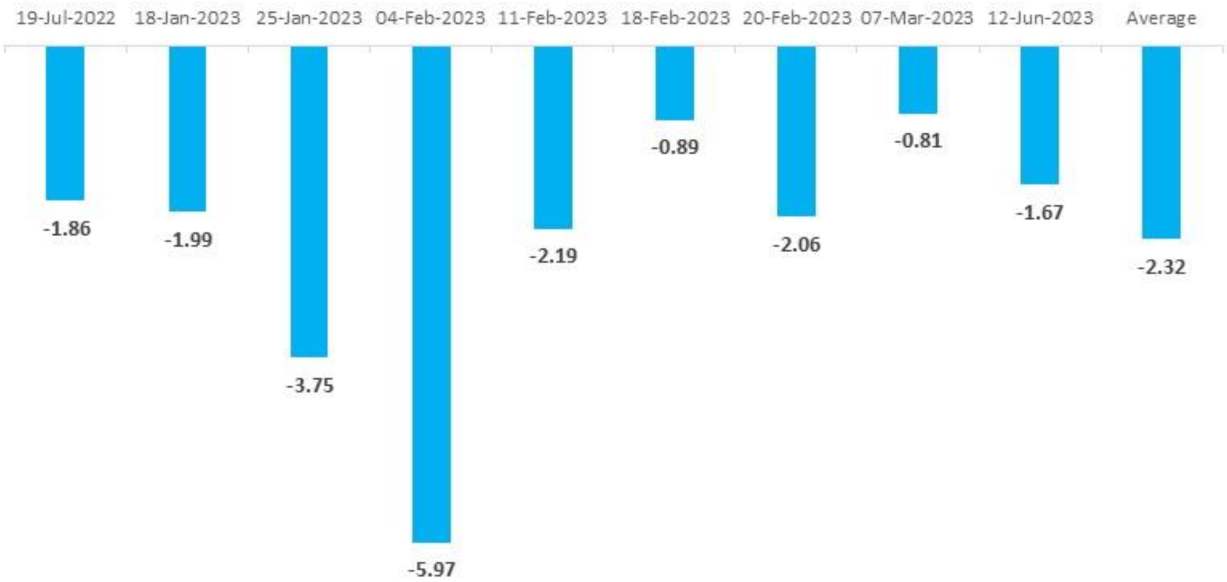
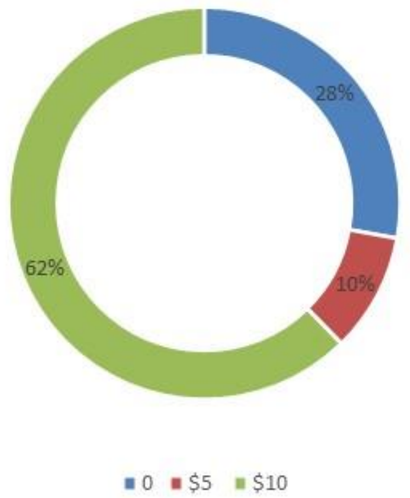


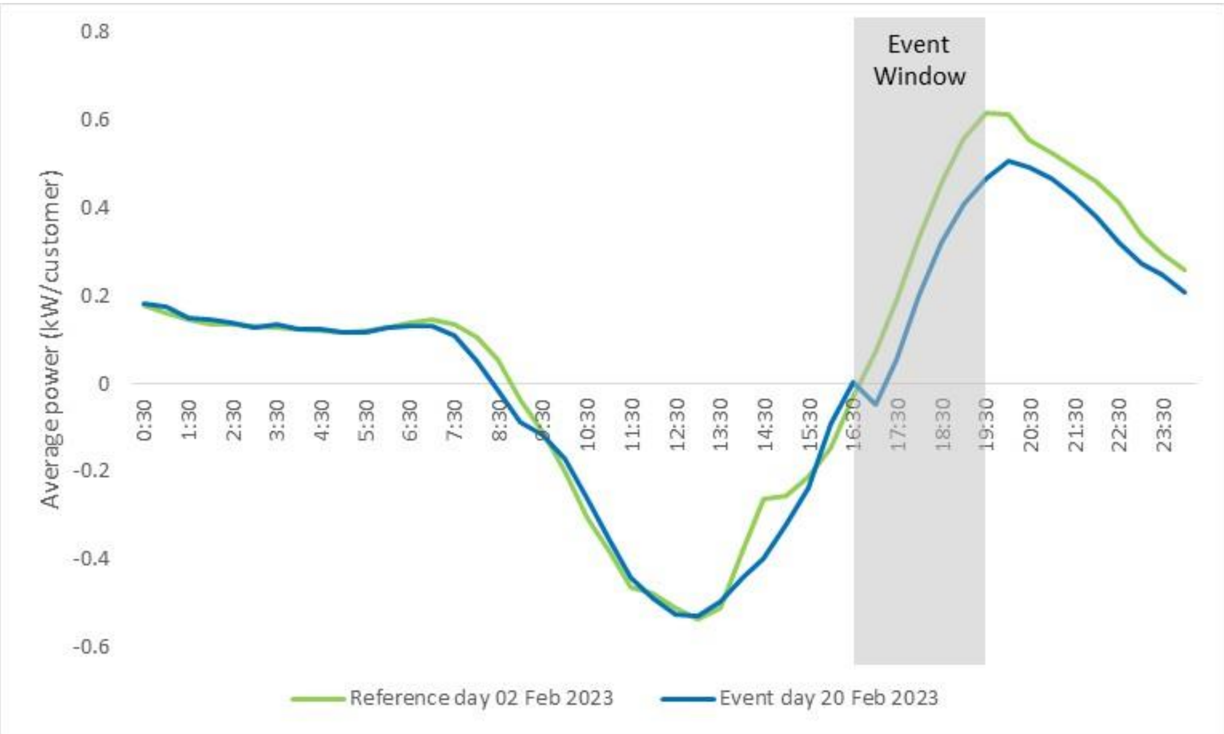
Figure 18 shows that the majority of the participants (72%) received a reward with most of them receiving the maximum reward of $10.

Figure 18 - Reward summary of event partipants for AGL events in 2023



Similar to the analysis with EnergyAustralia, we used a day-matching approach to select a reference day based on similar weather condition (see Figure 19). The apparent temperature was lower in the evening of the event day, both during and after the event, when compared to the evening of the reference day. This likely contributed to the lower consumption observed in the evening of the event day. However, a clear energy reduction can be observed around the start of the event at 16:30, which indicates that there were a significant number of customers that were actively trying to reduce their energy consumption.

Figure 19 - Demand profile for AGL participants (opt-in) for the event on 20 Feb 2023

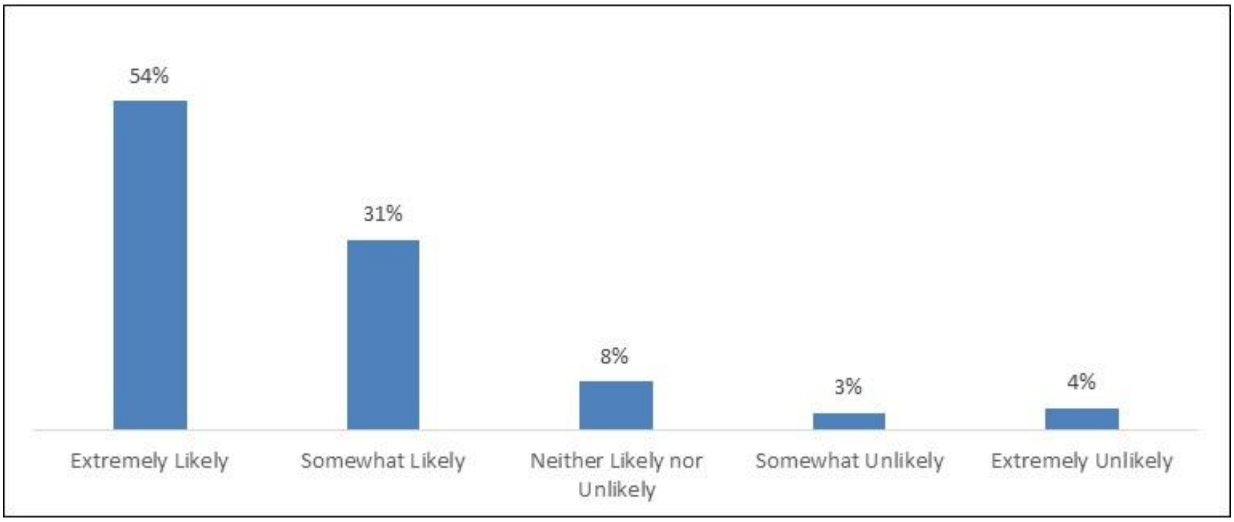


Survey Results

In May 2023 we ran a survey targeting some of the customers in the trial with over 2,650 customers invited to complete the survey.

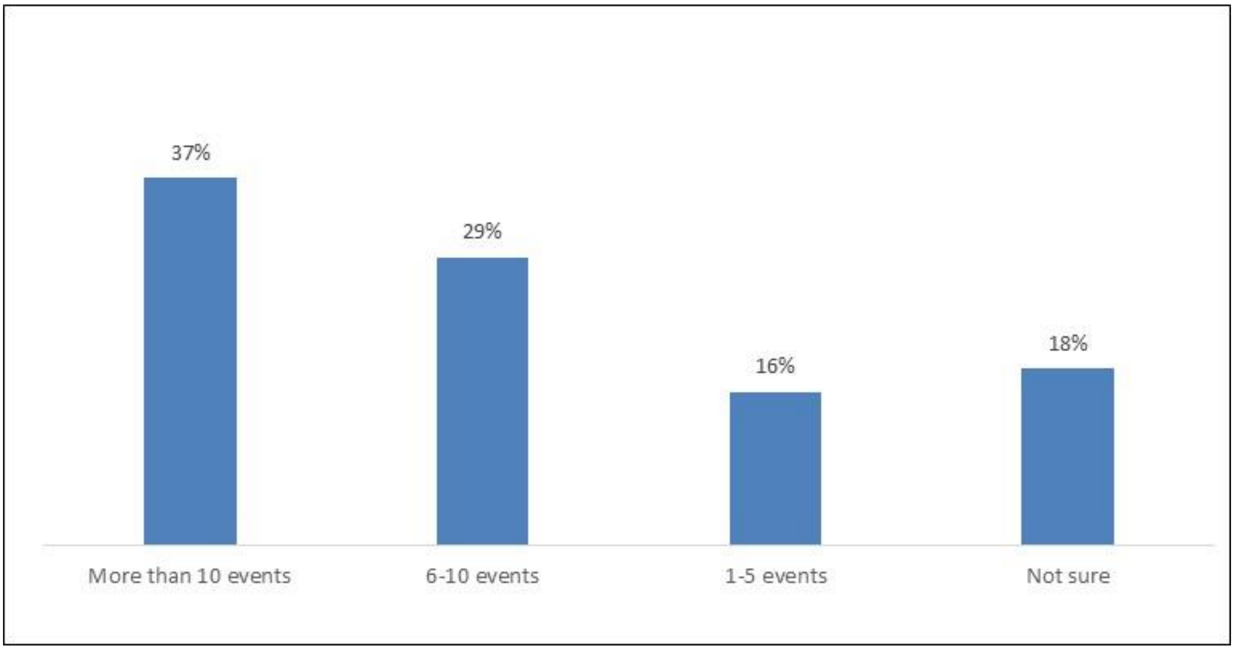
The results in Figure 20 suggest that, encouragingly, there is a high interest from the customers in participating in future events.

Figure 20 - Survey results "How likely is it that you would participate in future events?" (N = 226)



The results shown in Figure 21 allow Ausgrid to understand the number of peak demand days that could be targeted for energy reduction through the PTR program. It's encouraging to see more than 65% of the customers are willing to participate in 6 or more events (see Figure 21 below).

Figure 21 - Survey results for "How many events per year would you be interested in participating?" (N=212)



The fact that 22% of customers took actions to reduce consumption but didn't receive a reward (Figure 22) is concerning. We will continue to work with the retailers to explore strategies for addressing this issue.

Figure 22 - Survey results for "Did you always receive a reward whenever you've tried to actively reduce usage?" (N=226)

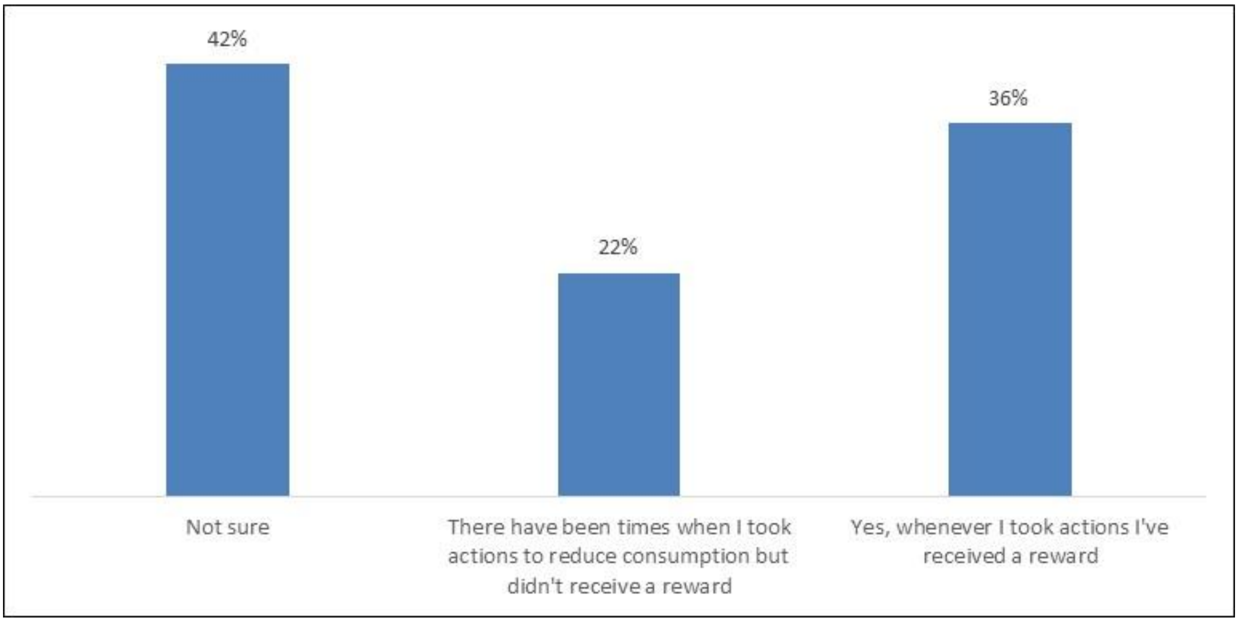
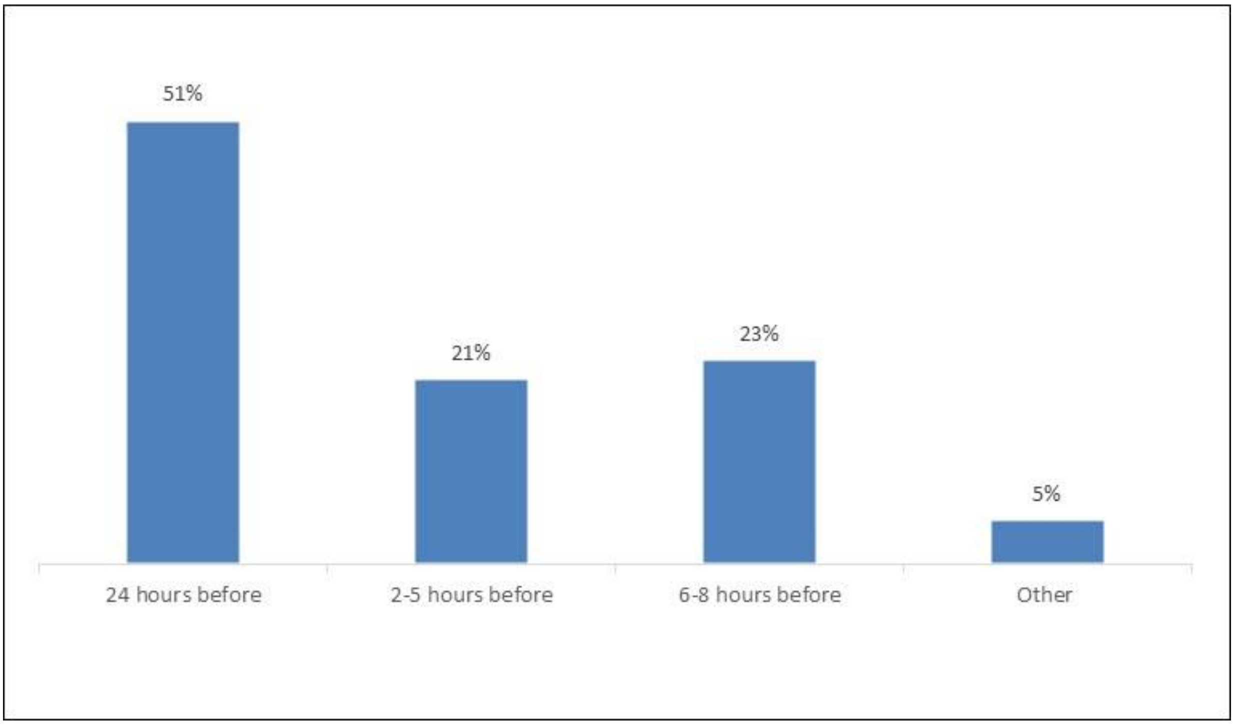


Figure 23 shows that approximately half of the customers require a 24-hour advance notification to participate in an event. Retailers and Ausgrid can use this data to facilitate customer participation and energy usage reduction.

Figure 23 - Survey results for "What would be the minimum notice period you need to participate in events?" (N=227)



Summary

Key findings from the 2022-2023 results:

Participation and customer performance

- The participation rates were relatively consistent throughout 2022-2023 with opt-out recruitment averaging 100% participation rate and opt-in recruitment averaging 53%.
- Similar to previous years, opt-out recruitment led to higher participation rates, but not necessarily higher reductions. Almost half of opt-out participants received zero credit, which indicates that a significant portion of them are non-active participants.
- On average, opt-in participants achieved a demand reduction of approximately 0.8kW based on the retailer's baseline.
- Around 46% of opt-out participants achieved a minimum 5% reduction, averaging approximately 1kW of reduction based on the retailer's baseline.
- Weekends and public holiday events had comparable participation rates and reductions as weekdays. Limited testing of weekend/public holiday events means that it is difficult to draw a firm conclusion.
- A 24-hour advance notification slightly increased the participation rates and reductions. Firm conclusions are difficult to draw due to variable customer performances. It should be noted that over half the surveyed customers indicated that they would need a notification at least 24 hours prior to the event for them to participate.
- The majority of the customers who achieved reduction received $1-$10 credit per event.

Customer sentiments

- Approximately 85% of the survey respondents are somewhat or extremely likely to participate in future PTR events.
- The majority of the customers surveyed mentioned that they're willing to participate in 6 or more events per year.

Future Considerations

- Investigate and address challenges related to scheduling weekend and public holiday events to ensure PTR events can be scheduled on any day, not just on weekdays.
- With 22% of survey respondents not receiving a reward after taking actions to reduce their energy consumption, further investigation is required to understand baseline methodology and ways to assist customers to achieve reductions.
- Explore the potential of additional notifications, such as 24-hour advance notice, to increase customer participation and performance.
- Continue to explore strategies like supporting smart meter rollout and implementing customer recruitment/education campaigns to promote PTR growth.

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 2022-2023 regulatory year. The project concluded in June 2023.

5.1 Project nature and scope

The forecast uptake of electric vehicles in Australia is still highly uncertain as per the most recent scenario forecasts from the Australian Electricity Market Operator (AEMO) 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 set out to 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 aimed 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 were explored with electricity retail partners during Phase 2. This involved a partnership with Origin and ARENA on the EV Smart Charging Project, which explored the orchestration value of electric vehicle charging for wholesale value and network support services. Ausgrid also participated in industry and internal research to explore vehicle-to-grid technology for network support services, including a published ARENA report on the opportunities and challenges of V2X in Australia[7].

5.4 Implementation approach

The project will be conducted in two phases:

Phase 1 - Charge Together project support, led by EVenergi (ARENA-funded)

There were 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.

Phase 2 – Electric vehicle charging trials, EV network tariffs and EV industry engagement.

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 was evaluated against the aims and objectives and delivery of the project delivery milestones outlined in the implementation approach. The outcomes of this project include:

- Enhanced our understanding of driving and charging patterns of EV owners by directly surveying electric vehicle owners which explored perceptions about EV usage and charging.

[7] V2X: Summary Report Opportunities and Challenges for Bidirectional Chargers in Australia: https://arena.gov.au/knowledge-bank/v2x-au-summary-report-opportunities-and-challenges-for-bidirectional-charger-in-australia/

- Participated in major Retailer led collaborative electric vehicle charging trials to explore a range of customer, network, electricity retailer and EV industry issues to ensure that distribution network considerations are assessed as part of the trials.
- Developed and tested network tariff options, including research to examine approaches for tariff design for new customer technology.
- Enhanced our understanding of 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 2022-2023, total project expenditure to date and the total project costs. All actual and projected costs are net of any partner contributions.

Table 9 - Project Costs

Budget Item	Actual project costs 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$103,817	$512,262	Complete

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

During 2022-2023, the following Phase 2 activities were concluded:

- Analysis of EV charging data and finalisation of the Origin EV Smart Charging Trial and ARENA report
- Exploration of the opportunities and challenges of fleet electrification and grid integration, in partnership with industry and research institutions.
- Exploration of the current state of V2G technology, precedent research, standards and development of a pathway for connection to enable future trials using V2X technology.
- Participation in the ARENA V2X Opportunities and Challenges report through supporting a DNSP reference group to understand the current state and opportunity for customer adoption of V2X technologies in Australia to inform future project trials.

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

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

5.7.2 Update on material changes to the project

There were no material changes to the planned activities during 2022-2023 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.

Phase 1: Electric vehicle demand planning tool

As reported in the 2021-2022 DMIA annual report, a spatial allocation model was developed and refined to estimate the electrical demand for EV charging using five electric vehicle typologies. This enhanced capability incorporates an energy model to forecast energy volumes related to EV uptake across the network. This is used to identify potential impact of EV uptake on different tariff classes and insights informed the electrical vehicle network pricing study to explore future tariff settings and trials.

Phase 2: Electric vehicle network pricing study

As reported in the 2021-2022 DMIA annual report, HoustonKemp, were engaged to provide guidance on 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 informs development of efficient network tariffs for electric vehicle charging. Effective network tariffs 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 in future projects.

Phase 2: Origin smart charging trial (ARENA)

Ausgrid is a project partner of the Origin EV Smart Charging Trial, which successfully installed more than 150 smart charging EV chargers, to test different scenarios of unmanaged, incentivised, and managed charging models with residential and commercial Origin retail customers.

Through the 2022-2023 regulatory year, Ausgrid supported project partners with input towards a knowledge sharing and closure report[10], **Error! Bookmark not defined.**which was published by ARENA in August 2023. Further information from Origin's preceding learning reports can be found on the ARENA website.

Ausgrid's role provided input into trial design to shape how the trial explores different elements of EV charging behaviour, informing 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 enabled Ausgrid to conduct analysis on the impact of convenience managed and unmanaged charging techniques at different levels of EV penetration to further qualify how smart charging techniques could be applied for cost effective and local network support.

[10] Origin EV smart Charging trial: https://arena.gov.au/projects/origin-energy-electric-vehicles-smart-charging-trial/

The final trial results captured through 2021-2023 have been outlined in Table 10.

Table 10 - Origin EV Smart Charging trial summary

Trial stage and description	**Early Morning** 5am to 10am	**Solar Sponge** 10am to 3pm	**Peak** 3pm to 9pm	**Overnight** 9pm to 5am	Outcomes
Baseline charging behaviour Baseline data capture occurred over 13 months from first install in 2020 to the beginning of experiment 1 in 2021.	9%	25%	29%	38%	Overnight and peak were popular (67%) as was charging in the middle of the day (25%).
Experiment 1 – Incentivised charging Origin tested a variable monetary incentive-based approach to charging. 10c per kWh reward for charging between the times of 10am – 3pm and 9pm – 5am. Rewards would accumulate and be provided as a credit on the customer bill. No reward was paid outside of these times.	5%	31%	11%	52%	Charging outside of peak periods (3pm-9pm) increased from 70% during baseline periods to 90% during the first experiment. Solar soak increased 6% and overnight increased by 17% indicating that overnight could have been more flexible to participants.
Experiment 2 – Managed charging Origin tested a fixed and variable reward mechanism to incentivise control. Fixed reward included 25c per day to curtail charging between 3pm-9pm. Variable reward retained the 10c reward for charging between 10am-3pm or 9pm-5am from Experiment 1.	9%	28%	7%	56%	Charging during the peak periods reduced by 22% when compared to baseline charging patterns and 4% compared to Experiment 1. Compared to Experiment 1, charging increased overnight by 4% and decreased during solar soak by 3%.
Re-baseline charging behaviour Following experiment two, over a 3-month period, no curtailment was in place and no incentives were on offer, and the same charging data was collected to understand if there was any lasting effect of the experiments on participant behaviour without the incentives in place.	10%	24%	25%	40%	A minor reduction (4%) was observed in peak compared to baseline, which indicates that charging patterns trended towards returning to baseline behaviour over time without the presence of incentives or active curtailment periods.

Ausgrid undertook detailed analysis of interim trial results based on data shared by Origin in May 2022 which were included in the previous DMIA report for the 2021-2022 regulatory year, published on the AER website[11].

[11] Ausgrid Annual DMIA Compliance Report 2021-2022: https://www.aer.gov.au/system/files/Ausgrid%20-%20DMIAM%20annual%20compliance%20report%20-%202021-22.pdf

Key learnings from the Origin Smart EV charging trial

Ausgrid has developed key learnings which guide how participation in the Origin & ARENA EV Smart Charging trial will inform and guide further demand management capability and innovation in the next period.

Recruitment of trial participants

- Customer recruitment was led by Origin and participants needed to meet Origin's eligibility criteria. Only a small number of Ausgrid residential customers became trial participants.
- Customers tended to be early adopters of EVs with 71% of customer leads owning solar, 25% owning a battery and owning either a Tesla or Hyundai, which reflected market share at the time.
- 66% of the trial participants mentioned they would be comfortable with charging via a standard socket but as engaged customers were keen to participate in the trial.
- Business customers were harder to recruit for the trial, but some businesses had started to consider charging infrastructure requirements.

Trial mobilisation and charger installation

- Eligible Origin retail customers were required to own their premises and have off-street parking to enable the installation of smart chargers.
- Site information provided by customers in advance of installations can mitigate the risks of installation complexity and cost, but certain factors will still result in cost variation of installation, including cable runs from the switchboard to charger location, trenching and existing switch board capacity.
- The EV Smart Charging solution demonstrated in the trial used a combination of Schneider hardware and the GreenFlux smart charging software platform. The Origin report outlines their assessment of different connectivity options that were considered, including 4G, Wi-Fi and Ethernet. EV chargers could go offline intermittently and there were some challenges reported with 4G network interruptions.
- Research on improving the stability and reliability of connectivity for smart chargers is an important component of the customer experience and the value of smart charging to electricity networks as scale and uptake increases.

EV charging preferences and willingness to allow managed charging

- Baseline charging behaviour was most popular overnight or during the day for solar-soak charging (likely supported by the high proportion of solar customers participating in the trial).
- Experiment 1 successfully demonstrated that incentives provided as rewards to a customer's retail bill was an effective strategy for shifting charging behaviour, reducing charging in the peak demand period from 29% to 11% compared with the baseline.
- Experiment 2 saw an additional 4% reduction in peak demand through Origin's managed charging arrangement.
- Ausgrid's analysis[12] when simulating the impact of managed charging on local network conditions indicated this could increase the risk of a secondary peak in the overnight period due to coincident response to price signals, which reinforces the importance of tariff design and guidelines for randomisation of managed charging to support efficient utilisation of local network assets, especially in areas with higher EV penetration or clustering.
- Origin's analysis from Experiment 2 provided learnings into curtailment opt-out behaviour. This showed that throughout Experiment 2 the opt-out rate compared to opportunities to opt-out was just 1.9% across all residential participants, indicating a high availability of load flexibility potential.
- 44/73 residential customers opted out at least once throughout the trial period and on average this was 11 times per customer, however this average is skewed towards the top 8/44 customers that opted out over 20 times and 1/8 opted out 108 times through the trial.

---

[12] Ausgrid Annual DMIA Compliance Report 2021-2022: https://www.aer.gov.au/system/files/Ausgrid%20-%20DMIAM%20annual%20compliance%20report%20-%202021-22.pdf

The value of smart charging to the network

The trial findings showed that customer incentives and managed charging were seen as effective strategies to reduce electricity demand from EVs at network peak times and increases electricity demand from EVs at network minimum demand times. These responses both help to lower network costs and so reduce long long-term costs to consumers.

Ausgrid explored the potential value of smart charging on avoided or deferred network investment. LV distributor capacity constraints could result in EV charging limitations or reduced reliability for all customers. As part of Ausgrid's CER integration model, Ausgrid isolated the impacts of EV charging and were able to compare the Ausgrid base case to the findings from the Origin Smart Charging trial.

Ausgrid's model indicated that the percentage reduction in EV demand (kW) at peak times (3-9pm) achieved in the trial could support up to $12m in avoided or deferred network investment, assuming similar EV charging behaviour was replicated across all residential EV users to 2029.

Origin also did further analysis across participating networks in the trial against the different ToU network tariffs which indicated that the average network cost of the Baseline charging profile was $135, which was reduced to $107 under Experiment 2, providing an approximate average network value of Smart Charging of $28 per EV per annum.

Ausgrid's additional analysis on case study areas of the network showed that managed charging can have unintended outcomes due to coincident responses to price signals, resulting in a local secondary peak overnight. This reinforces the importance of developing guidelines or requirements for mitigating the impacts of coincident response triggering EV charging, which is especially important in areas with higher EV penetration or EV clustering.

The trial reinforces the importance of tariff design and improved customer access to retail products that support efficient utilisation of network assets and reduce long term customer costs.

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

Ausgrid was 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[13] and Mar 2022[14] respectively. As at March 2022, AGL had signed up 400 participants with 200 smart chargers installed.

Ausgrid participation in the technical reference group through 2021-2022 supported program design for assessing distribution network impacts and orchestration value.

Phase 2: Exploring current state of V2X technology opportunities and challenges

In 2022-2023 Ausgrid sought to build understanding of the current state of V2X bi-directional charging technology in Australia, which supported the development of a connection pathway in advance of CEC product listing for eligible bi-directional chargers that were AS4777.2 compliant, within a controlled setting on the network.

Summary of the current state of V2X challenges and opportunities (ARENA-funded)

- ARENA has published a new report on the Opportunities and Challenges for Bidirectional Charging in Australia[15]. The study led by enX Consulting provides an overview of the current state of V2X technologies and the associated opportunities and challenges for the Australian market. The findings of this report were supported by national and international stakeholder engagement across the supply-chain led by the project team.
- Ausgrid supported the project through participation in the DNSP reference group. The reference group, with representation from 9 distribution network businesses were able to share knowledge and experience of integrating V2X technologies and trials, with a strong interest to exchange ideas on the current state of opportunities and challenges for emerging V2X applications that have been explored through research and trials in Australia.
- International insights also indicate how network distribution business collaborations are helping to spearheaded standards development and product testing processes to accelerate V2G technology and market readiness.

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

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

[15] https://arena.gov.au/knowledge-bank/v2x-au-summary-report-opportunities-and-challenges-for-bidirectional-charger-in-australia/

- In addition to the value EVs already provide through lower running costs and reduced vehicle emissions, V2X services can support the energy transition through allowing EV owners to unlock further value from their vehicle battery to power a home, business, appliances or export into the wider electricity grid at times of high demand.
- Ausgrid supports further industry collaboration and customer research to advance this nascent industry and further support customers to electrify, decarbonise and unlock value from their consumer energy resources, through identifying effective demand management solutions from new flexible technologies.

Learnings from connecting bi-directional capable technology to Ausgrid's network

- Ausgrid is collaborating with a local council which has Australian Standard certified Quasar Wallbox chargers. This is supporting Ausgrid to develop a process to review, commission and test bidirectional technology for safely enabling certified bi-directional electric vehicle chargers on the network. This provides Australian Standard certified V2G equipment a pathway to connect to Ausgrid's network.
- As the ARENA report indicates, the industry is shifting to CSS-based V2G and Ausgrid will continue to support future innovation and trials as CCS-based field trials become possible in Australia, to inform industry's understanding and implications for power system planning.

<u>EV demand research project summary: How the findings shaped Ausgrid's prioritisation of future research and Demand Management opportunities</u>

This EV demand research project has been critical foundation research on preparing for the update of significant new loads from electrification of transport. Ausgrid will continue to focus on new innovation and demand management solutions to support efficient and effective EV integration through further research and innovation projects. The below outlines how these findings will be taken forward:

- **EV visibility:** Ausgrid continues to build capability for visibility of EV charging across the network and analysis of load profiles as EV uptake scales will continue to support Ausgrid's demand forecasting.
- **Network Tariffs:** Ausgrid continues to trial new technology agnostic tariffs that could complement retail EV products well including the Super Off-Peak tariff and Flexible Load tariffs. Details of these can be found in Ausgrid's Tariff trial notification[16].
- **Customer Research:** Ausgrid has since explored further industry collaboration opportunities to undertake further research targeting larger trial sample sizes as adoption of EVs and diversity of customer preferences and priorities increase over-time.
- **Commercial Fleets:** Ausgrid is partnering with industry and research institutions to explore commercial fleet electrification, which presents a unique set of opportunities and challenges for load flexibility and demand management solutions across different fleet sectors.
- **Bi-directional charging:** Ausgrid continues to explore opportunities to trial and demonstrate flexible services provided by bi-directional chargers as new eligible technology enters the Australian market.
- **Charging infrastructure:** Ausgrid is working with industry partners to increase the availability of on-street parking and public EV charging infrastructure.

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

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.

[16] Trial Tariff notification 2023-24 https://www.aer.gov.au/system/files/Ausgrid%20-%20Tariff%20trial%20notification%20-%202023-24.pdf

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 2022-2023 regulatory year. The project concluded in June 2023.

6.1 Project nature and scope

This project was a research project led by Monash University in which Ausgrid provided both co-funding and in-kind subject matter expertise in partnership with Energy Consumers Australia and Ausnet Services. The project was also granted funding from the Australian Research Council due to its innovative combination of research techniques.

The project aimed to understand and forecast changing digital lifestyle trends and their impact on future household electricity demand, including at peak times. This was conducted by employing a range of innovative quantitative and qualitative research techniques that investigated customer behaviours and opinions and made 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 had 5 key aims and objectives, which were 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 aimed 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 adopted innovative approaches by applying ethnographic research techniques and sociological theories to investigate how changing social practices will impact on electricity sector planning. Expected outcomes included 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 took place over 3 plus years starting in 2019 and concluded recently. There were 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 was assessed by evaluating the extent to which the aims and objectives were met as meeting the project delivery milestones as outlined in the implementation approach.

Outcomes from the project included:

- Enhanced understanding of everyday household practices, how they are changing and how they affect household electricity consumption. (Objective 1)
- Identified and developed future trends and scenarios for household energy use that will inform forecasting methodologies and electricity sector planning. (Objectives 2 to 4)
- Researched and developed practical demand management solutions in the household customer segment, which guide future demand management initiatives with customer and social factors considered central to design of future initiatives. (Objective 5)

6.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2022-2023, 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 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	\$24,037	\$359,185	Complete

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 were 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: (completed)

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

Stage 5 (completed):

Development of the research and activities associated with Stage 5 commenced in 2020-2021 and were completed in 2022-23.

Stage 6 (completed)

Research and activities associated with Stage 6 were completed in 2021-2023.

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 and 6, including modelling and forecast development commenced in 2021-2022 with completion in 2022-2023, including the final report, future DEF scenario's and industry knowledge sharing and engagement on project outcomes.

6.7.3 Collected Results

The reports published so far as part of this project can be found on Monash University's website[17].

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.

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

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

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 (e.g. 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 household 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,

In the regulatory year 2022-2023 the following activities concluded this project:

- The research findings from preceding stages informed the development of plausible Future Living Scenarios to illustrate how people may live in the future. This was explored through different customer profiles in relation to emerging energy technologies and leads to system planning and demand management considerations for the future, including how customers might interact and participate with demand management initiatives and seeking equitable outcomes as the transition leads to new customer inequities.

- The final report was published in February 2023[18] and recommends that industry prepares for more diverse forms of customer participation and engagement as people don't only use automation for energy purposes, often override CER to maintain control, and match CER use to their everyday priorities & values.
- The four scenarios reflect plausible futures based on the Digital Energy Futures project evidence base, including qualitative research over the 4-year study period in Victoria and New South Wales 70 households and was supported by national data and trends from the Energy Consumer Behaviour Survey.
- The scenarios provide an alternative industry perspective grounded in social science that explores how diverse households will live, use, and participate or interact with energy over the coming decades. This includes how people relate to energy through what it helps them do, such as feed the family, clean the house and stay healthy, comfortable and entertained.
- To bring the scenarios to life, researchers developed narratives for different households to demonstrate how the scenarios impact different diverse groups including renters, rural households, and technology-savvy suburban households. This helped to demonstrate how different scenarios consider emerging or new inequalities over the coming decades as those that can afford to make home upgrades, electrify their appliances, and leverage smart technology to help manage their costs, while other households may be more exposed to the changes anticipated in climate, electrification, and other socio-economic trends.
- In two of the defined scenarios, the home takes on an even more essential role in everyday life, which has potential implications for both energy forecasts and social inequality. For Ausgrid, it is important to consider how time spent at home in the future scenarios will influence customer usage, as they opt to electrify appliances over time and become more reliant on the electricity network for their needs, including comfort, safety and transport.
- The research team studied household's everyday routines, priorities, and future visions, including the use of emerging digital and energy technologies. The scenarios also draw on demographic, technology, economic and environmental trends. A brief overview of the four scenarios is provided below:
    - Creature comforts – envisions a 2030 world of rising living costs and household investments in consumer electronics and home upgrades. In this scenario, energy usage at home remains high as households seek to create a comfortable home environment.
    - Hunkering down – builds on the creature comforts scenario, taking the trend further to 2050. This scenario envisages a world where homes are optimised for safe, productive and comfortable refuge from extreme weather and climate change.
    - Sharing the load – envisions a 2030 world where households invest where possible in solar panels, storage and electric vehicles. Households share their investments with the wider network, through exports in addition and smart technology helps manage home usage and demand management.
    - Sunrises and siestas – envisions a 2050 scenario where institutions and society must adapt to the risks associated with climate change through policy, community initiatives and infrastructure.
- As part of the launch of the Final Report, Ausgrid supported the presentation of the Digital Energy Future's work at the Energy Consumers Australia foresighting forum in February 2023, including an innovative interactive showcase of the research findings, scenarios and industry engagement.

Digital Energy Futures project summary: How the findings shaped Ausgrid's prioritisation of future research and Demand Management opportunities

[18]Reports published at https://www.ausgrid.com.au/Industry/Our-Research/DMIA-Research-and-trials/Digital-Energy-Futures and https://www.monash.edu/digital-energy-futures/home

The DEF evidence showed that:

- People don’t only use automation for energy purposes
- People can override CER to maintain control
- People often match CER use to their everyday priorities and values
- There are significant inequities in access, and knowledge, to operate CER

The DEF scenarios reveal that industry needs to take into account, encourage, and prepare for more diverse forms of participation and engagement than CER uptake to maintain high levels of material certainty. For Ausgrid, this will be explored through future initiatives informed by this study, including:

- Explore the implications and importance of social research in guiding future programs. DEF findings provide a key foundation to inform how Ausgrid considers customer behaviours and social science to examine implications on the effectiveness or potential barriers to enabling a customer response to dynamic pricing and demand management.
- Future research should consider how diverse social priorities guide customer response to retail products and services that are expected to emerge as market participation opportunities increase through dynamic pricing and demand management opportunities, in addition to how implementation approaches consider equity and efficiency to unlock customer benefits and participation.
- Identify opportunities to further explore customer preferences including quantitative, qualitative and longitudinal research to expand on the future living scenarios and improve Ausgrid’s understanding of the materiality of the future living scenarios in system planning and future demand management projects.
- Work with range of stakeholders (customer advocates, academia, industry) to identify and deliver collaborative research to explore new demand management opportunities raised through the Digital Energy Futures project, including the implications on automated futures through smart technology and mobility.
- Consider the design of customer facing trials and programs include appropriate customer quantitative and qualitative research components.
- Consider how new vulnerabilities and equity issues will occur through the energy transition and ensure inclusive design of projects is considered in future demand management and innovation trials and research.

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 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 2022-2023 regulatory year. The project will be ongoing into the 2023-2024 regulatory year.

7.1 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 trial.

7.2 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 trial. 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.

7.3 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.

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.

7.4 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 trial

The details and funding of a Phase 3 trial 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 trial under Ausgrid's Network Innovation program. The community battery trial has been developed in collaboration with Ausgrid's Network Innovation Advisory Committee (NIAC)[19]. 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 trial.

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 trial.

7.5 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.

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

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 trial.

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

As the trial 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.

7.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2022-2023, 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 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$12,474	$508,137	$600,000

7.7 Project Activity and Results

7.7.1 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[20].

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

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 7.7.3.

7.7.2 Update on material changes on the project

The delivery of the Phase 3 community battery trial 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[21].

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.

7.7.3 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[22]. Ausgrid's Community battery feasibility report can be downloaded from the project research page on Ausgrid's website[23].

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 public report containing the results from the survey is available on the project research page on Ausgrid's website[24]

Phase 3 – Community Battery Trial

As a part of the Phase 3 for the community battery trial program, quarterly surveys were conducted with the existing participants. A customer experience survey was conducted between October-November

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

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

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

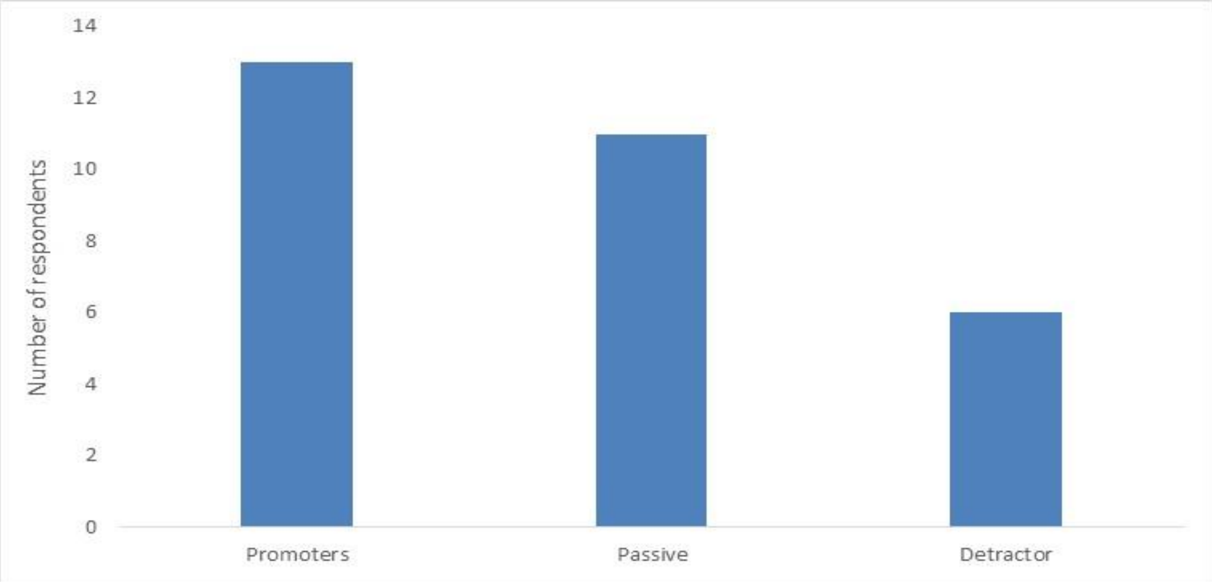
[24] https://www.ausgrid.com.au/In-your-community/Community-Batteries/Project-research

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.

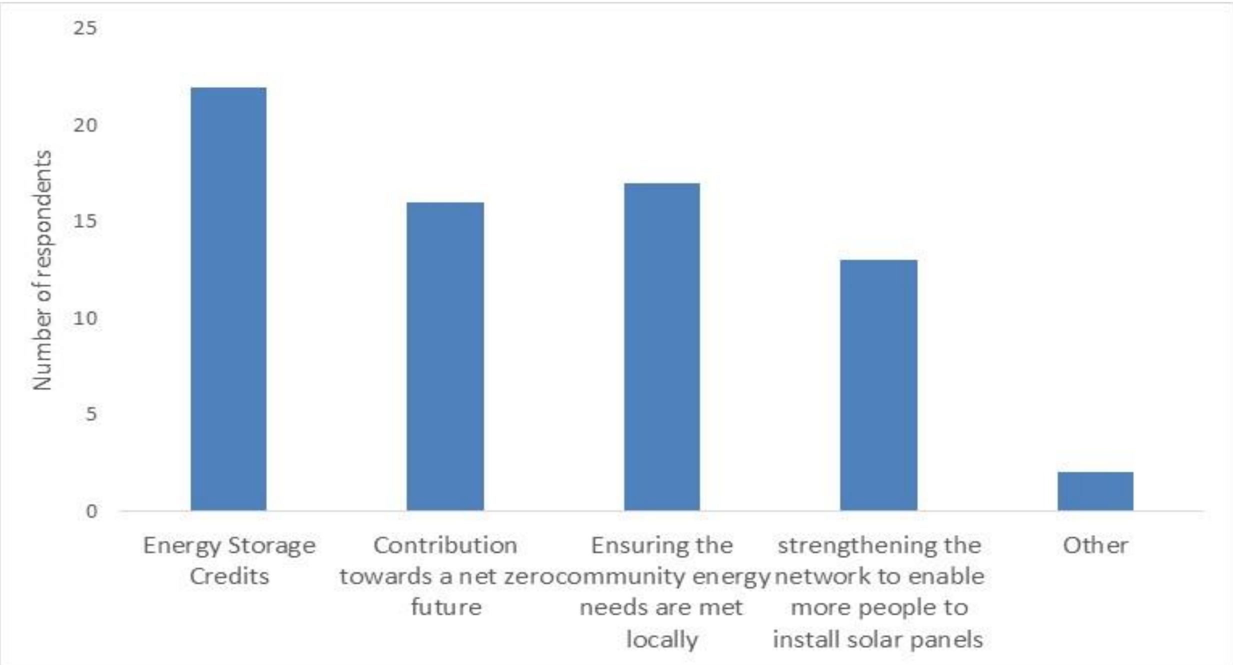
Customers were asked to give a score out of 10 on their experience so far with the Community Battery trial. Customers who gave a score of less than 6 or below were considered detractors, those who gave a score of 7 or 8 were considered Passive, and those who gave a score of 9 or 10 were considered Promoters.

Figure 24 - Survey response to "how would you rate your experience being a part of the Community Battery Trial until now?"



Customers have the option to leave the trial at any point without any penalty or charge. We asked the customers their reason for continued participation in the trial. Energy storage credits was the most selected motivator for continued participation.

Figure 25 - Survey response to "What are the key reasons for your continued participation in the trial? (multiple answers allowed)"



Participants 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. As shown in the results below, while approximately 75% of the customers found the data useful, the frequency of usage varied significantly among the respondents.

Figure 26 – Survey response to "Do you find the SwitchDin app and data useful?"

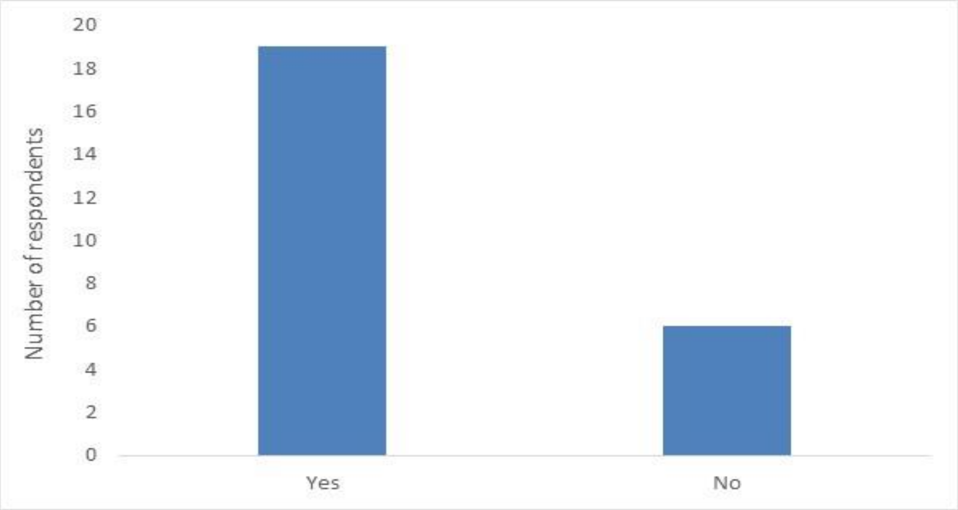
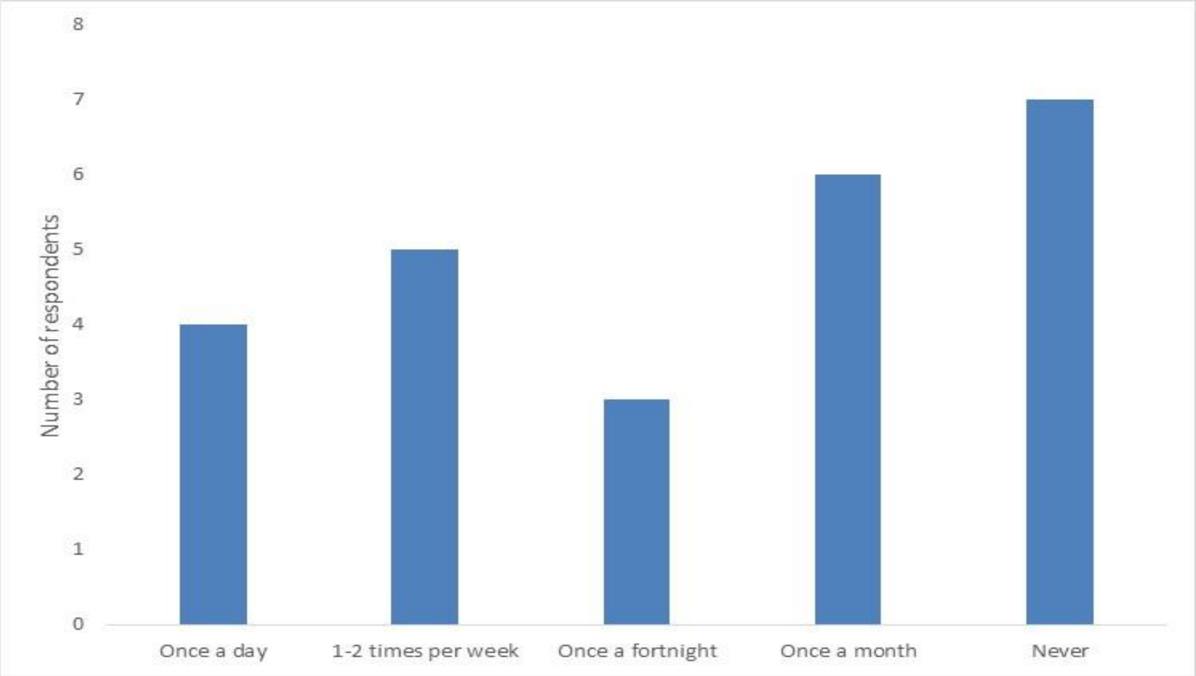


Figure 27 - Survey response to "How often do you check the SwitchDin app?"



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 funded by DMIA for 2023-2024.

7.8 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.

8 Battery Demand Response (Virtual Power Plant)

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 2022-2023 regulatory year. The project concluded in 2022-2023.

The field trial component of the project concluded in 2021-2022 regulatory year with no further dispatches in 2022-23. A final report of the project was published on Ausgrid's website later in February 2023[25].

8.1 Project nature and scope

Ausgrid's Battery Demand Response (Virtual Power Plant, VPP) trial explored whether battery VPP's can provide reliable and cost competitive sources of demand reductions or voltage support services to defer network investment. This project sought 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 aimed 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.

8.2 Project aims and expectations

The three primary objectives of the project were 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 included;

- 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.

8.3 How and why project complies with the project criteria

This research project explored 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 were dispatched to provide support to the network. Each Ausgrid dispatch event was 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 was 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.

8.4 Implementation approach

The project was divided into 2 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

[25] https://www.ausgrid.com.au/Industry/Demand-Management/Power2U-Progam/Battery-VPP-Trial

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 included customer battery system dispatch and further development of aggregator partnerships. This Phase was initiated in 2018-2019 and concluded at the end of 2021-2022.

8.5 Outcome measurement and evaluation approach

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

Project activities designed to achieve these objectives included:

- 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.

8.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2022-2023, 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 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$29,763	$1,132,322	Complete

8.7 Project Activity and Results

8.7.1 Summary of project activity and collected results to date

Ausgrid's partnership with Reposit Power[26] 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[27] and ShineHub[28] were selected to join the trial. Ausgrid's VPP fleet, at trial conclusion, consisted of approximately 750 battery customers. With multiple fleets and providers and a range of battery types in the trial, Ausgrid was able to compare different elements to identify how the various providers and batteries perform within a VPP.

26 https://www.repositpower.com

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

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

The project activities were not planned to align with an area of the network with an investment need. The project was 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[29] and published VPP reports on Ausgrid's website[30]. A summary table of dispatches completed during the trial has been provided below.

Table 14 – 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[31]	12	42	69	64

Results from the 2022/23 activities are as follows:

Ausgrid's VPP trial concluded in June 2022 with no further dispatches in 2022-23. Project activities in 2022-23 included downloading historical trial data, finalising agreements with our partners, and publishing the final report in February 2023[32].

Key lessons from the trial are summarised below:

- A sufficiently sized VPP can help address network constraints during peak demand periods and potentially defer or avoid network upgrades. However, a significant increase in residential battery uptake is required for this potential to be realised.
- While an orchestrated VPP dispatch can offer considerable additional power and demand reduction potential, residential batteries without VPP control ('business as usual' operation) can also reduce demand during peak periods, suggesting that a wider proliferation of residential batteries will have a positive impact on demand management of the network.
- A VPP can be used by multiple parties for different purposes, which could impact its availability during peak periods. It is important to coordinate and implement appropriate customer incentives, contracts and systems to manage VPP availability.
- While pre-charging the batteries is important for maximising VPP energy output, the timing of the pre-charging needs to be managed so that it doesn't add to the peak demand. For the customers, the benefits received from the dispatch need to sufficiently compensate for the cost of pre-charging.
- Sending updated command signals throughout a dispatch can help optimise VPP dispatches by adjusting VPP behaviour to respond to changing conditions (e.g. load, available stored energy) however this requires a reliable communication network.
- Both gross and net Feed-in-Management (FiM) can assist with lowering voltage during times of over voltage on the network, however these options reduce customers' solar output, leading to financial loss for the customers.
- Net FiM management is preferable to gross FiM as it allows the customer's load to be supplied by solar while restricting export into the grid. However, net FiM is more complex to implement because the inverter output must be constantly adjusted to supply the load but must be limited to prevent export exceeding a set threshold.

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

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

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

[32] https://www.ausgrid.com.au/Industry/Demand-Management/Power2U-Progam/Battery-VPP-Trial

- Participants' feedback for the trial was largely positive with the majority of the surveyed participants expressing that they're satisfied with their experiences with the trial and are likely to join a VPP again in the future.

VPP trial findings, in particular the potential impacts that VPPs can have on the network, have helped informed our forecasting and planning processes. Lessons from Ausgrid's VPP project have also been incorporated into the design and approach for Project Edith, which explores how the grid can facilitate demand response energy solutions (such as VPPs) through the use of tools such as dynamic operating envelopes and dynamic network pricing.

8.8 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.

9 Project Edith Customer Payments

This project is a new Demand Management Innovation Allowance (DMIA) project in the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2022-2023 regulatory year. The project will continue into the 2023-2024 regulatory year.

9.1 Project nature and scope

Project Edith is exploring how through dynamic network prices, distribution networks can unlock more value for and from customer energy resources that are enrolled in VPP arrangements.

The project takes a collaborative approach, co-designing the solution with project partners and engaging with stakeholders from across the industry.

The first phase of the project was a rapid demonstration phase to test whether existing ICT systems could be adapted to provide dynamic network pricing to unlock this additional value with only modest systems investments. A tariff solution was required that was sufficiently flexible to allow multiple changes within the year through a lean and iterative build-test-learn development cycle.

An off-market tariff approach was implemented in which customers remained on their Tariff Structure Statement-listed network tariff (e.g. EA116 or EA025) and network charges were calculated for the project tariff in parallel. The customer's agent optimised customer energy resources around the project tariff, which was provided to them via an API integration. In the case where this optimisation resulted in the project tariff charges being lower than the listed tariff charges, Ausgrid paid the agent the difference. This payment was funded from the DMIA.

Project Edith has now entered a second phase to test a more robust sample of customer agents and customers. This will include recruitment of more customers and customer agents with whom to test further iterations of the dynamic network tariff.

9.2 Project aims and expectations

Project Edith has three primary objectives:

1. To test and demonstrate the effectiveness of managing network capacity through dynamic network pricing in a growing two-sided market.
2. To highlight and inform key areas in operationalising this model.
3. To engage and share insights within industry.

The project sets out to meet these by developing an end-to-end dynamic pricing system including:

- A pricing engine that can calculate dynamic network pricing considering internal (load measurements, metering data, network connectivity) and external (weather, aggregator operation) inputs,
- An API that publishes 5-minute network pricing and operating envelope data to an aggregator on a day ahead and near real-time basis, and
- A basic billing engine to determine the differential between the underlying network tariff and the dynamic network tariff for each Agent's customers.

The intention for the first phase was to develop a proof-of-concept that could support up to 200 customers, primarily testing compatibility with existing systems in order to determine what investment in capabilities would be needed to scale the concept. The proof-of-concept was also intended to demonstrate dynamic pricing to stakeholders and contribute to policy discussions on how best to integrate CER into two-sided markets.

The second phase will test a more robust sample of customer agents and customers.

The DMIA project for customer payments supports these broader aims by providing a mechanism for the off-market tariff, allowing a lean and iterative research approach that could not have been achieved with an on-market trial tariff.

9.3 How and why project complies with the project criteria

Project Edith is demonstrating the effectiveness of dynamic network pricing to improve utilisation of distribution networks. If found effective, these price signals can reduce network costs to manage the impacts from minimum and maximum demand based on current and future trends, as well as improve customer outcomes such as reducing the need for curtailment of solar exports and unnecessary network upgrades. This will involve measures designed to reduce both peak demand and minimum demand scenarios. Importantly, achieving these outcomes will be primarily by effecting the behaviour of customer energy resources (CER).

This project is critical research to ensure Ausgrid, other DNSPs and AEMO can identify how effective dynamic pricing signals are at influencing CERs and consequently the future NEM.

This is the first trial of its kind in Australia. Dynamic Network Pricing can specifically target emerging issues that are widely regarded as key risks in our transition to a net zero, distributed energy system.

If the proposed aggregator/customer relationship demonstrates a change in customer energy profile, and this change demonstrates a more efficient utilisation of the distribution network, then long term network costs can be reduced. These cost reductions can be realised in both the LV and HV network, and effect both minimum and maximum demand constraints.

This project is primarily funded through Ausgrid’s Network Innovation allowance. The DMIA will be used to fund the customer savings realised by optimising for the off-market project tariff instead of their listed tariff. There are no NSW or national schemes we could use to fund this gap. It is also not covered by our forecast capital and operating expenditure.

This project is limited to Ausgrid’s distribution network.

9.4 Implementation approach

9.4.1 Pricing principles

Pricing principles for dynamic network pricing were developed to align with Ausgrid’s pricing principles used in the development of Ausgrid’s 2024-2029 Tariff Structure Statement and, as far as possible, with the NER pricing principles. This process also served to identify the rule change that would be required to accommodate dynamic network pricing in the NER.

These principles were then used to define a tariff that could be applied to the project customers.

The initial tariff included:

- A capacity subscription price - to incentivise investment in capabilities to reduce network use in accordance with Dynamic Operating Envelopes (DOEs) when needed
- A dynamic, two-way energy-based price – to reflect the cost of network use at different times and places
- A fixed charge – to recover remaining residual costs.

9.4.2 Pricing and DOE engine

The dynamic element of the tariff relies on short-run marginal-cost (SRMC) pricing to harness the price-elasticity inherent in CER such as battery storage to ensure that network use remains within network capacity limits. The tariff also included negative prices which act as rewards for network use that helps to offset constraints, e.g., for exporting energy during peak demand events. This required the development of a dynamic pricing engine, which was implemented in the Evolve platform.

The Evolve platform was developed by ANU and Zeppelin Bend, through a previous collaborative project, to calculate and communicate dynamic operating envelopes. Ausgrid engaged ANU and Zeppelin Bend to extend the Evolve platform to include calculation of dynamic network prices using the SRMC approach describe above. This included new endpoints for the Evolve API so that prices could be retrieved by customer agents along with DOEs.

9.4.3 Application Programming Interface (API)

Customer Agents carried out API integration to retrieve the dynamic network prices from the Evolve platform. They also updated their VPP optimisation engine to take dynamic network prices as an additional input so that optimal control actions could be passed through to solar and battery systems.

9.4.4 Billing engine

Finally, a billing engine was built by Ausgrid to calculate the network charges attributable to participating customers for both the project tariff and the customers’ listed tariffs and to calculate the payments due to Customer Agents arising from the difference between those costs.

9.4.5 Customer offer and recruitment

Initially, five existing customers were recruited to Project Edith. These initial customers already had a strong relationship with their Customer Agent and could be used for early testing where outcomes were uncertain. For these customers, the full SRMC-based dynamic prices were applied.

A further 60 existing customers were then added in a further round of recruitment. For these customers a simpler weather-based dynamic tariff was applied in which prices shifted from low default prices to pre-defined high prices (and corresponding high rewards) under certain weather conditions that correspond to times of constraint, for example late afternoon / early evening on hot days and early evenings on cold days for peak demand, and sunny periods at midday for peak exports.

It is up to the Customer Agent to determine how value is shared with their customers. Where they are not an energy retailer, value is shared separately to the customer's retail plan.

At end of June 2023, preparations were underway to recruit 150 additional customers with the initial customer agent.

9.5 Outcome measurement and evaluation approach

Within the billing engine described in section 9.4.4, energy flows for each connection point can be compared with the network prices applied to that connection point for each metered period (ranging from 5min to 30min depending on the meter settings). This comparison allows an assessment of the customer response to dynamic pricing. In these cases, the relevant customer response is a function of the VPP optimiser. The customers themselves do not have visibility of project tariff (see section 9.4.5) so behavioural responses are not tested.

With only a small number of customers participating in the first phase of Project Edith, evaluation was qualitative and done by observing correlations between energy flows and prices at times of rapid change.

Evaluation also included assessment of the tariff settings. Dynamic pricing is intended to deliver similar cost outcomes for customer agents as the default static pricing in the absence of re-optimisation and lower costs after re-optimisation. Cost outcomes over several months were analysed to assess the prices and to adjust them as needed.

9.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2022-2023 and total project expenditure to date. Total expected project costs by the completion of the project are unknown at this stage and will become available as the project progresses. Project costs to date were lower than expected for two reasons:

1. Capacity subscription costs were larger than anticipated, resulting in smaller savings compared to customers listed tariff, and therefore lower payments to the aggregator. The tariff has been adjusted to rectify this. This demonstrates the benefit of the flexibility afforded by an off-market tariff.
2. Lower customer numbers than anticipated. This was not a reflection of customer uptake; there was a negligible number of opt-outs. However, the work required by Agents to update their optimisation algorithms around Project Edith pricing was significant and incurred some delays, which in turn delayed recruitment of customers. Recruitment is continuing, however we are exploring options to mitigate risk of repeating this experience by financially supporting the integration and optimisation efforts of customer agents onboarded in the future.

Table 15 - Project Costs

Budget Item	Actual project costs 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$5,037	$5,037	N/A

9.7 Project Activity and Results

9.7.1 Summary of project activity and collected results to date

Phase one of the project achieved its objectives by:

- Validating the technical feasibility of an end-to-end solution for dynamic pricing, including a network model, pricing engine, and API integration. The project partner optimised their customers' solar and home battery systems around the dynamic network prices, showing that sophisticated tariffs for price-responsive devices can be implemented and add value for market-active customers.
- Demonstrating that dynamic network pricing can be implemented through an evolution of existing systems, providing confidence in a cost-efficient implementation at scale.
- Gaining support from stakeholders, including customer advocates, regulatory bodies, energy networks, energy retailers and aggregators, building confidence in dynamic network pricing as a way of generating value for networks and for virtual power plants and their customers.

The customer payments facilitated through the DMIA allowed completion of the end-to-end experience and were thus crucial for this demonstration and stakeholder support.

The demonstration faced several challenges. One of these was the effort required for Customer Agents to retrieve and optimise around the dynamic prices. Network prices have always been static in the past and applied in periods of no less than 30mins. Changes were made to their optimisation algorithms to accept 5-min variable network pricing, including both positive and negative values forecast a day ahead.

Several iterations were needed to complete these changes and to identify and rectify issues that inevitably arise when sophisticated code undergoes such changes. This challenge was among the reasons for limiting the fully dynamic SRMC pricing to only five customers. The time needed for completing this work also limited opportunity to observe response to prices.

The effort required also highlighted a potential challenge in recruiting further customer agents to the project. With substantial initial cost and effort required for a longer-term and uncertain benefit, it would be difficult for customer agents to prioritise participation. Greater support (in the form of co-funding) for this effort is possibly needed.

Another challenge was the combination of capacity-based pricing with dynamic pricing. The project tariff included a capacity subscription which allows customer agents to reserve a minimum capacity for each connection point, which is in effect a lower bound on DOEs that can be applied for that customer. Below the capacity subscription, usage charges were set to zero. This was intended to allow customer agents to optimise around customer assets depending on the level of available flexibility. During the trial we found that capacity subscriptions were set higher than we expected, due to the relative uncertainty around peak network use. This detracted from testing the dynamic prices since they were effectively zeroed for most of the time. This finding allowed us to pivot and move away from capacity subscriptions for the next phase of the project.

9.8 Other Information

Further work is required to establish the project's hypothesis is valid – that dynamic network pricing can be effective in managing network capacity in a growing two-sided market. A key element of this is determining price elasticity of customer energy resources, which requires both more participating customers and Customer Agents.

Therefore, to ensure that project objectives are met, efforts are underway to increase the number of customer agents and customers participating. This expansion will explore a wider range of customer agents and the resultant customer offers they develop and offer a more robust sample of customer participation.

Following an EOI process, a number of customer agents have expressed an interest in joining Project Edith, with a preliminary target of 1000 customers by June 2024. When conditions are appropriate, the trial will transition to an on-market sub-threshold trial tariff and ultimately a Tariff Structure Statement-listed formal tariff.

10 Project Edith CSIP-Aus Specification Extension

This project is a new Demand Management Innovation Allowance (DMIA) project in the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2022-2023 regulatory year.

The project will continue into the 2023-2024 regulatory year. Two knowledge sharing reports on Project Edith have been published on Ausgrid's website in 2022 and 2023.

10.1 Project nature and scope

The aggregation and dispatch of price responsive customer energy resources (CER – like batteries, electric vehicles, and home energy management systems) within the distribution network presents new opportunities and challenges for the allocation and management of network capacity. Traditional network tariffs and static export limits can create barriers to the participation of CER in two-sided markets.

Furthermore, poor coordination of CER can result in network issues such as poor voltage levels or overloads. In the long run, continuing to connect large numbers of CER to the network without appropriate limits or appropriate pricing for the use of the network service will drive the need for capital expenditure to mitigate against the network problems which are occurring, a cost borne by all customers including those without CER.

Project Evolve[33] established how Dynamic Operating Envelopes (DOEs) can address these emerging concerns, and Project Edith seeks to demonstrate how dynamic network pricing can both further address these concerns and provide new opportunities for unlocking the value of flexible CER to both customers and networks.

This project proposes to develop, build and test an extension to the currently published version of the CSIP-Aus API (Common Smart Inverter Profile – Australia, Application Programming Interface), that being version 1.1 dated June 2020. This extension is needed in order to provide the functionality required to communicate the dynamic network pricing model proposed by Project Edith.

The success of dynamic network pricing is expected to be increasing market participation opportunities for CER, increasing network utilisation, as well as enabling more efficient demand management support services based on two-way dynamic pricing rather than direct procurement.

It is intended that the results of testing and building this extension be made available to the broader industry to support understanding and future adoption of this capability in order to access the expected benefits of dynamic network pricing. The results of developing the CSIP-Aus API will be included in Project Edith's quarterly updates to industry and also via knowledge sharing reports.

10.2 Project aims and expectations

The objective of this project is to build and test an extended version of CSIP-Aus v1.1 that can communicate dynamic network pricing, and provide the specification, test results and insight gained to industry. While this work will be delivered within the broader goals of Project Edith, its deliverables are discrete and satisfy the eligibility criteria of DMIA funding.

Therefore, this project's success will be in demonstrating that CSIP-Aus v1.1 can be appropriately extended to communicate Project Edith's dynamic network pricing concept. Validating the pricing concept remains with Project Edith.

The expected outputs of this project are to

1. Develop a revised CSIP-Aus API specification that provides the necessary additional features and requirements to communicate dynamic network pricing in a way that is consistent with both CSIP and IEEE 2030.5; and
2. Build, test and validate an implementation of the revised API. Validating the API implementation will include integrating the API server into Project Edith's end-to-end testing with customers.

[33] https://arena.gov.au/projects/evolve-der-project/

10.3 How and why project complies with the project criteria

This project will build technology to communicate pricing signals that will support Project Edith. If found effective, these price signals can reduce network costs to manage the impacts from minimum and maximum demand based on current and future trends, as well as improve customer outcomes such as reducing the need for curtailment of solar exports. This will involve measures designed to reduce both peak demand and minimum demand scenarios.

This project is critical research to ensure Ausgrid, other DNSPs and AEMO can identify how effective dynamic pricing signals are at influencing CER and consequently the future NEM. This is possibly the first implementation of dynamic network pricing functionality in an API intended for CER communication; it is certainly the first in Australia.

The development of this technology enables dynamic network pricing as envisaged by Project Edith. Therefore, its success is integral with Edith. If Edith's proposed aggregator/customer relationship demonstrates a change in customer energy profile, and this change demonstrates a more efficient utilisation of the distribution network, then long term network costs can be reduced. These cost reductions can be realised in both the LV and HV network, and effect both minimum and maximum demand constraints.

The costs for this project are not recoverable under any other jurisdictional, state or national scheme. The costs are also not covered by our forecast capital and operating expenditures allowed by the AER.

The funds allocated for Project Edith do not cover this project.

10.4 Implementation approach

10.4.1 Phase 1 – CSIP-Aus specification extension

In the project's first phase, the CSIP-Aus v1.1 specification will be extended to allow communication of dynamic network pricing. Care will be taken to achieve this by remaining within the guiding principles already established by the DER Integration API Technical Working Group who published the first CSIP-Aus specification. Principally this will be following the existing IEEE 2030.5 (which contemplates dynamic network pricing) and CSIP standards that inform CSIP-Aus.

ANU will carry out this work. As subject matter experts on the current CSIP-Aus implementation, they are well placed to determine an extension that is consistent with both the guiding principles and standardisation of CER interoperability.

10.4.2 Phase 2 – Build and Test

With the API specification now extended, Phase 2 will build an implementation and integrate it into the groups of systems Project Edith is using to demonstrate dynamic network pricing. Once integrated, the API can be thoroughly tested, and the specification's extension validated.

The timing of integration will largely be driven by other Project Edith activities. Therefore, results will be available according to that schedule. At the time of writing, it is anticipated that integration will have occurred by December 2023, and so testing and results gathering will occur after this.

Once the specification extension has been implemented and tested, the results, specification extension and broader insights will be shared with industry.

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:

- Stakeholder engagement with our project partners and suppliers, and the Project Reference Group (PRG) including; Energy Queensland, Endeavour Energy, Essential Energy, Energy Networks Australia, Red Energy, ENEL X, TEC, AEMO, AER, ESB, NSW Gov – IPART, ECA, Redback, ARENA, NSW Gov - DPIE, AEMC. Project Edith has a strong focus on external engagement with industry. Providing an industry standard for communication of dynamic network pricing that is consistent with broader CER interoperability objectives is a key objective of the project.

- Some members of the project team are involved with or on the ARENA DER Integration API Working Group which is the owner of CSIP-Aus. Any proposed changes to CSIP-Aus will be discussed with the API working group.
- Development, integration and testing with various aggregators/customer agents.

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 16 - Project Costs

Budget Item	Actual project costs 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$166,294	$166,294	$200,000

10.7 Project Activity and Results

10.7.1 Summary of project activity and collected results to date

Phase 1: A detailed examination of the IEEE 2030.5 standard has been conducted by ANU. Through discussions with Ausgrid, it was determined that the use of the "Pricing Function Set" within 2030.5 would be able to support the use cases of Project Edith without any extension or non-conformance. It is expected that this will be documented in a proposed amendment to CSIP-Aus following testing in Phase 2.

Phase 2: ANU has built an initial implementation of an IEEE 2030.5/CSIP-Aus server with the 2030.5 Pricing function set within Ausgrid's information technology (IT) environment and with appropriate cybersecurity controls. This has been tested by ANU using a demo 2030.5/CSIP-Aus client which is able to register a connection point/device and retrieve dynamic network pricing information. Further testing will occur when aggregators have their first 2030.5/CSIP-Aus clients which are able to retrieve prices.

ANU has prepared two documents providing information for software developers on integrating with their CSIP-Aus server:

1. Edith Client Development Quickstart – an introduction into Edith's use of a CSIP-Aus server.
2. Utility Server Client Development Guide – detailed description of implemented functionality.

These documents have been included in Ausgrid' information package to aggregators/agents for the Project Edith expansion.

10.8 Other Information

Further information about Project Edith can be accessed on Ausgrid's website at https://www.ausgrid.com.au/About-Us/Future-Grid/Project-Edith.

The latest version of the Common Smart Inverter Profile -Australia (CSIP-Aus) can be accessed on ARENA's website at https://arena.gov.au/knowledge-bank/common-smart-inverter-profile-australia/.

11 Barriers to Electrification Study

This project is a new Demand Management Innovation Allowance (DMIA) project in the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2022-2023 regulatory year. This project will continue into the 2023-2024 regulatory year.

11.1 Project nature and scope

As traditional technologies that use fossil fuels are replaced with technologies that use electricity as a source of energy, a key uncertainty is the degree and pace of electrification that will take place.

Greater electrification is expected to unlock more benefits, including greater load flexibility, better network utilisation and lower network costs for all customers. It also supports customers to unlock more value from CER investments and reduce their overall fuel costs and impact on greenhouse gas emissions.

Demand-side tariff and non-tariff solutions can play a role to manage both minimum demand and maximum demand conditions as customers make the transition.

The study will explore how demand management solutions can support efficient integration of new electricity load to the grid and develop an understanding of potential barriers to electrification customers may experience.

The project will also help to build further understanding of the pace and scale of electrification of homes, businesses, industry, and transport, that is likely to occur across Ausgrid's network and will be informed by market and industry research and stakeholder engagement to provide effective recommendations.

11.2 Project aims and expectations

The aim of the Barriers to Electrification Study is to better understand the current state of electrification across decarbonisation pathways and customer segments and identify what capabilities will be needed to support customer electrification and integration of new flexible loads.

The objectives of the research are to:

- Develop a prioritised list of customer barriers, based on external expert advice, rapid literature review and primary research including external stakeholder engagement.
- Develop a better understanding for how the pace and scale of electrification might be influenced by a range of policy, social, economic and technical customer barriers.
- Identify opportunities or challenges for electricity networks, that guide priorities towards enabling efficient electrification and prioritise novel demand management opportunities.
- Develop a better understanding of the potential for demand management tariff and non-tariff interventions that could be explored to integrate new load efficiently and support increased CER hosting capacity.

11.3 How and why project complies with the project criteria

This project will build Ausgrid's understanding of how the impact of decarbonisation, through rapid electrification will impact the changing role of electricity networks and inform how we can leverage the addition of millions of new potentially flexible loads to the grid.

The project is critical foundational research into electrification to understand how we can:

- Prioritise initiatives to implement or trial demand side management and price incentives to address barriers to electrification and reduce long term costs to customers through a pathway for DNSPs to guide efficient investment decisions.
- Improve network utilisation, leading to lower average costs per customer over time.
- Identify network expenditure savings, leading to lower average network charges per customer, compared to BAU, benefitting all network users, resulting from demand management, flexible CER and cost-reflective pricing.

11.4 Implementation approach

This project will be delivered in 2 phases including:

11.4.1 Barriers to Electrification market engagement (Phase 1)

This project will develop a prioritised list of the expected customer barriers and electricity network opportunities and challenges towards electrification. The project outcomes are expected to be organised into a report spanning the following topics:

- A current state landscape for decarbonisation relevant to Ausgrid's operating environment, including analysis on scale and pace of change and identify risks or uncertainties to likely electrification pathways.
- A list of customer barriers to electrification, including the nature and materiality of barriers to unlock customer and whole of system benefits and/or outcomes.
- A prioritised set of opportunities or challenges for Ausgrid and/or electricity networks to reduce the barriers identified or facilitate more efficient or accelerated electrification.
- A prioritisation framework to guides investment timing and priorities in electrification research, and innovation.

11.4.2 Customer demand management trials (Phase 2)

The Phase 2 will be informed by the findings of phase 1, including project development to develop customer research and demand management trials to explore non-network tariff and non-tariff solutions identified through phase 1 to facilitate efficient customer electrification. Some of the possible customer trial activities might include:

- Demand side solutions to support efficient least cost electrification for customers e.g. apartment buildings, including identification and assessment of network and non-network solutions (e.g. retrofitting for EV-ready buildings, gas to electric hot water systems)
- Explore how electrification could be managed through development or trial of new network tariff structures or controlled loads.
- Explore how electrification could be incentivised to increase network CER hosting capacity.
- Explore demand side solutions to support efficient least cost electrification of social housing and potential barriers to lower costs for low-income housing customers.
- Undertake longitudinal customer research on priorities and preferences relating to electrification and improved understanding of customer attitudes towards electrification of residential energy use and incentives.
- Customer research and innovation into commercial or technical solutions that enable electrification for industrial or commercial loads and demand-side solutions for efficient integration of these loads to the network.

11.5 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.

Findings from Phase 1 of this study will inform the development of model business cases for select projects prioritised to their impact in addressing customer barriers to electrification and opportunities for demand management to provide pathways to efficient electrification and meeting future geospatial capacity needs.

Benefits of this research and future scoping of trials are expected to include:

- Prioritised initiatives to implement or trial demand management solutions across Ausgrid's network to address barriers to electrification and reduce long term costs to customers.
- Greater network utilisation, leading to lower average costs per customer over time (including reduced cost of CER integration due to improved offsetting of new customer load and generation)
- Network expenditure savings, leading to lower average network charges per customer, compared to BAU, benefitting all network users, resulting from demand management, flexible CER and cost-reflective pricing.

11.6 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 Phase 1 of the project.

Table 17 - Project Costs

Budget Item	Actual project costs 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$162,222	$162,222	$350,000 (Phase 1)

11.7 Project Activity and Results

11.7.1 Summary of project activity and collected results to date

Through 2022-2023, an external consultant was engaged to support the delivery of Phase 1 of the Barriers to Electrification study. Activities completed include development of the current state assessment of electrification pathways through primary and secondary research, which included the development of customer barriers to electrification which were tested with external stakeholder groups.

The external stakeholder consultations with a range of customer representative groups and industry were undertaken to understand and evaluate the needs of customers they represent including views and preferences relating to electrification and the barriers faced when considering adoption of electric appliances in place of gas or fossil fuels.

Table 18 outlines the stakeholder groups and timeframes of the engagement phase:

Table 18 - Barriers to Electrification Stakeholder Engagement

Stakeholder group	Period	Summary of research themes discussed
Residential customers	May-June 2023	• Understand and confirm key residential electrification barriers. • Understand implications of residential electrification as flexible loads through new technologies • Understand levels of customer awareness, preferences and motivations for electrifying their home • Understand the customer expectations of electricity distribution networks to enable efficient electrification
Commercial & Industrial customers	May-June 2023	• Understand and confirm key commercial and industrial barriers to electrification for large energy users. • Understand opportunities, challenges and risks for high-energy users, including technology availability. • Existing load flexibility opportunities and technologies • Current approaches and challenges to achieving electrification and decarbonisation. • Understand customer expectations of electricity distribution networks to enable efficient electrification.
Electrification industry (including retailers, Original Equipment Manufacturers (OEMs) and representative bodies)	May-June 2023	• Understand industry perspectives on barriers and opportunities of electrification via innovative technology and customer outcomes • Understanding customer sentiments and motivations to pursue electrification in the near-term • Understand the industry expectations of electricity distribution networks to enable efficient electrification.

Outcomes of the stakeholder engagement and Phase 1 activities will continue to be developed and delivered through 2023-2024.

Further activities will continue through the 2023-2024 regulatory year including identification of prioritised opportunities for Ausgrid to leverage demand management techniques to efficiently integrate new load and maximise use of renewable generation, which will be reported in future.

11.8 Other Information

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.

12 C&I Thermal Load Flex

This project is a new Demand Management Innovation Allowance (DMIA) project in the current 2019-2024 regulatory control period. The following project report provides details of the project activities up until the end of the 2022-2023 regulatory year. This project is expected continue into the 2023-2024 regulatory year.

12.1 Project nature and scope

Ausgrid is seeking to assess the effectiveness of commercial and industrial customers' thermal load flexibility in providing network support during peak demand and minimum demand conditions. Flexible demand response for such loads is evolving as part of recent ARENA funded trials. For example, supermarkets, shopping centres and refrigerated distribution centres could offer load flexibility under both peak demand and minimum demand conditions achieved via "thermal flex", that is, through advanced control of refrigeration and HVAC loads. With the addition of on-site CER such as solar PV and batteries, a material quantum of load flexibility could be realised. As loads that are substantial in scale and commonplace in the community, thermal flex could potentially offer an attractive and reliable source of load flexibility across a wide range of network assets.

The project aims to test the performance of this option when used to manage location specific network constraints. The project involves partnerships with 3rd party organisations.

12.2 Project aims and expectations

The primary purpose of the project is to determine the viability of thermal flex as a demand management solution through building partnerships with 3rd party organisations and conducting customer trials. The objectives are to gain an understanding of:

- Quantum and reliability of response acknowledging that thermal flex participants may also be participating in other market schemes;
- Ability of provider to shape response to maximise network benefit;
- Customer acquisition strategies and subsequent take-up of thermal flex;
- Impacts from customer comfort/product requirements;
- Customer experience;
- Procurement and operating costs;
- Viability as a BAU solution.

12.3 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 thermal flex as a non-network alternative. It is considered innovative in that the proposed thermal flex trials will utilise technologies, techniques and processes that differ from those previously used in the market.

If viable, the approach being trialled in this project has the potential to offer a cost-efficient alternative to network infrastructure upgrades in parts of the network that include customers with thermal flex capability. Collaboration on thermal flex 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.

12.4 Implementation approach

The thermal flex project is expected to take place across 3 phases. The first phase commenced during 2022-2023 with negotiations progressing with one flex provider.

Phase 1 of this project includes the establishment of the collaborative thermal flex trial with 3rd party providers. Key activities will involve setting up partnerships, establishment of trial agreements, setting out the trial outcomes and site selection. Ausgrid has undertaken analysis of the low voltage and high voltage network leveraging existing planning models to shortlist candidate areas of the network where thermal flex might provide network benefits.

Phase 2 of the DMIA project will involve field trials of thermal flex consistent with the project aims and expectations and evaluated using the approaches outlined below.

Phase 3, as an optional phase and subject to the outcomes of Phases 1 and 2, could explore further activities to aid in development of the solution as a BAU process for managing network risk.

12.5 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 project partners and are expected to include quantitative and qualitative measures such as:

- Assessment of energy and demand reductions customers during peak demand and minimum demand conditions;
- Assessment of equipment reliability and comparison of planned vs actual dispatch outcomes;
- Identification of customer experiences including impact to business operations;
- Assessment of any tested customer incentive and acquisition strategies;
- Identification of demand reduction density and potential effectiveness for deferral or reduction of network capital upgrades for typical network constraints; and
- Assessment of suitability of thermal flex solutions as a BAU tool in providing network support

12.6 Costs of the project

The table below shows Ausgrid's actual project costs for 2022-2023 and total project expenditure to date. Total expected project costs by the completion of the project are unknown at this stage and will become available as the project progresses.

Table 19 - Project Costs

Budget Item	Actual project costs 2022-2023	Total project costs as at end of June 2023	Total expected project costs
Total project costs (excl GST)	$4,785	$4,785	N/A

12.7 Project Activity and Results

12.7.1 Summary of project activity and collected results to date

Project activity to-date includes initiation of discussions with one market provider of thermal flex during 2022-2023. As this DMIA trial progress further project activity updates will be provided in subsequent DMIA Annual Reports.

12.8 Other Information

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.