Demand Response Air Conditioning Programs

Final Report March 2022

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1. Executive Summary

This report summarises the results and learnings from Ausgrid's trials and use of Australian standard AS/NZS 4755 compliant demand response enabling devices (DREDs). The Cool*Saver* trials, which ran in Maitland, Central Coast and Lake Macquarie areas, were completed in 2016/17. The learnings from the Cool*Saver* trial were used to inform the planning and strategy for Ausgrid's AirconSaver Program, a 2-year air conditioning demand management program which was delivered to manage local supply constraints in the Gillieston Heights area. The objectives, planning strategies and outcomes from the program are also presented in this report.

The Cool*Saver* trial aimed to explore ways to reduce the impact of peak demand from residential air conditioners by partnering with customers and offering direct incentives for managing the power demand from their air conditioners on peak summer days. A series of trials were run to test a range of customer acquisition and marketing approaches as well as comparisons between demand response enabling device (DRED) technology.

The collective learnings over the trial period established that customers were comfortable with the concept of Ausgrid's approach to managing their energy use and were receptive to an incentives-based approach. This was demonstrated by the consistently high score of 8 and above (out of 10), when participants were asked to rate their overall experience during the trial, and the relatively stable retention rate of participants across most of the trial areas. The main motivation for customers to participate in the trials was consistently around the financial benefits they would gain, with other key factors being the level of ease to register/ re-join the program and the "set and forget" nature of the technology once the DRED was installed.

From a network project delivery perspective, the costs to administer the Cool*Saver* trial, such as operational costs relating to installing, maintaining and removing the DRED's, customer acquisition costs and other sunk costs were high, and considered to be prohibitive for most future demand management project opportunities. The full set of interim research reports for the CoolSaver trials preceding this report can be access on Ausgrid's website at https://www.ausgrid.com.au/Industry/Our-Research/DMIA-Research-and-trials.

The transition in the Australian energy industry towards a net zero economy over the past couple of years has placed a greater focus on the role which demand flexibility and its integration with renewables has started to play and is expected to grow at an increasing pace in the near future. With these changes taking place, the need to ensure that Ausgrid's practices of demand flexibility is low cost and viable is highly important when addressing customers' energy supply constraints.

This change in demand flexibility management is reflected in the change in the planning strategy developed for Ausgrid's Power2U AirconSaver Program which ran between FY2019 and FY2021. The program was commissioned to address the local energy supply constraints in the Maitland area of Gillieston Heights.

To initiate the first year of AirconSaver program, Ausgrid issued a Request for Proposals (RFP) seeking market submissions to address the identified need. No viable proposals were received indicating the low level of interest from the market for smaller locally based network constraints. Consequently, Ausgrid assessed the feasibility of an internally run demand management program,

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based primarily on air-conditioning (AC) load control techniques leveraging past experiences in the *CoolSaver* trial program and using the same DREDs from that program.

Customer response to the engagement campaign was positive with an initial registration interest response rate of 5%. However, similar to the CoolSaver trial experience, the program was high cost per customer in relation to the demand reduction level achieved, attributed largely to substantial sunk costs relating to administration, installation costs of the DREDs and project management of both third party suppliers and marketing costs.

A second-year deferral of the investment over FY2020-21 was considered viable, however this time the opportunity arose to change the demand flexibility solution mix to deploy additional demand reductions techniques including behavioural demand response (BDR) with energy retail partners and potentially network support from a grid-connected battery. This marked a clear observable transition occurring in the market from energy service providers and retailers becoming more willing to provide contracted demand response services and to collaborate with network providers such as Ausgrid. This has helped Ausgrid to achieve demand flexibility objectives more efficiently and at lower cost.

Ausgrid's integration with the BDR retailer programs during the second year resulted in more favourable outcomes of higher load reductions and lower operational costs per customer, largely as a result of the higher volume of customers engaged in the retailer programs given the direct relationships retailers could leverage. Further details on Ausgrid's retailer BDR trials can be found at https://www.ausgrid.com.au/Industry/Our-Research/DMIA-Research-and-trials.

The final section of this report discusses the overall future considerations for demand flexibility management evolving with the increased integration of network and market led demand flexibility services. As discussed in this report, these new partnerships may provide lower cost and more efficient alternative solutions compared to pure network led demand management programs. In parallel, customers are also seeking the flexibility to manage their energy usage that best suits their individual needs and have responded very positively towards energy saving programs offered via these collaborations due to engaging service bundling with lower cost, out of the box, user installed technologies.

A summary of a range of regulatory and industry factors which will also impact future demand flexibility management practices in air conditioning demand management programs have been identified in the report. The majority of these factors will support and enable greater flexibility moving into the future for delivering more cost-effective network and customer-centric solutions.

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2. Introduction

Air conditioners used to cool homes and businesses are a significant contributor to peak demand on hot summer days. They are the largest residential appliance with, until recently, no flexible load option currently available to customers and offer significant potential for residential peak demand reductions. It is estimated that residential air conditioners result in a doubling of residential demand on a peak summer day compared to a mild summer day.

The Ausgrid CoolSaver trial aimed to explore ways to reduce the impact of peak demand from residential air conditioners by partnering with customers and offering direct incentives for managing the power demand from their air conditioners on peak summer days. The CoolSaver trial was funded through the Demand Management Innovation Allowance (DMIA) approved by the Australian Energy Regulator. This allowance provides funding to explore new innovative demand management solutions. It enables network companies to develop cost-effective demand management options that could potentially offer a lower cost option for addressing a network investment than supply side solutions.

Delivering safe and reliable electricity at the lowest cost helps to keep power bills lower for all customers in the long term. One of the main objectives of the CoolSaver program was to trial low-cost technology and communications solutions that did not require a costly smart meter roll-out for individual participating customers (noting that at the inception of the trials, the Power of Choice smart meter reforms had not yet been adopted). The voluntary adoption of the Australian standard AS/NZS 4755 by a number of air conditioner manufacturers and the development of commercially available demand response enabling devices has also substantially lowered the potential cost to introduce direct load control to air conditioners.

The CoolSaver trial was completed after 5 phases of trials between FY2014/15 and FY2016/17 aimed to test different objectives including technology options, customer experience, incentives and customer engagement approaches and the impact of direct load control on peak winter days. Section 3 of this report summarises the trial and results of the final phase of the trial for the summer period FY2016/17 and a summary of key learnings across the entire trial.

Learnings from the CoolSaver trials were then utilized and applied to the development of a demand management project for addressing local network constraints in the Gillieston Heights area in the Maitland local government area of NSW. A two-year deferral of the network investment using residential air conditioner load control was found to offer a viable, cost efficient alternative and was selected as the preferred solution.

The project, branded as “Ausgrid’s Power2U AirCon Saver Program”, commenced in September 2019, and was implemented in summer 2019/20 and summer 2020/21. The objectives, overview of the dispatch activities and results of the first year of the deferral has been presented in Section 5 of this report.

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3. Background

Ausgrid initiated the CoolSaver Air Conditioner Load Control trials during FY2014-15 as a multi-phased project that aimed to further develop trials that explored the practical application, technical and customer engagement aspects of a preceding research project, which investigated early methods of managing residential air conditioners (and pool pumps) using AS4755 compliant devices. Together the two projects consisted of 5 phases, the final 5th phase is detailed in section 4 of this report, "CoolSaver Summer 2016-17".

The detailed trial objectives and results for the preceding four phases of the CoolSaver trials are provided in a series of CoolSaver interim reports available on Ausgrid's website on the DMIA Research and Trials page at https://www.ausgrid.com.au/Industry/Our-Research/DMIA-Research-and-trials.

In summary, the main objectives of the first 4 phases of the trial consisted of:

Phase 1: During FY2012/13 the trial commenced with the development and testing of demand response enabling device technologies and solutions applicable for Ausgrid's network. This included testing a commercially available ripple frequency signal receiver (DRED) with Ausgrid control systems and the development of a new signal receiver based on mobile phone communications technologies and SMS commands. Preliminary testing of this signal receiver was conducted on a small number of AS4755 air conditioners at the homes of Ausgrid staff before preparing for a rollout to customers.

Phase 2: In December 2013, the trial was rolled out in the Central Coast and Lake Macquarie areas with 109 households opting in to participate in the program. The primary aims of this phase of the trial were to further test the technology but more importantly to understand customer response and acceptance to a customer offer with a direct incentive for participation.

Phase 3: Launched in February 2015, this phase focussed on testing the effectiveness of an alternative customer engagement approach via 3rd party channels through appliance retailer and air conditioner installer partnerships in the Maitland area. The aim of this approach was to test the effectiveness of engaging new participants into the trial at the initial purchase stage of new compliant air conditioners from a retailer or through the installation of new units through an air conditioning installer and test if this method provided a potentially lower cost customer acquisition model for the trial.

Phase 4: In June 2016, the project was modified to explore customer response to the use of the demand response technology in winter. A customer offer was made in June 2016 to 55 existing CoolSaver participants in the Central Coast area, with 27 accepting the offer to participate. Over the course of the winter period of June to Augusts, a total of 5 dispatch events were initiated on cold winter evenings when demand for electricity was high.

Results of Phases 1-3 can be read in Ausgrid CoolSaver Air Conditioning Trial Interim Report – September 2015. Results of Phase 4 can be read in Ausgrid CoolSaver Air Conditioning Trial Interim Report –February 2017.

Customers' experience and satisfaction levels throughout the trial was also tracked through a series of online surveys where participants were invited to provide at the end of each trial period, their

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feedback on their cooling experiences during dispatch events, their satisfaction with notification methods, financial incentives and their attitudes towards override capability. A summary of the survey results can be read in CoolSaver Survey Highlights – April 2016.

Background of Gillieston Heights DM Project

In early 2019 Ausgrid identified an emerging network constraint with the 3 interconnected 11kV feeders supplying the Gillieston Heights area. The proposed preferred network option involved the installation of new underground cables, reconductoring and augmentation of identified sections of overhead lines in the Gillieston Heights area for an estimated cost of $695,000.

A preliminary assessment indicated there was potential to use demand management techniques to defer the proposed supply-side solution. In early May 2019, Ausgrid issued a Request for Proposals (RFP) seeking market submissions to address the identified need. Only one submission was received, which was assessed as being non-viable.

Following the unsuccessful market engagement process, Ausgrid assessed the feasibility of several internally developed solutions based upon past demand management trials and projects. Assessed options included power factor correction, non-residential demand response and residential air conditioner (AC) load control.

A one-year deferral of the network investment using residential air conditioner load control was found to offer a viable, cost efficient alternative and was selected as the preferred solution.

The option for a second-year deferral of the investment was considered in early 2020 based on the latest available information. It was determined that deferral of the network solution for another summer in 2020/21 was also viable.

Further details of the Gillieston Heights project are provided in Section 5.

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4. CoolSaver Summer 2016/17

4.1 Objectives

The final stage of the CoolSaver program was marked by the running of a third and final trial over the summer period between November 2016 and March 2017. This phase of the trial aimed to:

- Improve understanding of the average demand reductions that can be achieved on hotter summer days;
- Continue to verify and test the functionality of the two different demand response technologies deployed between the trial participant groups in the existing trial areas; and
- Continue to measure customer perceptions and satisfaction, particularly among participants who did not receive notifications of the peak event activations compared to participants who did receive notifications.

4.2 Customer engagement

Invitation letters were mailed to the 119 existing program participants across the Central Coast, Lake Macquarie and Maitland areas. Trial to run between 1/11/16 and 31/3/17.

The offer conditions and rewards comprised of a $100 summer bonus for participants with an air conditioner rated with a cooling capacity of 10kW or more, and a $50 summer bonus for participants with air conditioners rated with a cooling capacity less than 10kW.

Table 1: Customer incentive offer structure

Offer element	Customer payment maximum (Air conditioner <10kW*)	Customer payment maximum (Air conditioner >10kW*)
Summer 2016/17 rewards	$50	$100
Reduction Amount Per Override (Central Coast only)	-$10	-$20

4.3 Program Trial Results

4.3.1 Participation results

A total of 106 participants took part in the final summer trial:

- 28 comprised participants from the Maitland area, after two customers from the Maitland trial area opted out, one moved house and the other opted out from the program;

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- 34 participants who resided in the Lake Macquarie trial area extended their participation (100% retained from previous year); and
- The remaining 44 participants were from the Central Coast (79% extended). Of the 11 Central Coast customers who did not continue, 7 had moved out of the property (or 12% of the total participant numbers).

4.3.2 Peak event results for Summer 2016/17

A total of 7 summer events were initiated when the maximum temperatures at the local weather station was forecast to exceed 30°C on working weekdays. Table 2 below shows a summary of all 7 summer peak dispatch events. Air conditioner load information was collected from all participants in the Central Coast, Maitland and Lake Macquarie trial areas with load information being measured by a current sensor that had been installed on the electrical input power supply to the air conditioner. Analysis of the data for the summer program 2016/17 indicated across the 3 areas, an estimated average reduction of 1.0 kVA per customer for the 79 participants with ducted air conditioners >10kW cooling capacity and about 0.50 kVA per air conditioner for the 27 customers with non-ducted air conditioners between 4-10 kW cooling capacity.

Other key findings from the dispatch events included:

- Ripple receivers were more cost effective than SMS receivers, as SMS was almost double the cost when taking into account other related operating costs, SMS broadcast costs and limited internal resourcing challenges;
- Ripple performance was less advanced than SMS, due to being only a one way communication method. If there was a problem with a receiver, there was no way to test or extract data from it remotely;

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Table 2: Dispatch events summary

Phase 5	Day of week	Start Time	Finish Time	Mode	Max. Daily Temp (°C)	Participants	Number of Overrides
2016/17 Dispatch events in Central Coast (SMS) – Phase 5							
13/12/2016	Tuesday	3:00pm	8:00pm	DRM2	38.1 °C	45	1
14/12/2016	Wednesday	2:00pm	7:00pm	DRM2	38.3 °C	45	1
11/01/2017	Wednesday	3:00pm	8:00pm	DRM2	41.7 °C	42	4
17/01/2017	Tuesday	3:00pm	8:00pm	DRM2	37.3 °C	43	5
24/01/2017	Tuesday	2:00pm	7:00pm	DRM2	39.1 °C	42	2
30/01/2017	Monday	2:00pm	7:00pm	DRM2	38.8 °C	42	2
10/02/2017*	Friday	3:00pm	8:00pm	DRM2	41.2 °C	36	3
2016/17 Dispatch events in Lake Macquarie (Ripple Receivers)							
13/12/2016	Tuesday	3:00pm	8:00pm	50%	35.5 °C	34	n/a
14/12/2016	Wednesday	3:00pm	7:00pm	50%	36.2 °C	34	n/a
11/01/2017	Wednesday	3:00pm	7:00pm	50%	37.5 °C	34	n/a
17/01/2017	Tuesday	3:00pm	8:00pm	50%	36.1 °C	34	n/a
24/01/2017	Tuesday	2:00pm	6:00pm	50%	38.7 °C	34	n/a
30/01/2017	Monday	2:00pm	6:00pm	50%	31.9 °C	34	n/a
10/02/2017*	Friday	4:00pm	8:00pm	50%	32.7 °C	34	n/a
2016/17 Dispatch events in Maitland							
13/12/2016	Tuesday	3:00pm	8:00pm	DRM2	37.0 °C	18	3
14/12/2016	Wednesday	2:00pm	7:00pm	DRM2	37.9 °C	18	2
11/01/2017	Wednesday	3:00pm	8:00pm	DRM2	39.6 °C	18	2
17/01/2017	Tuesday	3:00pm	8:00pm	DRM2	40.9 °C	18	2
24/01/2017	Tuesday	2:00pm	7:00pm	DRM2	40.6 °C	17	3
30/01/2017	Monday	2:00pm	7:00pm	DRM2	40.0 °C	16	4
10/02/2017	Friday	3:00pm	8:00pm	DRM2	43.7 °C	16	2

The chart below shows the average load profile of 72 households with systems above 10kW with a clear dip in demand occurring from 4 to 8pm of between 1-1.5kW on average amongst the households in the trial. Note that 10 Feb 2017 was the maximum demand day in 2016/17 for the Ausgrid network at 5802 MW.

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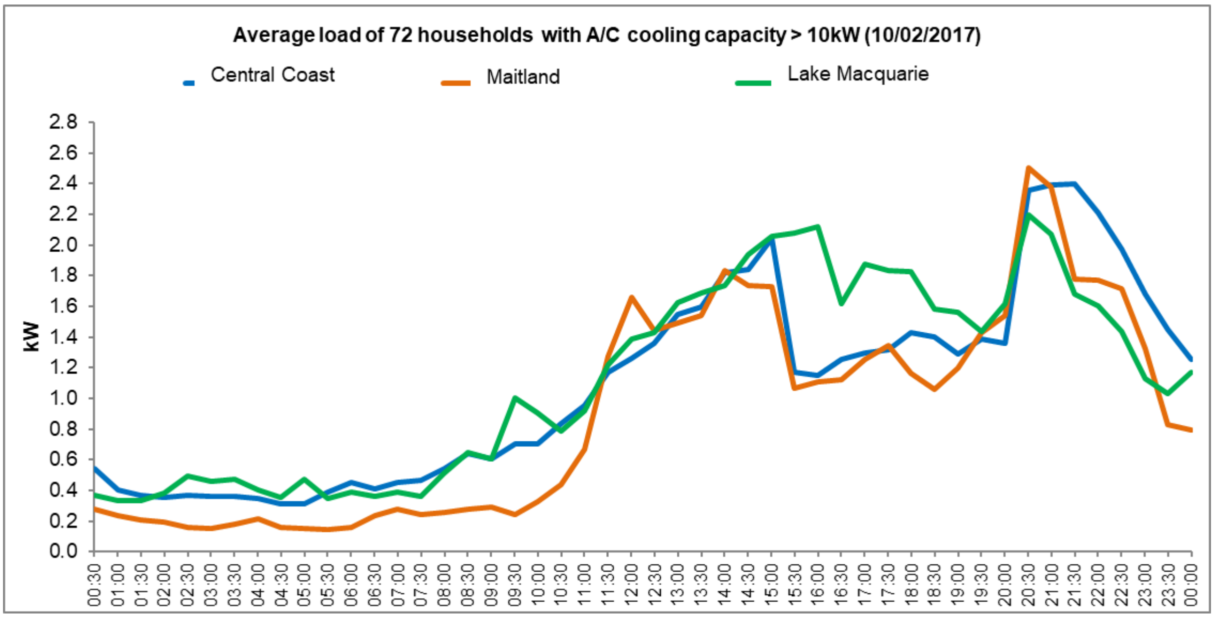
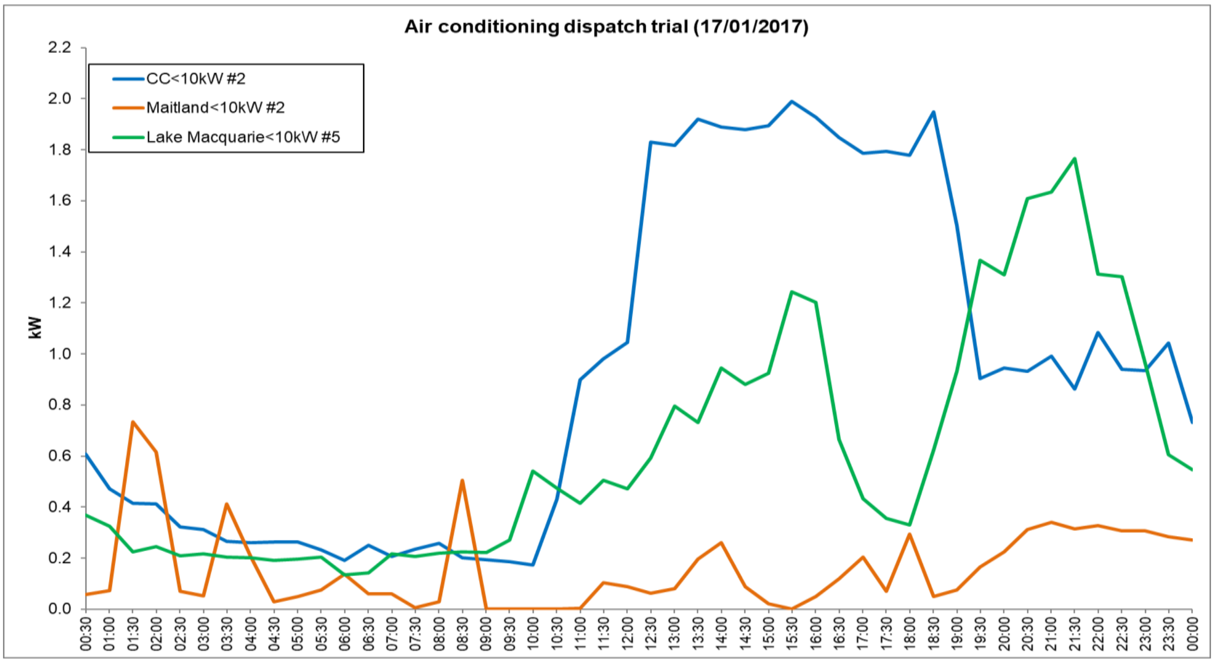
Figure 1: Average load of households (>10kW, 10/2/2017)



Results for participants with systems less than 10kW were less consistent and more irregular in their energy patterns and have therefore been treated in this report as indicative rather than representative, which is illustrated in the table below.

Figure 2: Average load of households (<10kW, 17/01/2017)



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The irregularity in the reduction patterns may have been attributed to a number of factors which impacted the energy reduction levels of the smaller units, such as high heating loads of the homes, temperature settings of air conditioning units not high enough or continuous running of fans.

4.3.3 Customer experience survey results

An important element of the trial was to measure customer satisfaction levels and identify ways to improve the customer experience. *CoolSaver* was dependent on the voluntary participation and thus, a poor customer experience could detrimentally impact the cost effectiveness of future demand management programs using solutions of this type.

With Coolsaver being a new concept for Ausgrid customers, it was important to measure the level of interest and satisfaction with the program and build positive advocacy for similar innovative offers in future.

Initial surveys were sent out to all participating customers in April 2015, comprised of 35 questions. The questions sought information regarding customer demographics and specific aspects of the trial. Customer responses around their overall experience were generally positive and detailed results of this survey are covered in the *CoolSaver Interim Reports September 2015 and February 2017* and are also separately available on Ausgrid's website at www.ausgrid.com.au/dm.

Whilst the initial customer survey results were encouraging, it remained unclear whether extended customer participation over multiple summer seasons would yield the same levels of positive customer experience. Extension of the program over the following two summers 2015/16 and 2016/17 provided an opportunity to test this.

Following each summer, customers were re-surveyed in both April 2016 and 2017 with predominantly the same questions to allow for comparison of the responses. See Table 3 below for a snapshot of some of the main responses, comparing the shifts in their sentiments over the past three summer periods.

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Table 3: Customer experience and satisfaction survey results

Metric	Trial area	2014/15	2015/16	2016/17
Survey response rates	Maitland	NA	90%	62%
	Central Coast	53%	68%	49%
	Lake Macquarie	52%	75%	67%
% Who rated their experience during trial of 8 or above	Maitland	NA	84%	100%
	Central Coast	98%	87%	85%
	Lake Macquarie	99%	88%	91%
Experienced slight or no difference to cooling during activation	Maitland	NA	53%	56%
	Central Coast	95%	58%	65%
	Lake Macquarie	90%	92%	91%
Main reason for participating in the *CoolSaver* program	**Maitland**			
	Interested in new technology	NA	11%	13%
	Money incentive	NA	63%	63%
	Overall reduction in network charges	NA	26%	25%
	Central Coast			
	Interested in new technology	30%	21%	25%
	Money incentive	50%	53%	45%
	Overall reduction in network charges	20%	26%	30%
	Lake Macquarie			
	Interested in new technology	52%	19%	14%
	Money incentive	33%	50%	59%
	Overall reduction in network charges	14%	31%	23%
	No response	1%		5%

Despite some fluctuation in survey response rates there was little difference over the trial period for most of the metrics measuring the level of customer experience or their perceived differences in the level of cooling (apart from the Central Coast participants) on event days. Their primary motivation

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for participating also remained relatively consistent over the 3-year period. In terms of receiving the SMS notifications, the majority of Maitland and Central Coast participants preferred to receive an SMS on the morning of the dispatch event, as opposed to receiving it the day before or none at all.

Participant Experience Feedback

"I wouldn't change anything. It was nice to be rewarded for something I don't feel made an impact in our family."

"Liked the gift cards and the chance to participate in [the] trial to save energy"

"Overall we had no issues with the unit fitted or noticed much difference in our Air Conditioner"

4.4 Trial Insights & Conclusions

The trial found that the implementation of the ripple control method was more cost-effective and provided a sufficient solution, despite being a lower technology solution, particularly in instances where funding is prohibitive. Ripple control was a more cost-effective option particularly for small network needs as it avoided software costs and other set up costs per the SMS control method. Customers participating in the Ripple method were generally satisfied with the 'set-and-forget' approach of the program, evidenced by their survey responses around a consistently high level of satisfaction and not noticing any significant difference during the trial events. This suggests that this type of approach could be suitable for most local area network needs where existing ripple infrastructure is in place.

For the SMS method to be cost effective, sufficient economies of scale are required to absorb additional costs associated with activities such as the management of the SMS communications and individual settings on each device.

Providing customers with event notifications on the morning of an event day would be recommended, to enable them to plan or make decisions around what activities or changes they wish to make, such as pre-cooling their homes, leaving the house or other ways to manage their home's temperature.

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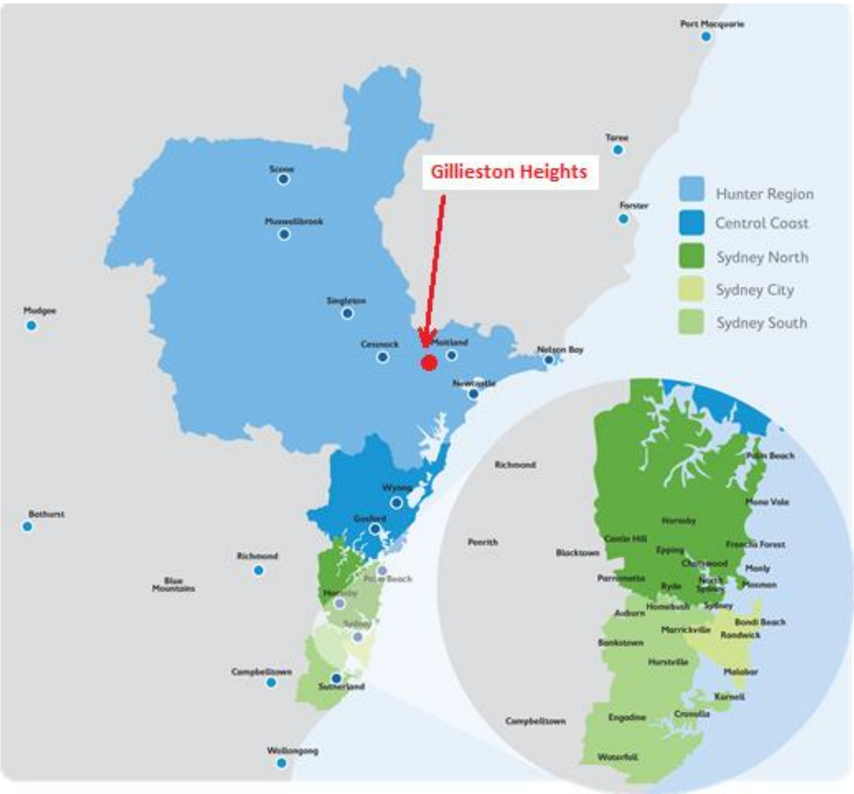
5. Gillieston Heights Aircon Saver Program

5.1 Project background

Over the last decade the region surrounding Gillieston Heights has changed from a non-urban to urban planning region due to several residential developments that have occurred in the area, and are expected to continue over the near term. As part of the Distribution Network Planning standards, Ausgrid identified an emerging network constraint associated with three interconnected 11kV feeders in the area (Metford feeder 83307, Telarah feeder 48010 and Kurri feeder 80923) due to the increase in electricity demand. The proposed supply-side solution to the identified need was initially estimated to cost $695,000.

Figure 3: Location map showing Gillieston Heights



A preliminary assessment indicated there was potential to use demand management techniques to defer the proposed supply-side solution. In early May 2019, Ausgrid issued a Request for Proposals (RFP) seeking market submissions to address the identified need. However, no viable proposals were received. Following this, Ausgrid assessed the feasibility of an internally run demand management program, based primarily on air-conditioning (AC) load control techniques leveraging past experiences in the *CoolSaver* program and using the same Demand Response Enabling Devices (DREDs) from that program. Based on a cost-benefit assessment, Ausgrid considered it was economically feasible to reduce load at risk on the relevant 11kV feeders for the upcoming summer 2019/20, deferring the proposed supply-side solution until summer 2020/21.

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5.2 Project objectives

The project objective was to reduce network risk and defer network investment by reducing summer maximum demand in the Gillieston Heights area through the management of residential customer air-conditioners on hot summer days via demand response mode-enabled air-conditioning units

A target of total demand reduction was set to around 130kVA, which represented 67% or two-thirds of the total expected load at risk in summer 2019/20 (190kVA

5.3 Technical solution

The proposed demand management program offered customers who had an eligible AC unit with incentive payments in return for allowing Ausgrid to install a DRED on their AC unit and manage their AC on hot summer days to reduce network demand. An eligible AC unit was determined to be one that was able to support the installation of a DRED and potentially over a minimum capacity threshold, dependent on the number of customers who expressed interest in the program.

For the program, based on Ausgrid's *CoolSaver* program experiences, we considered both ripple and SMS control methods for the Gillieston Heights program. The ripple control method utilises the same broadcast system as that used to communicate with existing ripple-controlled hot water systems. A series of pre-programmed instructions are broadcast by the Newcastle control room and travel via a 750Hz or 1050Hz carrier signal, depending on the location, to communicate with individual DREDs installed on participating customer's AC units. This method is an "all in approach" since all connected DREDs that fall within the catchment of the broadcast area will respond to the broadcast. No prior notice is given for each event and there is no functionality for customers to opt-out once an event has started. Customers who wish to no longer participate in the program must have the DRED physically removed from their AC unit. Additionally, the ripple method is a one-way broadcast, which means visibility of individual customer performance does not occur until after the event.

The SMS method uses SIM cards controllable via SMS messages which are able to communicate with DREDs at an individual level. Prior notice is given before an event and there is functionality for individual customers can opt-out of individual events. The SMS method involves higher cost compared to the ripple method.

Ausgrid elected to use the ripple method for the Gillieston Heights program. Ripple control was chosen as it offered a lower cost signalling technique compared to SMS technology for Gillieston Heights. Key factors in this decision were the limited available funds for the program (derived from cost-benefit analysis) and having existing ripple control infrastructure in the area.

5.4 Customer engagement strategy and customer incentive

Around 2,800 customers in the Gillieston Heights area, part of the constrained network area, were sent a letter in mid-September 2019 which explained how the Power2U Aircon Saver program (brand name for program) worked with the installation of a signal receiver on the AC unit which would enable Ausgrid to remotely activate their air-conditioner's in-built power saving mode, if required, up to 8

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dispatch events for 3 to 5 hours per dispatch between 4pm and 9pm over the summer period (November 2019 – March 2020).

The letter also explained the incentive offered to eligible participants, being a $100 gift card once the receiver was installed on their outdoor unit. At the end of the 2019/20 summer period, they would then receive an additional summer bonus gift card of an amount based upon the size of their AC's cooling capacity as a "stay-on" incentive.

Table 4: Structure of incentive payments offered

Air conditioning cooling capacity	Installation Bonus	2019/20 Summer Bonus
> 10 kW	$100	$150
4-10 kW	$100	$100
< 4 kW	$100	$ 50

If Ausgrid did not need to activate the power saving mode at all, customers would still receive their summer bonus provided they didn't opt-out prior to the end of summer. The letter also invited them to register their interest to participate and provided the details for them to register via Ausgrid's website to initiate the assessment of their AC unit and confirm the customer's details.

A second round of follow-up letters were sent during October 2019 to confirm participation with the cohort of customers who expressed interest and who were eligible, and also to follow-up those who had not responded to the initial letter. We also notified customers who expressed interest, but unfortunately were not eligible to take part.

Customer's participating in the program were confirmed by late October/early November 2019 in readiness for the DRED installations to take place.

5.5 Material changes that occurred during the program

DREDs were scheduled to be installed by late November 2019, however, technical issues encountered with dispatch hardware and software in Ausgrid's Newcastle control room required several rounds of investigation, reconfiguration and testing. This delayed the installation time window of when the DREDs could be installed until December/January.,

Due to NSW Government's public health notices and Ausgrid's safety practices that were starting to take place in response to the emergence of the COVID-19 pandemic by early March, we decided not to survey customers at the end of the summer period to minimise disturbing customers who potentially were under already challenging circumstances. Therefore, customer satisfaction and experience were not tested as would otherwise have taken place.

5.6 Project outcomes and learnings to date

The customer registration process was open for 8 weeks between 16 September and 19 November 2020 during which time 128 registrations were received (5% response rate). From this group, 45 customers (49 eligible AC units where a few customers had multiple units) were deemed eligible and accepted the offer to participate in the program having met the following assessment criteria:

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- Each AC unit met AS4755 standards;
- Each AC unit had a cooling capacity greater than 4kW; and
- If the customer was a renter, written consent was required by their landlord.

While the numbers of initial applications received from targeted customers well exceeded the targeted quota by 171% (128/75), the number of *eligible* air conditioners fell short of the targeted volume by 35% (49/75) where either the units were either too old, too low in capacity and/or were not compatible with the AS4755 demand response control standards.

Demand Response Enabling Devices (DREDs) were installed on 49 air-conditioning units at 45 customers' premises to enable them to receive Ausgrid's communication signals.

5.7 Dispatch and demand reduction results

This section presents the results of the 3 dispatch events on 23 January, 31 January and the 1 February 2020.

Analysis of customer interval meter data showed that the average demand reduction achieved was about 1.7kW per customer. Applying this per-customer demand reduction across the 45 customers participating in the program gives an estimated total demand reduction capability of 96kVA (assuming a power factor of 0.80).

<u>Dispatch day 1 – 23 January 2020</u>

On 23 January 2020, Ausgrid dispatched Aircon Saver customers in the Gillieston Heights area between 5pm and 8pm. The maximum temperature on this day reached 41.2°C with a 50% reduction in electrical input energy (DRM Mode 2).

The majority of the air conditioning units had a system size less than 10kW. The units below 10kW in capacity, achieved an average reduction of 1.1kW, while those with larger cooling capacities of above 10kW achieved an average reduction of 2.5 kW. The overall average reduction was 1.7 kW per customer. Figure 4 below shows load reductions that occurred during the curtailment period (dispatch window) for 5 example customers, but some customers generated an artificial peak just after the completion of dispatch.

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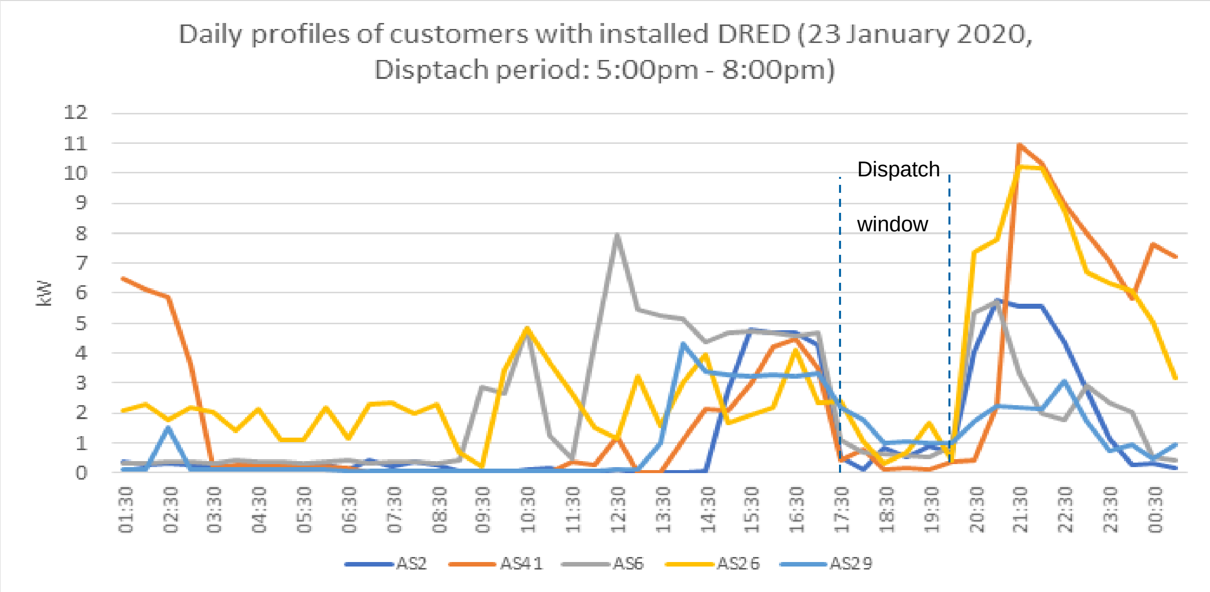
Figure 4: Dispatch 1 - 23/01/2020



Dispatch day 2 – 31 January 2020

On 31 January 2020, a second dispatch was scheduled within a smaller 2-hour dispatch period between 5:30-7:30pm with a 50% reduction in electrical input energy (DRM Mode 2). The maximum temperature on this day reached 32.4°C.

The air conditioning units with a system size less than 10kW had an average reduction of 1.7kW, while those with larger cooling capacities of above 10kW achieved an average reduction of 1.7kW. The overall average reduction was 1.7 kW per customer.

Figure 5 below shows the demand profile reducing during the dispatch window, however, the reduction was less pronounced compared to day 1. This difference was likely due to the lower maximum temperature on day 2.

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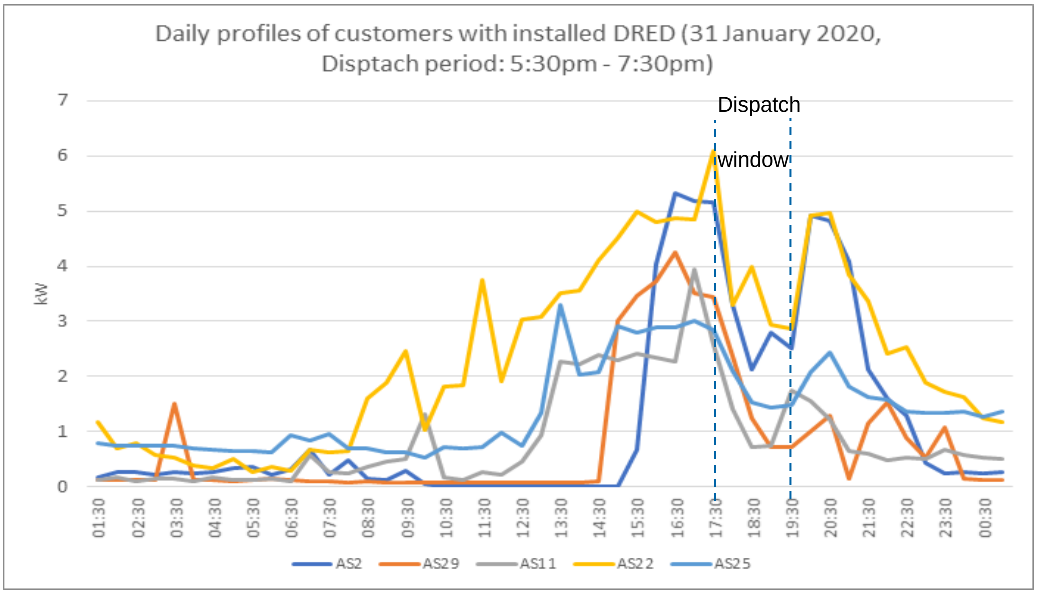
Figure 5: Dispatch 2 – 31/01/2020

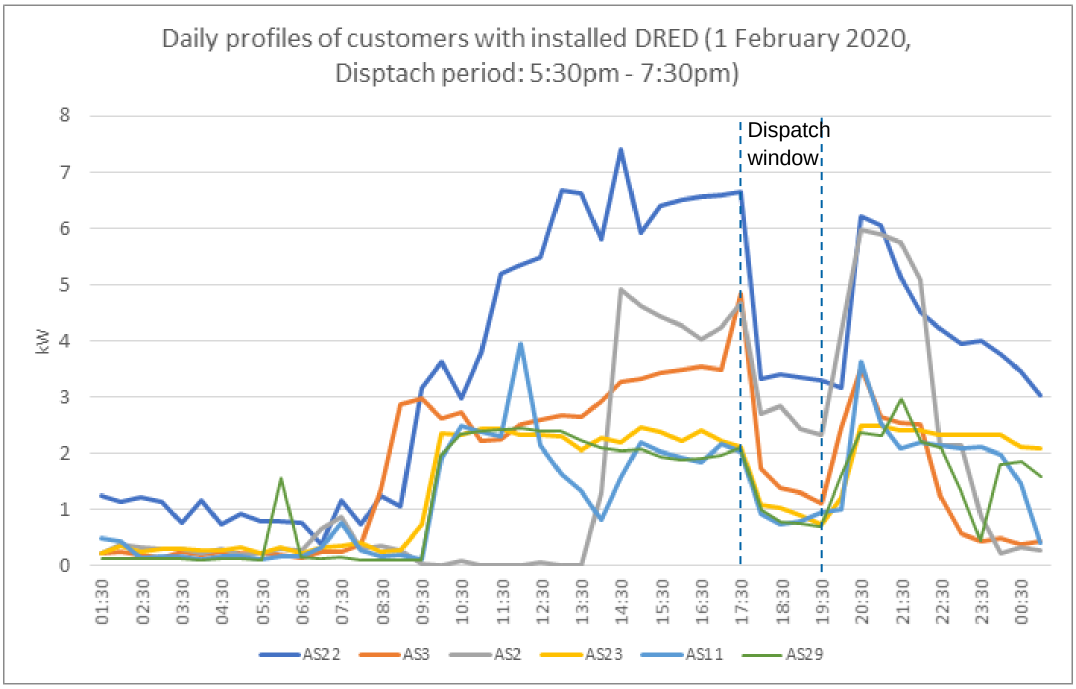


Dispatch day 3 – 1 Feb 2020

On 1 February 2020, Ausgrid ran its third and final dispatch between 5:30pm-7:30pm, again using DRM Mode 2. Temperatures on this day reached 36.4°C.

The air conditioning units with a system size less than 10kW had an average reduction of 1.7kW, while those with larger cooling capacities of above 10kW achieved an average reduction of 2.6kW. This day achieved the highest reduction on average per customer of 1.9kW.

Figure 6: Dispatch 3 - 1/02/2020



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5.8 Discussion of Results

Customer participation

Final numbers of customers who were recruited to participate in this stage of the trial was lower than initially anticipated, however this is typical of demand management programs where customer registration of interest may be high but trial eligibility criteria, such as air conditioning size and the make and model compliance with AS4755 standard, reduced the number of those with eligible systems that could take part in the trial.

This was the case in this program, where the initial response rate to participate in the trial was a promising 5% (128/2,800) prior to eligibility screening (AC size, make/model), but reduced to 1% (31/2,800) for the actual operational dispatches. This compares favourably with customer participation rates in the Coolsaver trials, where the initial response rate was slightly higher at 11% (1,205/16,141) however the final participation rate was lower at 0.7% (109/16,141).

Demand reductions achieved and operational outcomes

The demand reductions achieved were in the range 1.5 to 1.9 kW/customer over the 3 dispatch events, with an average of 1.7kW/customer, which was slightly higher than the planned 1.5kW/customer. In addition, 94% of the DREDs operated as intended.

Operationally, once the initial configuration issues with the dispatch hardware at the Newcastle control room were resolved, running dispatch events was a smooth process. Identification of dispatch days during the summer season involved monitoring weather forecasts for the Maitland area several days ahead, with event days being identified around 1 to 2 days prior. Booking an event was a straightforward process involving a simple email being sent to the Newcastle control room to nominate the date and time of the event. A confirmation email from the control room notified that the event had been booked in.

Throughout the summer, there were zero instances of customers requesting to cease participation in the program.

Broadly representative

The network need in the Gillieston Heights area is broadly representative of what a typical residential summer overload would look like elsewhere in Ausgrid's network. An exception may be residential areas in close proximity to the coastline, where sea breezes and cooler average temperatures, even on hot summer days, may result in few opportunities for a peak demand program such as that employed in Gillieston Heights.

The weather monitoring process for Gillieston Heights involved not only the forecast maximum daily temperature, but also the temperature profile. On days where there was a high maximum temperature, but cooler evening temperatures (cool change effect) were not chosen as event days due to the lower likelihood of air conditioner usage during these times.

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Implementation issues

The timing of the installation of the DREDs was delayed due to technical issues encountered with the ripple signal controller hardware located in Ausgrid's Newcastle control room, involving a legacy computer terminal and time required to troubleshoot and make the system operational. As a result, a number of DREDs were installed post-final dispatch, however, these will be available for future dispatch events.

5.9 Extension of Gillieston Heights Program 2020-21

Following the summer 2019/20 demand management program, Ausgrid's review of the Gillieston Heights area confirmed that it was technically and economically feasible to extend the program for another summer season into 2020/21.

Customers who participated in the 2019-20 program were invited to participate again. 34 out of the 49 customers continued and re-registered to join the program. In the analysis for this summer period a different approach was applied in that only those customers who had interval metering and who did not have solar power systems were analysed. This is because solar customers with net metering have grid supply demand profiles that do not fully reflect their underlying customer demand and a degree of error is introduced when adjusting for estimated solar generation.

Results from this subset can be extrapolated to the entire population of participants, some of whom may not have interval metering and may have solar systems. As a result, there were 12 customers analysed, who did not have solar and who had interval metering out of the total cohort of 34 participating customers.

5.9.1 Material Changes that occurred for the Summer 2020/21 program

During the planning phase for the program extension, the opportunity to deploy additional demand reductions techniques including behavioural demand response and network support from a grid-connected battery became available. Accordingly, planning for the extension of the Gillieston Heights demand management program targeted total demand reductions of 1230kVA, or 88% of the expected load at risk of 1.4MVA in summer 2020/21, comprised of the following:

- 96kVA from participating residential AC customers,
- 32kVA from participating BDR customers,
- 1100kVA network support from the grid battery

Although planning for the summer 2020/21 program included the battery, there was a degree of uncertainty around whether the grid battery would be online prior to the summer season, when considering the limited available timeframe to cover activities that included approvals, funding agreements, procurement, delivery and commissioning in time for summer dispatch events. Planning accounted for the Gillieston Heights program with and without the battery for summer 2020/21.

Air conditioning customer re-activation

Customers who participated in the AC load control program for 2019-20 were re-contacted and invited to participate in the Summer 2020-21 program. The ripple method of signalling customer AC units was again chosen, which meant that the DREDs installed for the prior summer could be re-

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used. These customers were contacted and invited to re-register their interest to participate in summer 2020/21.

A similar set of customer materials were sent to the same customers who participated in the AC load control program and a similar flat incentive payment of $100 for their further participation (no installation bonus since the DREDs were carried over from the previous summer) was offered again, up to 8 dispatch events being allowed for. Each dispatch event was planned to occur between 5pm and 9pm consistent with the residential peaking load in the area.

Behavioural Demand Response (BDR)

For the BDR component, Ausgrid engaged retailers AGL and EnergyAustralia to deliver BDR as part of a 3-year demand management innovation trial. The areas for the 2020/21 trials were expanded to include Gillieston Heights and surrounding suburbs where BDR dispatch events in these suburbs would offer load reductions that would satisfy the requirements of the Gillieston Heights DM project. It was planned that BDR events would run for 2 to 3 hours either as a shared event (both retailer and Ausgrid participating) or a network triggered (Ausgrid only) event, with costs allocated accordingly based on the driver of each dispatch event, either innovation-driven (DMIA funded) or network-need driven (DMIS funded).

It was estimated that 50 customers in the Gillieston Heights area would participate in a BDR dispatch event with average curtailment of 0.5kW or 0.63kVA per customer, based on Retailer guidance.

Grid Battery

Around the time when Ausgrid was planning for the Gillieston Heights program extension, an energy retailer had proposed the installation of a 2.2MWh / 1.1MVA grid connected battery as part of a project co-funded with the NSW Government and ARENA.

The Retailer had originally projected the availability of the battery by late 2020, but delays meant that the battery was not available to provide network support services.

5.10 Project outcomes and learnings to date

The table 5 summarises the results of the 4 dispatch days which were conducted on 28 November, 29 November, 1 December and 25 January 2021. Demand Response Mode 2 was used on each dispatch day which capped the electrical input load for air-conditioning units to 50%.

Table 5: Summer 2020-21 average demand reduction per dispatch event

Dispatch Day	Time	Demand profile adjustment	Number of customers analysed	Average demand reduction per customer (kW)
28 Nov 2020	4:00pm-9:00pm	No	12	1.0
29 Nov 2020	4:00pm-9:00pm	Yes	12	1.0
1 Dec 2020	4:00pm-9:00pm	No	12	0.6
25 Jan 2021	4:00pm-9:00pm	No	12	0.9

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Measurement of the ACLC demand and energy reductions achieved by the Gillieston Heights demand management project was determined using a “day-matching” method whereby a day with similar weather to each dispatch day was identified using weather station data. Table 6 below shows a comparison of each dispatch day with its selected reference day.

Table 6: Summer 2020-21 matched-weather days

Dispatch day	Reference day	Dispatch day		Reference day	
		max temperature °C	avg temperature °C	max temperature °C	avg temperature °C
28 Nov 2020	26 Jan 2021	39.2	28.5	37.4	28.1
29 Nov 2020	26 Jan 2021	41	30.4	37.4	28.1
1 Dec 2020	14 Jan 2021	36	25.1	35.3	25.7
25 Jan 2021	26 Jan 2021	37	25.7	37.4	28.1

Based on the selected reference day, average peak demand reductions were calculated for each dispatch day within the dispatch window of 4-9pm AEDT based on analysis of half-hourly NMI energy consumption data (primary grid supply tariff) converted to kW. The kW for each half-hourly interval is therefore the average kW per half-hour based on the kWh consumed in that same half-hour.

Comparison charts for the dispatch days 25 Jan 2021, 1 Dec 2020, 28 Nov 2020 and 29 Nov 2020 are shown below overlaid with their respective reference days. The individual customer load profiles that form part of this set of 12 customers are metered at the point of grid supply, which means other household loads will be represented in the profile. This introduces additional variability in the comparisons.

The dispatch days of 1 Dec 2020 and 25 Jan 2021 shown in Figures 7 and 8 below. A visible reduction in aggregate customer demand compared to their respective reference baseline days can be seen during the dispatch window. The indicative average peak demand reduction on 1 Dec 2020 is about 0.6kW per customer and on 25 Jan 2021 is about 0.9kW per customer.

For the 1 Dec 2020 dispatch event, the maximum and average temperatures for the reference day are within 2% for that on the dispatch day. The similar demand profiles for the test group outside of the dispatch window would indicate that the day matching approach and reference day are reasonable.

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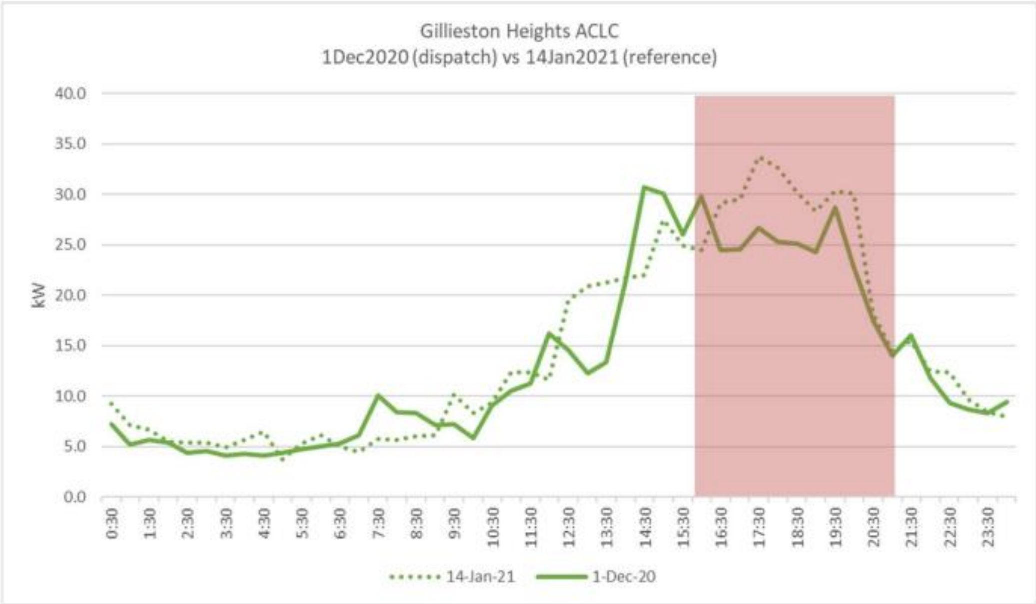
Figure 7: Comparison 1 December 2020 (dispatch day) vs 14 January 2021 (reference)



For the 25 Jan 2021 dispatch event, the maximum and average temperatures for the reference day are within 1% and 8% respectively of the dispatch day. The similar demand profiles for the test group outside of the dispatch window would indicate that the day matching approach and reference day are also appropriate.

Figure 8: Comparison of 25 January 2021 (dispatch day) vs 24 January 2021 (reference)

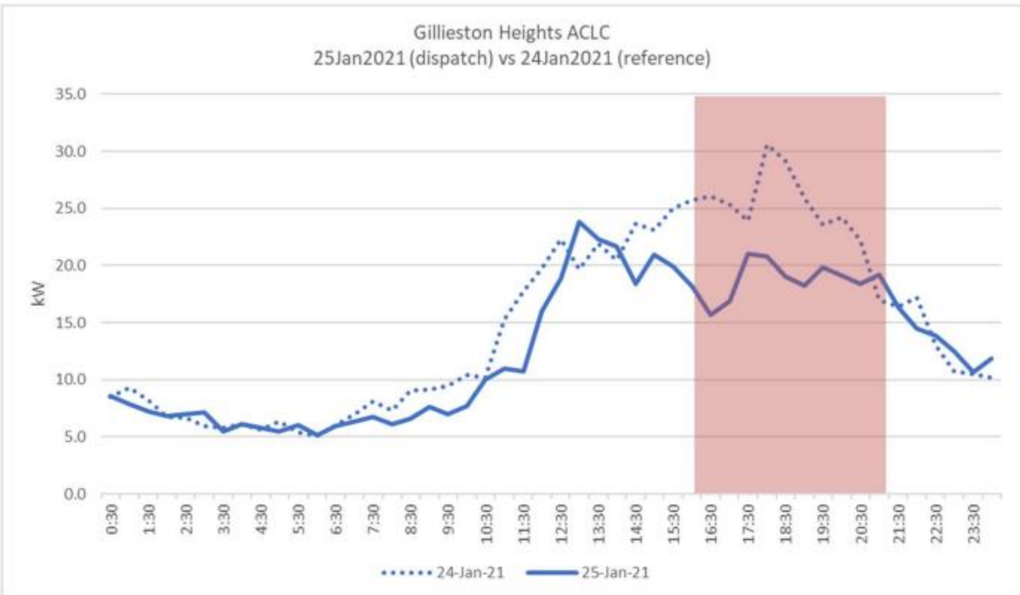


Figure 9 below shows the aggregated demand on dispatch days 28 Nov 2020 and 29 Nov 2020 compared to the reference day 26 Jan 2020. There is a visible demand reduction on 28 Nov during the dispatch window, with an average peak reduction of about 1.0kW per customer.

However, 29 Nov does not show a lower demand than the selected reference day with demand higher in the dispatch window compared to the reference day. The reason is likely due to 29 Nov

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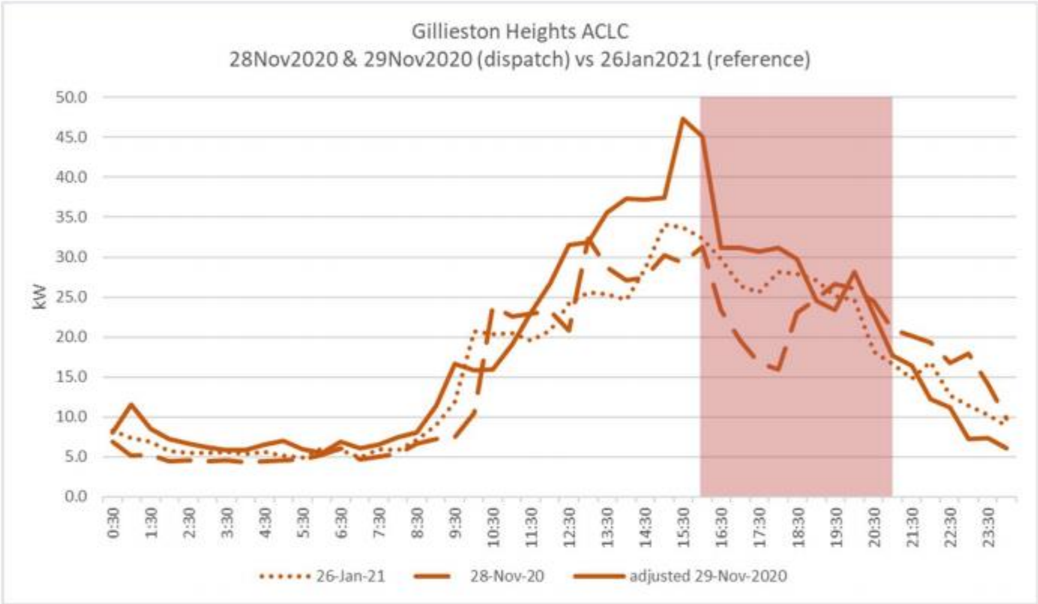
being the hottest day in the summer period and that comparison with the selected reference day 26 Jan 2021 is not appropriate. Looking at the maximum and average temperatures for the dispatch day and the reference day in Table 6 above, maximum temperatures on the 29th Nov reached 41°C with an average daily temperature of 30.4°C. These maximum and average temperatures are 10% and 8% higher than the temperatures of 37.4°C and 28.1°C on the reference day, respectively. These results highlight the challenge of estimating demand response for residential customers using this method when similar baseline days are not available.

Figure 9: Comparison of 28, 29 November 2021 (dispatch days) vs 26 January 2021 (common reference)



One possible technique is to firstly adjust the dispatch day profile using the time intervals immediately prior to the dispatch window to account for the differences in maximum and average temperatures between the dispatch days and reference day. For example, in Figure 10 below, the demand profile of 29 Nov 2020 has been shifted down based on the average of the four half-hourly periods (2:00pm to 4:00pm) prior to the commencement of dispatch at 4:00pm. This method of adjustment is similar to some of the baselining approaches used in other jurisdictions, a discussion of which is provided in Section 5.11 below. Average demand in this period is 32kW on the reference day 26 Jan 2021 and 42kW on the 29 Nov 2020 dispatch day, leading to an adjustment of 10kW (decrease) for 29 Nov. In Figure 10, the adjusted profile of 29 Nov is shown only for time periods around the dispatch window to avoid having to scale the adjustment for other times far from the dispatch window. Figure 10 shows this might be a reasonable method of accounting for the temperature difference between 29 Nov and the reference day. The calculated average demand saving is around 1.0kW per customer following the adjustment. This is roughly in line with results for other days indicating that this adjustment method has merit. It also minimises complexity.

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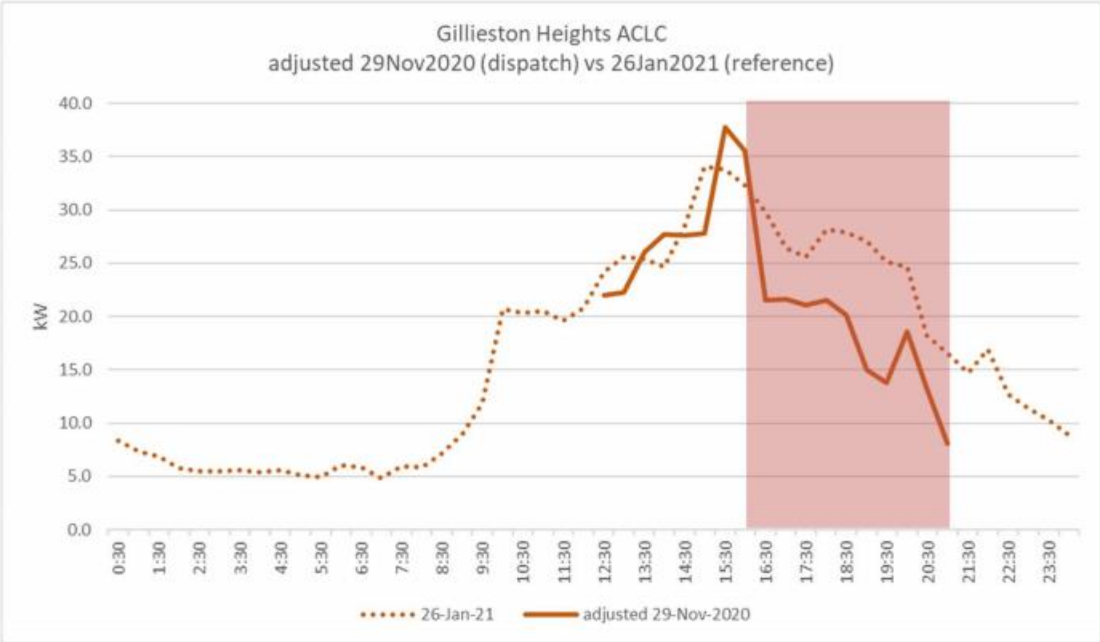
Figure 10: Comparison of adjusted 29 November 2020 (dispatch day) vs 26 January 2021 (reference)



As maximum demand for the season occurred on the 29 November, the average demand reduction on this day is estimated to be the peak day demand reduction. Extrapolating these results to all 34 participating ACLC customers gives a total demand reduction of 34kW for the ACLC component of the Gillieston Heights demand management project.

5.10.1 Comparison with CoolSaver trial results

Figure 11 below shows the results obtained from the ACLC program run as part of Ausgrid's Coolsaver trial (Figure 5 in the Coolsaver Report). One key difference was that during Coolsaver, the air-conditioning electrical circuit load for participating customers was monitored directly, meaning that measurements were not confounded with other household loads, as is the case with the Gillieston Heights program. The Coolsaver trial used the same method of signalling customer air conditioning units, so comparing the Gillieston Heights results against Coolsaver is reasonable noting the difference in point-of-measurement mentioned above.

The blue line in Figure 11 shows a clear reduction of around 1.5kW per customer under the Australian Standard AS4755 Demand Response 2 (DRM2) mode for customers with cooling capacity over 10kW during the period of dispatch. This is higher than the results shown in Table 5 above where demand reductions were estimated to be about 0.6 to 1.0kW per customer.

Possible reasons for the lower results from the Gillieston Heights project include errors introduced when selecting the reference day (matched weather day) shown in Figures 7, 8, 9 and 10 above and changes in the demand from other appliances in the home. Further work is required to refine and develop higher confidence in the measurement and verification of demand reductions from demand response programs.

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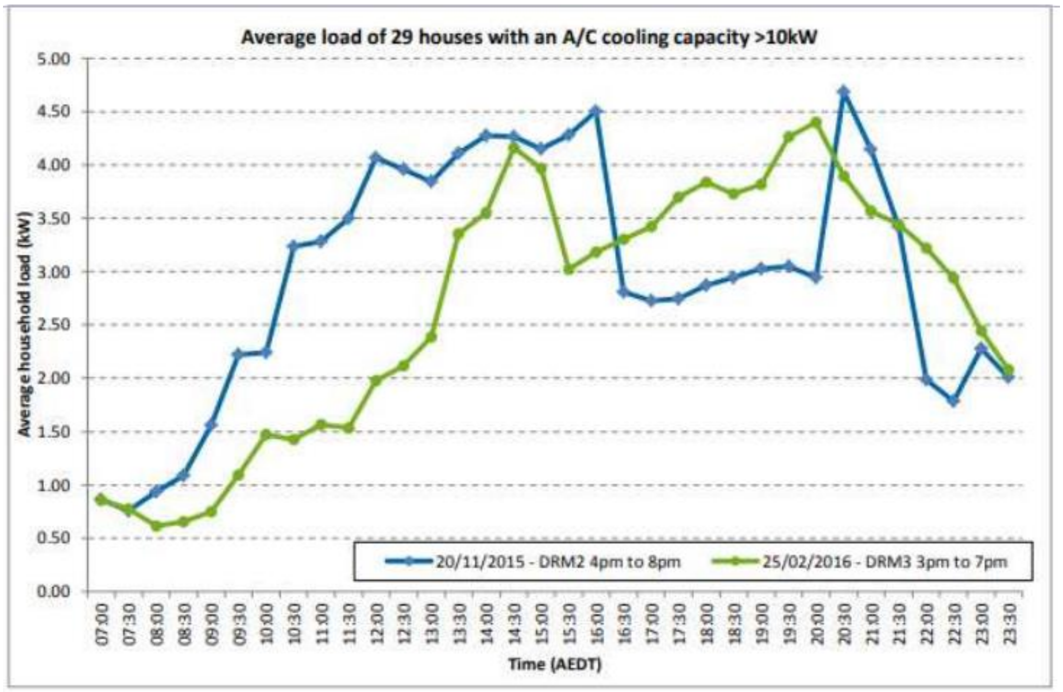
Figure 11: Coolsaver trial air conditioning load control results



5.10.2 Plan for 2021/22 – end of program:

Latest analysis into the 2021/22 summer season for Gillieston Heights has revealed that, due to the size of the network need, which is now much larger than previous summers from the rapid pace of residential development and some light commercial development, the ability of demand management to address an adequate proportion of unserved energy risk has fallen considerably.

The decision has been made to not proceed with the DM program for summer 2021/22.

5.11 Baselining

While the results presented in section 4 above provide some examples of how the dispatch day outcomes can be determined, the results are dependent upon the methodology and assumptions used in creating a "baseline" set of conditions against which the events of interest (dispatch days) can be compared against. A dedicated discussion around baselining is warranted.

Baselining, in the context of measuring demand and energy reductions, is the method by which a "baseline" set of conditions are determined, against which a set of demand and energy reducing initiatives can be calculated. In other words, "what would have occurred" in the absence of the demand reducing initiatives. The baseline cannot be measured directly, so estimation methods are required.

In developing the baseline approach used to measure the Gillieston Heights program, Ausgrid gave due consideration to the following pieces of work around baseline approaches.

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5.11.1 Previous baselining work – published reports

AEMO/ARENA

In September 2019, Oakley Greenwood published a report titled "Baselining the ARENA-AEMO Demand Response RERT Trial" on behalf of ARENA. This report was jointly developed by ARENA and AEMO as part of 'proof on concept' projects to support the integration of renewable energy into the energy market, while maintaining system reliability and security. The report studied the relative accuracy, bias and precision of a baselining methodology called '10 of 10' used to predict actual metered load for participants in a RERT trial. Put simply, the '10 of 10' methodology uses the consumption of the 10 most recent qualifying days to construct a baseline. The report analysed the application of the '10 of 10' methodology on a mix of load types such as industrial, commercial and residential loads across VIC and NSW, with mixed results by state and by load type.

From the Oakley Greenwood report, the 2 recommendations most relevant to this Coolsaver report are that the '10 of 10' baselining methodology might not be appropriate for:

- Highly weather-sensitive loads such as residential loads; and
- Loads influenced by rooftop PV generation, which affect at least some of the participants of the Coolsaver or Gillieston Heights DM programs.

Although not studied in detail within the Oakley Greenwood report, alternative approaches for calculating baselines were presented, the key aspects of which are provided below for the AGL, United Energy, Zen Ecosystems and PJM & South Korea methods.

AGL

AGL developed a methodology based on the concept of 'anchoring', which applies the following steps:

- Averages the usage at a particular time of day, based on qualifying days over the last 5 weeks that have similar temperatures to the event days;
- Differentiation was made for weekdays and weekends, controlled load and solar (net load was used);
- Regression techniques were applied to create a load shape to model the event day. A de-biassing step was carried out to adjust for errors in forecast vs actuals over the past week;
- Finally, the predicted consumption outside the event period is anchored to the actual consumption on the event day based on the hours near the event.

United Energy

United proposed a modified '10 of 10' approach which applies the following steps:

- A longer period from which to select qualifying days – 2 years;
- Select 10 reference days based on similar maximum temperatures, rather than maximum and average temperatures per the '10 of 10' method;
- Profile adjustment based on 1hr prior to the event, rather than 3hrs per the '10 of 10' method.

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Zen Ecosystems

Zen used a linear baseline rather than the ’10 of 10’ method. The linear baseline involved constructing a straight line from the half-hourly metered consumption around 1hr prior to the event to 1hr post the event. Zen’s method only uses data on the event day. No days outside of event days are used at all. This approach has some of the characteristics of anchoring, and that it effectively averages out any variations between the hour before and the hour after the event.

PJM & South Korea

PJM (transmission network operator in the USA) and South Korea use alternative baselining approaches in their demand response programs. Their approaches use the same basic components as per the ’10 out of 10’, with some specific changes. PJM defined their own parameters around the selection window, qualifying days, determining the reference days, adjustment period and an adjustment limit.

South Korea use either a ‘6 out of 10’ method or ‘4 out of 5’ method, with optional adjustments relating to unusual days where average load fell outside a given envelope and an adjustment that could be applied using time periods immediately prior to the dispatch window.

5.11.2 Internal Ausgrid modelling

In addition to the above approaches, Ausgrid investigated a clustering method. The aim was to use the consumption pattern of similar customers in the area as the baseload for the participating customers.

The residential customers in the area were grouped into distinct clusters and then the average load profiles of the customers in the program at the event time were compared to the other (non-trial) customers within the same cluster (i.e. with similar load pattern). Rather than comparing individual customer load profiles which are subject to the impact of random operation of appliances, average load profiles were compared.

The half-hourly metered net load data of around 1100 residential customers within the same region (Gillieston Heights), for extended summer 2021 period 1 Nov 2020 to 31 March 2021 were used to group the customers into 1 of 10 clusters.

The k-means clustering method was used. The load profiles were smoothed using the fast Fourier Transform method and the dimensionality of the profiles was also reduced by applying principal component analysis method. These two pre-processing steps are useful before applying clustering method to time-series data to smooth the variability of the time series and to also reduce the number of features (timestamps) used in the clustering algorithm.

For customers with solar, the behind the meter solar generation is estimated using the average solar generation in the region and scaled based on the installed solar capacity of each individual customer. The estimated solar generation is then added back to the net load of each customer to estimate the underlying consumption.

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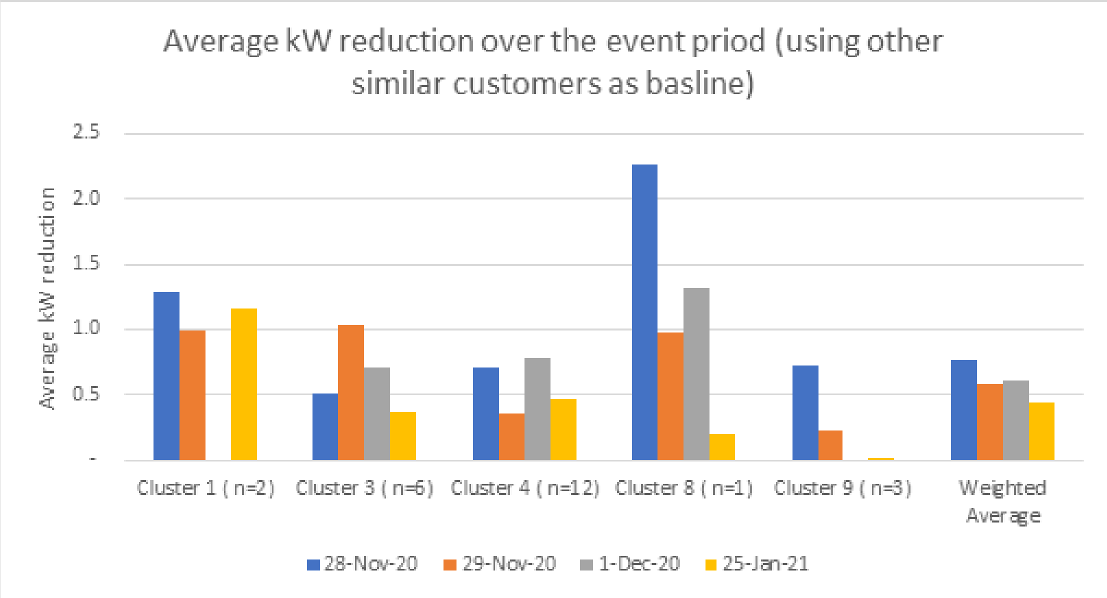
Out of the 1100 total load profiles used in the clustering analysis, there were 25 participating customers (solar and non-solar).. Using k-means, the load profiles were clustered into 10 groups. Three clusters captured only the outlier load profiles including one participating customer. The remaining seven clusters captured the other customers including 1118 non-participating customers and 24 participating customers. Half of the trial customers were grouped into cluster number 4 and the others were grouped into three other clusters.

For each cluster the ratio between the kWh consumed during the event periods and the kWh consumed over the whole day were compared to the non-participating customers (base load) to estimate the likely reduction of customers' load during the event. Figure 12 below shows the estimated average kW reduction on each event day for the customers within each cluster using the adjusted average load of other customers within the same cluster as the baseline. The weighted average is the average kWh adjusted for the number of customers in each cluster so that the clusters with higher number of customers will have a higher impact on the final average. The result show a demand reduction ranging between 0.44kW to 0.77kW per customer based on the weighted average method.

Figure 12: Average kW reduction for customers in each cluster



Figures 13, 14 and 15 show the load pattern of the participating and non-participating customers in cluster 4 which has the highest number of participating customers. Note that Figure 13 shows two consecutive event days. This event time window on each dispatch day is shaded and shows a noticeable reduction in the demand profile of the participating customers compared to the respective baseline profile on each event day.

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Figure 13: Cluster 4 participating customers vs baseline on 28 & 29 Nov 2020 (x-axis=48hrs)

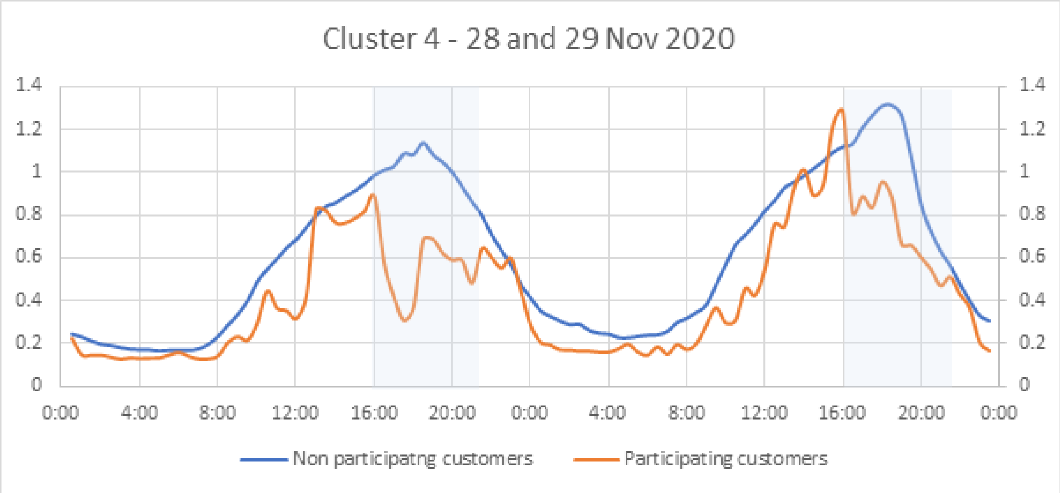


Figure 14: Cluster 4 participating customers vs baseline on 1 December 2020

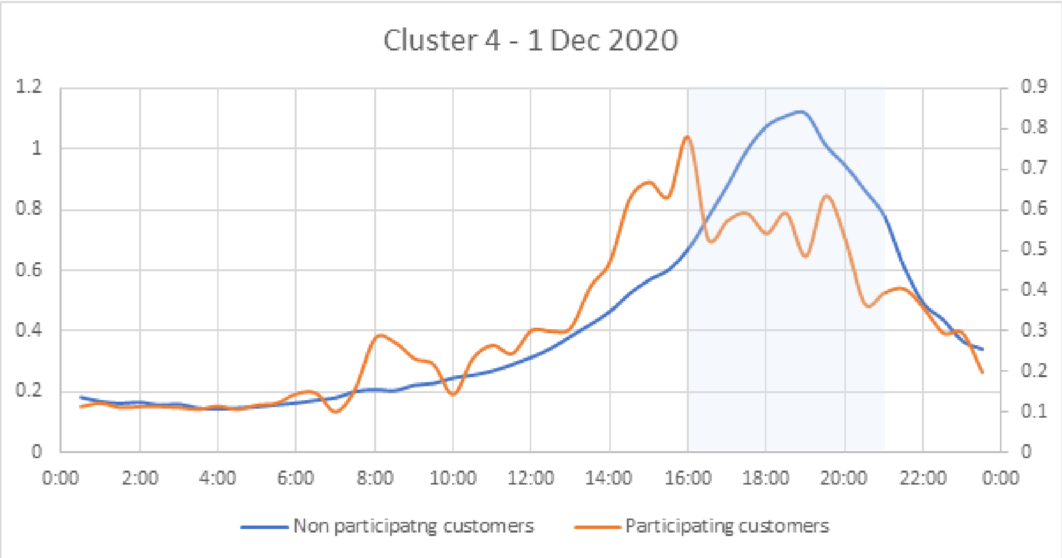
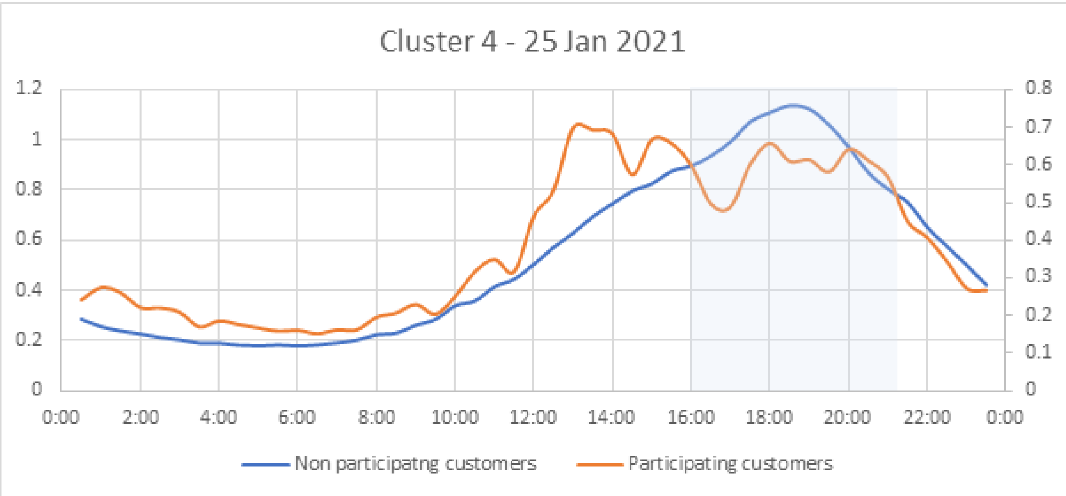


Figure 15: Cluster 4 participating customers vs baseline on 25 January 2021



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6. Future Considerations

The future of air conditioning demand response as a demand management solution used by both electricity distributors as well and energy retailers is likely to strengthen moving forwards due to the following factors:

- Increasing adoption by Energy Retailers of demand response offers for customers such as the AGL's Peak Energy Rewards[1], Origin's Spike[2] and EnergyAustralia's PowerResponse[3];
- Technological advances that enable customers to manage the thermal comfort of their homes by remotely operating their air conditioners (and other appliances) and reduce their energy costs. This capability could enable low-cost establishment of demand response automation for customer participation in demand response programs with energy retailers or third-party aggregators;
- Greater take-up of solar power which drives both more informed customers and, with lower feed-in tariffs, a financial interest to self-consume as much of their solar power as possible;
- Demand response services appear to be evolving as part of integrated Retailer offers to customers where they are bundled with energy supply, solar and storage which may raise awareness of these products and encourage greater adoption;
- The Australian Energy Market Commission's current review of the regulatory framework for metering services[4] which is expected to accelerate the roll-out of smart meters for small customers and provide the underpinning technology for Retailer demand response products;
- The introduction of the New South Wales Peak Demand Reduction Scheme[5], which will offer financial incentives for customer demand response;
- Potential changes around demand response standards which may also have a positive impact in supporting demand management solutions;
- The introduction of the Demand Management Incentive Scheme[6] in 2017 which offers financial incentives for electricity distributers implementing demand management solutions to network needs; and
- The emerging consensus to act on climate change and establishment of targets to achieve Net Zero emissions (e.g. NSW Net Zero Plan[7]) is raising public awareness and may encourage greater levels of voluntary action to help achieve community goals.

Factors that may challenge or impede customers' willingness to take up demand response activities include:

- Bushfire and climate change impacts which may lower customers' tolerance for reducing their cooling during summer;
- Challenges with efficiently rewarding consumers for their demand reduction as baselining methods become increasingly complex;

[1] https://www.agl.com.au/campaigns/peak-energy-rewards
[2] https://www.originenergy.com.au/spike/
[3] https://www.energyaustralia.com.au/home/help-and-support/faqs/power-response
[4] https://www.aemc.gov.au/market-reviews-advice/review-regulatory-framework-metering-services
[5] https://www.energy.nsw.gov.au/government-and-regulation/energy-security-safeguard/peak-demand-reduction-scheme
[6] https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/demand-management-incentive-scheme-and-innovation-allowance-mechanism
[7] https://www.environment.nsw.gov.au/topics/climate-change/net-zero-plan

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- Recent research which examined customers' perceptions about their future use of energy (Digital Energy Futures[8]) related technology indicated that the majority of customers were not as interested in their energy technology as other technology relating to entertainment, communication services; and
- As Retailer offers mature, customer financial or other benefits may not be sufficient to entice, encourage and retain participation.

[8] https://www.monash.edu/emerging-tech-research-lab/research/research-programmes/energy-futures/digital-energy-futures

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