Ausgrid Demand Management

Hot water load control trials

August 2016

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Acknowledgements

The projects described in this report were funded from the Demand Management Innovation Allowance (DMIA) operated by the Australian Energy Regulator (AER). The DMIA allows network service providers to trial innovative solutions that aim to develop and build capability and capacity for demand management alternatives to network investment. Ausgrid's DMIA allowance is a maximum of $1 million per year on demand management innovation projects approved by the AER.

Results from Ausgrid's DMIA projects are reported annually by the Australian Energy Regulator. Past reports are found on the AER's website at www.aer.gov.au.

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Executive summary

Ausgrid currently has around 1.5 million households connected to its distribution network - around two-thirds (or 900,000) of these have electric hot water systems. Of these, around 500,000 have electric storage hot water systems connected to one of Ausgrid's controlled load network tariffs. The remaining 400,000 customers have electric hot water systems on continuous electricity supply, with about three quarters in apartments.

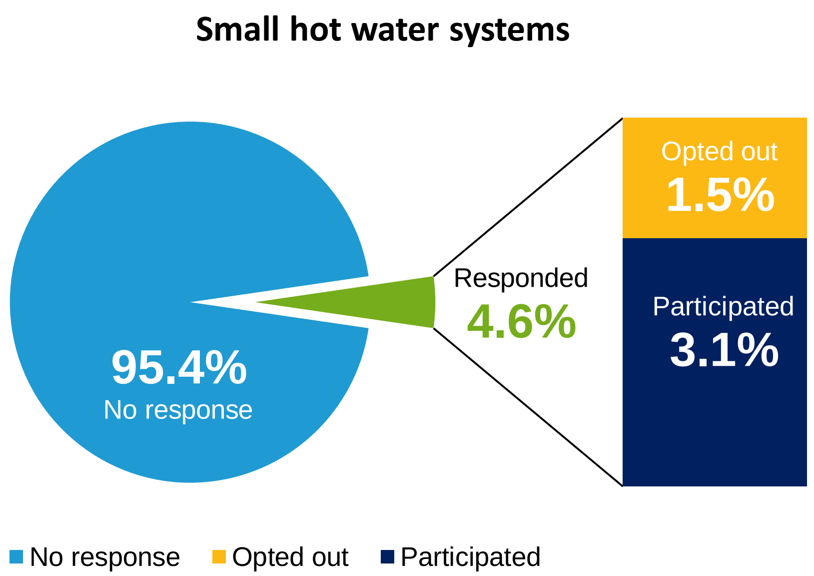
Three demand management innovation projects were developed and implemented by Ausgrid between 2011 and 2015 with the aim of exploring innovative approaches to reducing the impact of peak demand from residential hot water systems using load control solutions. These projects had different objectives including testing different technology and load control options, discovering customer take-up rates from various incentives and marketing approaches, customer satisfaction and response to load control solutions.

PROJECT 1: Control of small hot water systems

The first project focused on investigating a demand management solution for electric hot water systems on continuous electric supply that are not eligible for our existing controlled load tariffs. We estimate there are around 300,000 customers with small hot water systems with storage of less than 100 litres, mainly in older apartments. An offer was made to 1,400 apartment dwellers to participate in the trial for a modest incentive of $50-100 per year. A total of 44 customers elected to participate over two winter periods and one summer period.

The results from the trial indicated that customers accepted the occasional switching off of the electricity supply to their hot water system during the late afternoon / early evening peak times of 5pm to 9pm, once per week. This was not well understood before the project commenced and was a positive outcome from the trial laying the ground work for the technique as a potential solution to consider in the future.

However, the costs associated with the supply and installation of the controlled load devices were high in relation to the demand reductions, and a lower cost solution will be required before it would be considered a cost-effective alternative to other network and non-network solutions. A possible pathway to a lower cost solution might use the demand response capability of Australian Standard 4755.3.3, smart meter capability and customer aggregation programs facilitated by emerging smart grid technologies.

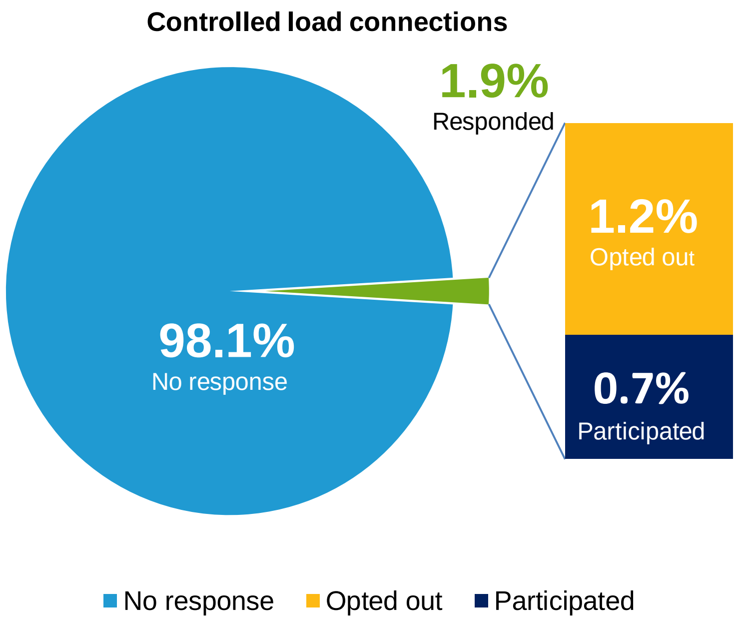


PROJECT 2: Subsidised controlled load connections

The second project was targeted at the estimated 100,000 customers with eligible hot water systems but who are not connected to a load control tariff. This project tested a subsidised controlled load connection offer to customers with the aim of investigating new marketing approaches for encouraging customers with eligible hot water systems to connect to an existing lower cost controlled load tariff. Various offers were made by letter or marketing brochures to 14,800 customers in various areas of the Ausgrid network.

The take-up rate was small with a total of 104 customers proceeding with connecting their hot water system to a controlled load tariff. In an additional component to this project, Ausgrid partnered with the NSW Land and Housing Corporation to conduct a pilot offer of a no cost subsidised connection offer to around 100 social housing tenants. The results from these customer trials showed that the upfront costs for installing new controlled load and metering equipment and associated electrical works can be significant and take-up over select geographic areas was relatively low. One segment of customers with a reasonably high take-up rate was customers with existing controlled load equipment that were able to reconnect their eligible electric hot water system back to controlled load at a low cost.

Due to the low take-up rate and high unit cost, this approach would not be considered cost competitive with other network and non-network solutions. The low volumes mean that any contribution to a network deferral would be very small and in most instances, not material.



PROJECT 3: Controlled Load 2 summer scheduling

The third project focused on optimising the summer load control schedule for our existing Controlled Load 2 customers with the aim of obtaining summer peak demand reduction benefits in the summer afternoon period. There are 153,000 customers in Ausgrid's network area on the control load 2 tariff. After conducting an initial trial in three areas of the network in the Hunter region in summer 2013/14, the trial progressed to a broader implementation of the schedule change in 2014/15 summer across 28 zone substations in the Newcastle load area.

The estimated summer peak demand reduction during 2014/15 was estimated to be 4.0 Megawatts during the summer afternoon period of 2:30pm to 6:00pm. The solution was shown to be reliable and low cost, utilizing Ausgrid's existing equipment and infrastructure with insignificant effects on customers. Due to the low unit cost, this approach would be cost competitive with most alternative network or non-network solutions. Where network needs are assessed, this solution will be a strong alternative option when determining the least cost solution to the need.

1 Background

1.1 Peak demand and demand management

To fulfil our corporate purpose of supplying safe, reliable and affordable electricity, Ausgrid must invest in electrical infrastructure to meet the growing needs of our 1.69 million customers in an efficient and sustainable manner. Ausgrid's electricity infrastructure must be designed to supply the maximum electricity demand of our customers, whenever and wherever it occurs, and this peak demand typically only occurs for 20-40 hours in a year or less than 0.5% of the time.

What is peak demand?

Maximum demand occurs when there is a large demand for electricity from customers simultaneously on the network; typically, these peak demand events result from customers increasing their electricity consumption due to temperature changes (cold winter evenings or hot summer afternoons). Figure 1 shows the Ausgrid system electricity demand on summer and winter peak days in 2015/16 in comparison to the average for summer and winter weekdays.

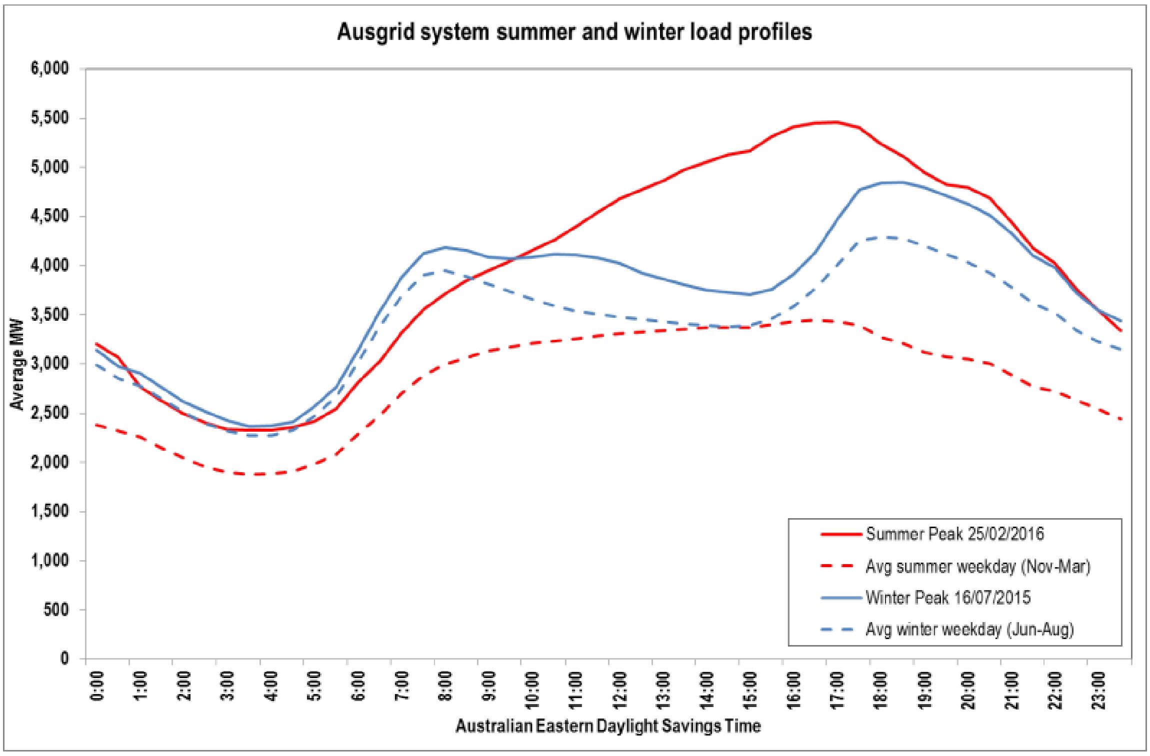


Figure 1: Ausgrid system load profile – winter and summer peaks and averages

While the overall system peak demand highlights the network wide impact of peak demand, localized electricity infrastructure such as cables, transformers or zone substations may experience localized peak demand events at different times of the day and year depending on the electricity demand from customers in that local area. Figure 2 shows the seasonal average and peak demand profiles for a typical Sydney zone substation with a high percentage of residential customers.

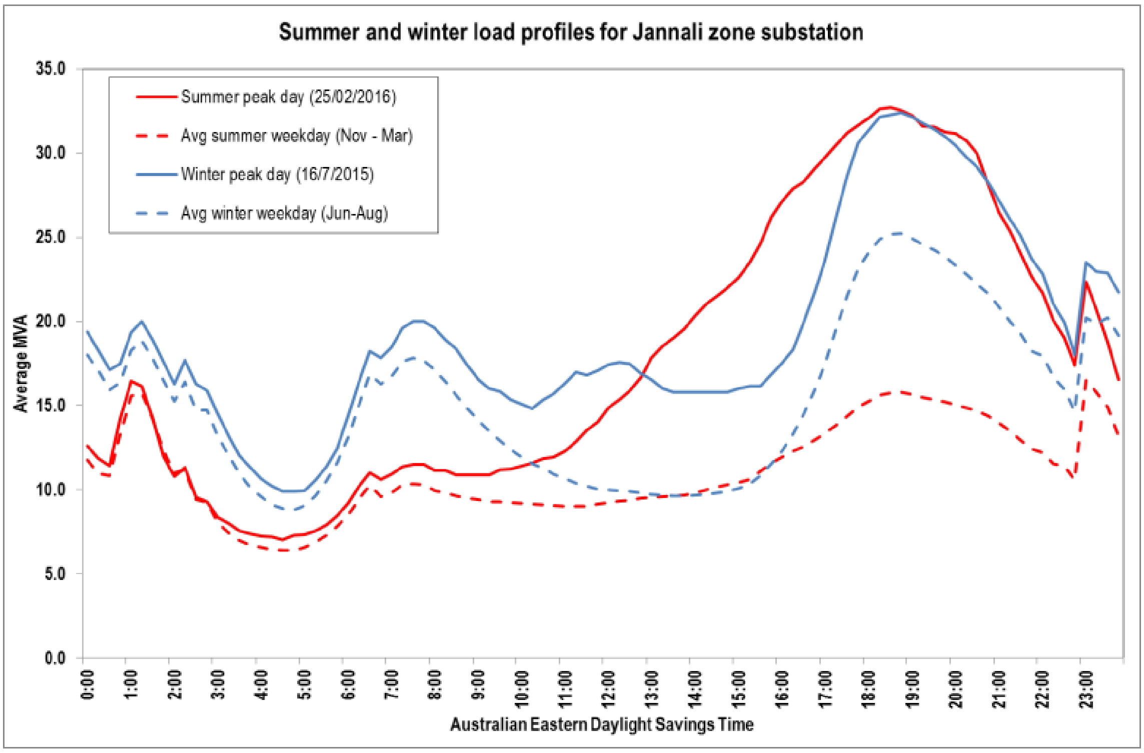


Figure 2: Average and peak demand summer and winter profiles for Jannali zone substation

When the demand for electricity at peak times approaches the capacity of network infrastructure, Ausgrid must act to maintain reliable electricity supply to customers. Reliable electricity supply to customers can be maintained by either increasing the network capacity (supply side management) or reducing the peak electricity demand on the network (demand side management).

What is demand management?

Demand management is an important part of efficient and sustainable network operations. It can involve either the voluntary moderation of customer electricity demand at peak times or the supply of electricity from generators or storage batteries connected at customer's premises or to the distribution network. Effective network investment considering demand management is used for both replacement of aged network assets and network expansion due to growth in demand. Demand management solutions are also referred to as non-network solutions and similarly, a demand management provider may also be referred to as a non-network provider.

Effective use of demand management reduces the cost to maintain the network and helps lower electricity charges for the entire community.

1.2 Residential electric water heaters

Ausgrid currently has around 1.5 million households connected to its distribution network and it is estimated that around two-thirds (or 900,000) of these homes have electric hot water systems. Electric water heaters are one of the largest electricity using appliances in a typical home and present one of the biggest opportunities for peak demand reductions in the residential sector. One of the benefits of electric storage water heaters is that water can be heated in off peak times and then stored in an insulated tank for usage at peak times. A medium size (250 litres) hot water system can store around 10kWh of hot water (thermal energy storage). This storage capacity is equivalent to a large residential battery system.

Of all Ausgrid residential customers, around 344,000 have appliances connected to our Controlled Load 1 network tariff and 153,000 have load connected to our existing Controlled Load 2 network tariff. These controlled load tariffs limit the electricity supply to the customer's hot water system during peak times and customers receive a cheaper tariff for their hot water system electricity supply (Section 1.3). The electricity retailers pass on these cheaper controlled load tariffs to customers and are significantly cheaper than the continuous supply electricity tariff used to power household appliances and lighting (see Table 2 for comparison of retail prices).

It is estimated that there are a further 400,000 customers with electric hot water systems on continuous supply electricity tariffs in Ausgrid's network area. The majority of these additional electric hot water systems would have smaller tanks and be located in older apartment buildings. However, it is estimated that about 100,000 are in freestanding homes rather than in apartments, and are likely to have eligible size hot water systems that could be connected to a controlled load tariff. Table 1 gives an overview of the estimated numbers of domestic water heaters in Ausgrid's network area by energy type and electricity tariff.

Table 1 – Domestic water heater summary by energy and electricity tariff (Ausgrid network area)

Electric water heaters: 900,000	Customers with electric water heater on a controlled load electricity tariff: 500,000	**Controlled Load 1: 344,000**
		Controlled Load 2: 153,000 (Project 3)
	Customers with uncontrolled electric water heater on a continuous supply tariff: 400,000	**Large hot water systems: 100,000 (Project 2)** Eligible for the controlled load tariffs and mainly found in freestanding homes
		Small hot water systems: 300,000 (Project 1) Not eligible for controlled load tariffs and mainly found in townhouses or apartments
Gas hot water systems: 600,000		

Electric storage systems are the most common type of electric water heater, but in recent years more efficient systems such as electrically boosted solar and heat pump water heaters have been installed in new and existing homes. The three main types of electric water heaters are described below in more detail.

Electric storage water heaters

These hot water system types use electric resistance elements to heat water in a storage tank. Water heating is controlled by an independent thermostat that measures the temperature of the water in the tank and when it falls below a certain level the electric heating element operates.

Electric storage hot water systems can have various storage tank sizes ranging from small 50-80 litre tanks (eg. often located under the sink in older apartments) through to large 300-400 litre tanks connected to a controlled load electricity tariff that heats the water during off peak times.

Solar water heater (electrically boosted)

A solar water heater consists of a storage tank, solar collector panels and a boosting system. Solar collector panels are usually installed on the roof of a home or building, preferably facing north for the best sun exposure. Water is either passed directly through the collector panels to be heated by the sun, or is indirectly heated by an anti-freeze fluid, before being stored in an insulated storage tank.

Storage tanks can be located on the roof, in the roof space or at ground level. The boosting system ensures that a household does not run out of hot water during times of low sunlight. Boosting can be done by electricity or gas, but the electrically boosted option is generally more popular and a resistive heating element is located in the tank to provide this additional heating.

Heat pump water heater

Heat pump water heaters draw heat from the surrounding air and use this to heat water in a tank. They operate similarly to a reverse cycle air conditioner as they use an electrically driven refrigeration system, but instead of heating a room they are heating water.

Heat pump water heaters work better in warmer weather as their efficiency is lower in colder outdoor temperatures. Heat pumps are not suited to climates where regular freezing or very cold conditions are experienced. This is not an issue in the Ausgrid service area. Some heat pump water heaters come with an electric element as a booster to operate when outdoor temperatures are low.

1.3 Controlled load tariffs for hot water systems

Controlled load (off peak) tariffs have been in existence in NSW for more than 50 years and currently there are over 1.3 million customers in NSW taking advantage of these cheaper tariffs.

What is a controlled load tariff?

A controlled load tariff is an electricity charge that applies to the energy consumed by an appliance that is measured separately to the rest of a households electricity supply and is controlled so that it runs outside peak times (e.g. overnight). Domestic hot water systems make up the vast majority of the appliances connected to these tariffs, and the times of electricity supply is determined by network service providers.

Ausgrid has two controlled load network tariffs (Controlled Load 1 and Controlled Load 2), and these are marketed by electricity retailers to customers with different names (e.g. Off Peak 1 or Off Peak 2). A summary of the controlled load hours of supply and system size eligibility are contained in Table 2.

Table 2 – Controlled Load tariff eligibility and conditions

Tariff	Controlled Load 1	Controlled Load 2
Hours of electricity supply	Electricity supply is available overnight for at least 6 hours between 10pm and 7am.	Electricity supply will be available for at least 16 hours a day, and generally off between 5pm and 8pm.
System size	Hot water tank must be 250 litres or greater	Hot water tank must be 100 litres or greater

The Controlled Load 2 tariff is slightly more expensive than the Controlled Load 1 tariff and is suitable for larger households or households with small hot water tanks. The EnergyAustralia residential electricity rates for the Ausgrid network from 1 July 2016 are shown in Table 3 comparing the prices for controlled load tariffs to other continuous supply tariffs (time-of-use or block tariffs).

Table 3 – EnergyAustralia electricity prices for residential customers in Ausgrid's network

Energy usage prices (including GST)	EnergyAustralia Standing Offer	EnergyAustralia FlexiSaver Home
Controlled Load 1 (c/kWh)	9.53	7.78
Controlled Load 2 (c/kWh)	13.31	10.86
Domestic All Time - Block 1 (c/kWh)	26.73	21.81
Domestic All Time - Block 2 (c/kWh)	26.12	21.32
Domestic All Time - Block 3 (c/kWh)	25.53	20.83
Time of Use – Peak (c/kWh)	53.99	44.06
Time of Use – Shoulder (c/kWh)	21.62	17.65
Time of Use – Off Peak (c/kWh)	12.04	9.82

How is controlled load managed?

Traditionally, controlled load tariffs have been implemented by electricity network providers by installing switches at the customer's meter board that control the electricity supply to a dedicated hot water circuit that is separately metered.

In NSW, the majority of this load is controlled via 'ripple' signals sent along the power lines from equipment located at network zone substations. These ripple signals activate the switches located at the customer's meter board turning on or off electricity supply to the dedicated electrical circuit for the hot water system. In some situations, time switches are used as an alternative to the ripple switches.

1.4 Impact of electric water heating on peak demand

As discussed in Section 1.1, peak demand prompted by very cold or very hot weather events results in large increases in electricity usage and network operators must plan, operate and build network infrastructure to supply reliable and safe electricity to customers on these peak demand days.

What is the contribution of domestic water heating to peak demand?

To better understand the contribution of electric water heaters to peak demand, the load profile of uncontrolled electric water heaters was analysed to predict the average contribution to peak demand in winter and summer. Figure 3 shows the estimated uncontrolled average load profiles of electric hot water systems at residential premises on cold days (winter) and hot days (summer) in 2014. These profiles were derived from interval meter data for dedicated hot water system electrical circuits for 1887 residential customers.

Figure 3 indicates that the load contribution of uncontrolled electric water heaters during network peak conditions is around 200-250 Watts per customer in summer and around 500-600 Watts per customer in winter.

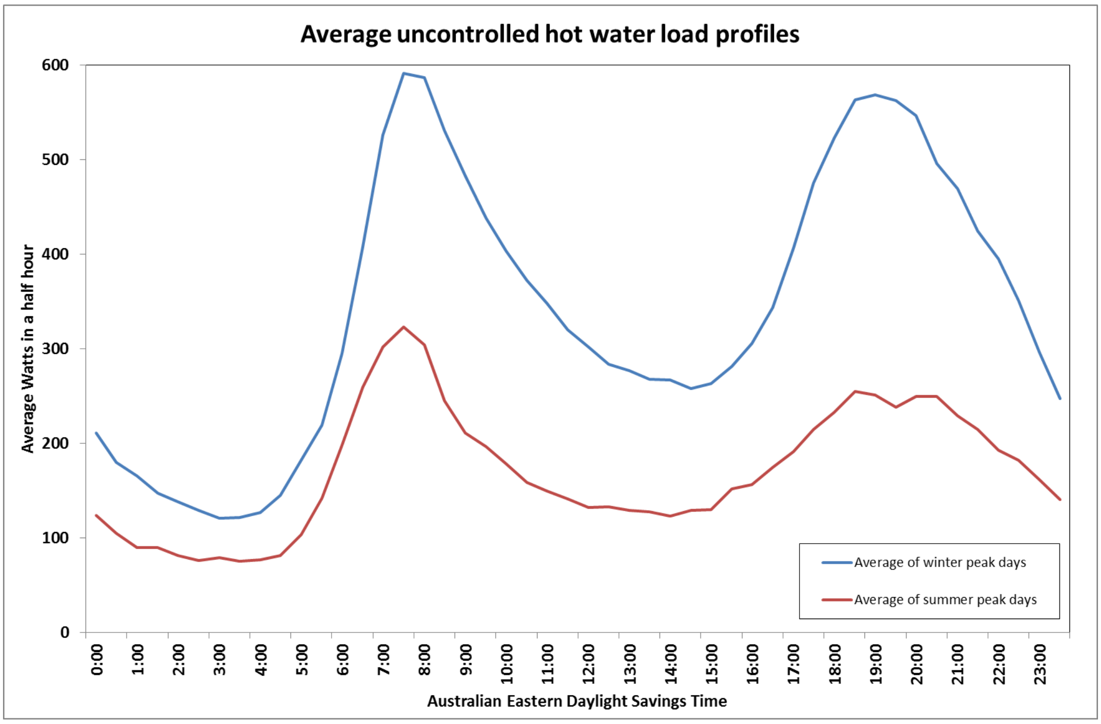


Figure 3: Residential electric hot water load profiles during summer and winter peak days

How effective is hot water load control at reducing peak demand?

Because of the high penetration of electric water heaters and relatively high electrical load, controlling residential electric storage water heaters to operate outside peak times is one solution which can be used to reduce winter and summer peak demand. By switching off electrical supply to this load during peak times and restoring this electricity supply later in the evening, this electrical load can be shifted.

Electric hot water storage systems provide an existing thermal heat store and, provided the cylinder is suitably large and well insulated, allows the heated water to be stored and used later when it is needed during peak times. The thermal energy storage characteristics of hot water systems lends itself well to the application of load control and consequently, there is wide spread take up by customers as evidenced by Ausgrid's 500,000 residential customers on controlled load tariffs.

Across Ausgrid's network area we estimate that our controlled load tariffs contribute to reducing peak demand at the system level by around 300 MW in winter (approximately 6% of system peak load) and around 100 MW in summer (approximately 2% of system peak load). On a localized level, where there is a higher penetration of residential customers on controlled load tariffs the peak demand reductions can be higher as a percentage of total load experienced by an asset. For example, the Jannali zone substation (Figure 2) has 7,000 controlled load customers reducing summer peak demand by 1.4 to 2.1 MVA (4 to 6% of peak) and winter peak demand by 3.5 to 4.2 MVA (11 to 13% of peak).

The effects of restoring the electricity supply to controlled load customers can be clearly seen on the zone substation demand profile shown in Figure 2 for Jannali zone substation. In particular, when electricity supply is restored to groups of controlled load customers at around 11pm and 1am the increase in load can be seen. The restoration of this load needs to be carefully managed and is currently controlled by networks. Spikes in load can occur on average or low load days but these load spikes are significantly lower than the electricity demand experienced on the hottest summer and coldest winter days. See for example the peak day loads that occur around 6 to 7pm in winter and summer for the Jannali zone substation (Figure 2) before the restoration of controlled load at 11pm and 1am.

1.5 Demand response standard for electric water heaters

AS/NZS 4755 is the Australian Standard defining the framework for demand response capabilities and supporting technologies for electrical products. The standard is intended to enable standardized modes of controlling large electric residential appliances (e.g. air conditioners, pool pump controllers and electric water heaters) by remote agents. A remote agent could be a network service provider or other market participant such as a third party aggregator or electricity retailer.

Due to their contribution to peak demand and inherent ability to store and release thermal energy over time, electric storage water heaters have long been targeted for residential load control solutions such as the existing controlled load tariffs which have been widely accepted by customers across Australia (most widely in NSW and QLD). Traditionally, controlled load tariffs have been implemented by electricity network providers by installing switches at the customer's meter board that control the electricity supply to a dedicated hot water circuit that is separately metered.

The demand response standards take a different approach, where a standardized demand response interface is built into the electrical appliance and via a Demand Response Enabling Device (DRED) connected to this interface a set of standardized appliance Demand Response Modes (DRM) can be activated. A summary of the demand response modes for electric water heaters is described in Table 4.

Table 4 – Australian Standard demand response modes for electric water heaters (AS4755.3.3)

Demand Response Mode	Description of Mode Operation
DRM1	No electric heating of water
DRM2	When heating water, energy consumed shall be between 40% and 60% of reference value
DRM3	When heating water, energy consumed shall be between 60% and 80% of reference value
DRM4	The water heater goes into a higher storage mode operation

This Australian Standard 4755.3.3 was first published in January 2014 and is a voluntary standard where compliance is satisfied by providing DRM1 only. At the time of publishing this report, Ausgrid was not aware of any electric water heaters being offered on the market that have the AS4755 demand response interface built into the hot water system appliance. Note however that no thorough market review had been conducted.

1.6 Overview of load control hot water projects

Over the period from 2011 to 2015, three hot water projects were implemented to explore new ways of reducing peak demand from residential electric hot water systems. The projects had different drivers and objectives which are described in more detail in sections 2 to 4.

An overview of the three projects is described below:

Project 1: Control of small hot water systems

This project (Section 2) aimed to explore the technical and practical considerations for controlling small hot systems (less than 100 litres) directly at the appliance within the home rather than through a controlled load tariff arrangement. A further objective was to test customer response issues for limiting the electricity supply to small hot cylinders on an occasional basis to determine whether customers were still satisfied with hot water system performance.

Project 2: Subsidised controlled load connections

This project (Section 3) aimed to explore new ways of getting more customers to connect their eligible hot water systems to Ausgrid’s existing controlled load tariffs through an offer for a subsidised meter installation. A key objective of this project was to test different marketing approaches to achieve cost-effective take-up rates. An extension to this project involved partnering with the NSW Land and Housing Corporation to test a subsidised controlled load connection offer directly to social housing tenants.

Project 3: Controlled Load 2 summer scheduling

This project (Section 4) aimed to explore and implement load schedule optimisation for controlled load 2 customers for achieving peak demand reductions during the summer afternoon period.

2 Control of small hot water systems

This project aimed to test the potential for a demand management solution involving remotely controlling the power supply to small electric hot water systems that are not eligible for a traditional controlled load tariff. An important part of the project was to test take-up rates for different combinations of marketing message formats, channels and incentive levels.

2.1 Project background

Historically small electric storage hot water systems (less than 100 litres) have not been eligible for connection to Ausgrid's Controlled Load 1 and 2 tariffs. As they have less hot water storage capacity, small hot water systems would not provide the typical customer with continuous hot water under the terms and conditions of Controlled Load 1 or 2 tariffs.

Another factor that has challenged the ability to control small hot water systems is that typically these systems are often in apartments or townhouses where the hot water circuits are not generally wired back to the meter board where the controlled load equipment and meters are located. This makes the costs involved with installing a dedicated hot water electrical circuit and control device to the meter board prohibitive.

We estimate there are about 300,000 customers in Ausgrid's network area with small electric storage hot water systems (less than 100 litres), predominantly in older apartments. In recent years, there has been a trend for new apartment buildings to install gas hot water systems, particularly since the introduction of the BASIX policy for new multi-unit dwellings in NSW around 2005/2006.

2.2 Project objectives

The primary objectives of this project were to determine the level of technical and financial viability for the control of small hot water systems (less than 100 litres). The specific objectives were to:

- determine control times for small hot water storage systems that would provide satisfactory customer acceptance.
- determine the customer response to various marketing offers and what level of marketing effort would be needed to achieve various take-up rates. This included testing the relationship between customer take-up rate and the size of monetary incentive offered.
- determine the level of diversified demand reduction per customer.

2.3 Project results

The project was conducted in three progressive phases. The first phase involved a small staff trial to test the workability of controlling small hot water systems. The second phase was a market research phase aimed to improve understanding of customer responsiveness to various incentive offers and including various technology applications. The third phase was a customer trial targeted in a select geographical location of the Ausgrid network area. The results from each phase of the project are presented in the following sections.

2.3.1 Phase 1: Pilot trial

The pilot trial involved installing a time switch with a bypass button on the hot water electrical circuit at the homes of ten Ausgrid staff members. The time switches were set to switch off the electricity supply to the hot water system for four hours a night on three weeknight evenings. The bypass button allowed participants to override the timer if needed. Figure 4 shows the average load of a single small hot water system over 4 weeks on weekdays with and without load control between 5pm to 9pm in the evening.

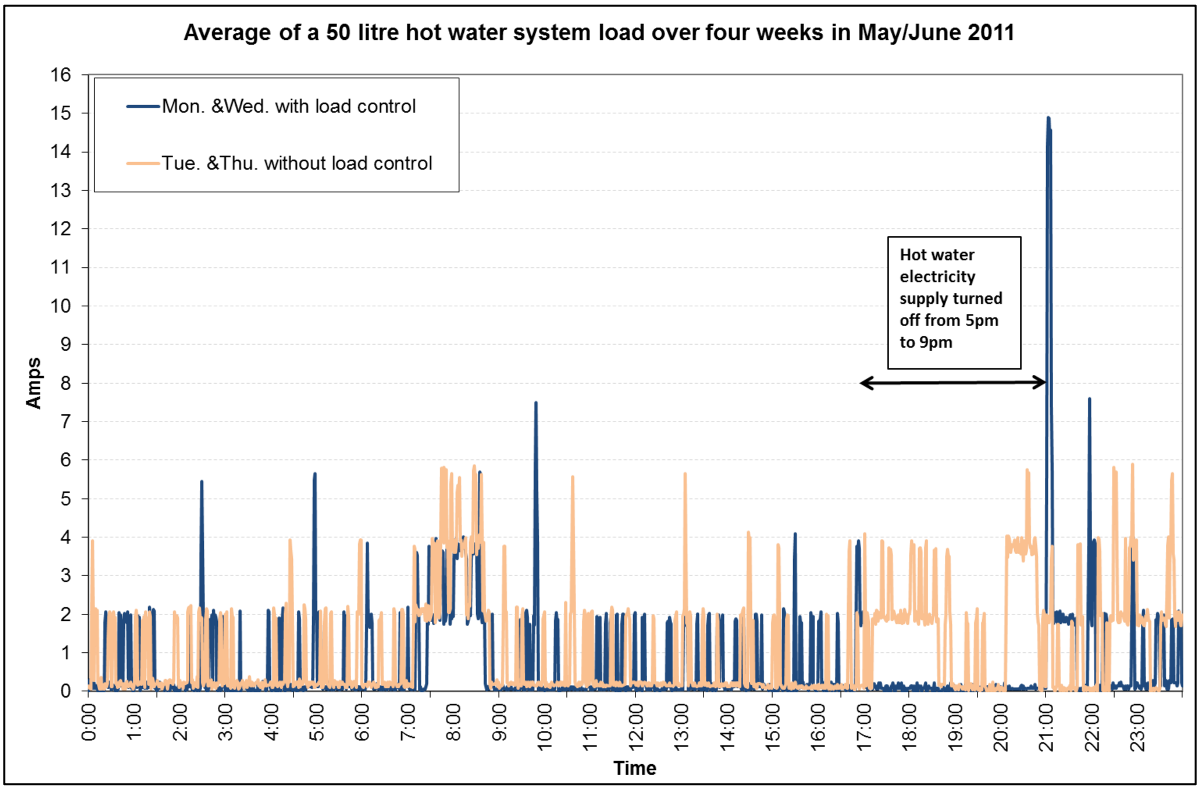


Figure 4: Load profiles of small hot water cylinders with and without load control

The pilot trial tested primarily the workability of controlling the small hot water systems. As the majority of installations passed the customer experience (workability) test, we evaluated the data from the trial to determine a range of results including the peak demand impact using the metering data (before and after control), as well as the percentage of time the override button was used. Results from the pilot trial indicated that there were no times when the override button was used.

2.3.2 Phase 2: Market research

As the pilot trial showed that it was workable to control small hot water systems, we proceeded to the next phase of the project which was focused on conducting market research to better understand and refine the details for making a customer offer.

An external company was engaged to conduct a market survey with 400 respondents. The survey criteria included:

- respondents used electricity to operate their hot water system (not gas)
- all respondents lived in either a unit or semi-detached duplex or townhouse (freestanding houses were excluded as they typically have large hot water systems).
- all respondents were solely or jointly responsible for paying the energy bills for the household

The results of the survey indicated that a reasonable customer response rate would be achievable with a moderate amount of marketing effort. However, it was recognized that the practical results can vary notably from the responses collected from the survey. A snapshot of some of the key results of the survey is shown in Figure 5, which indicates that customer take-up rate of a load control offer is highly sensitive to the monetary reward offer.

Key Insights

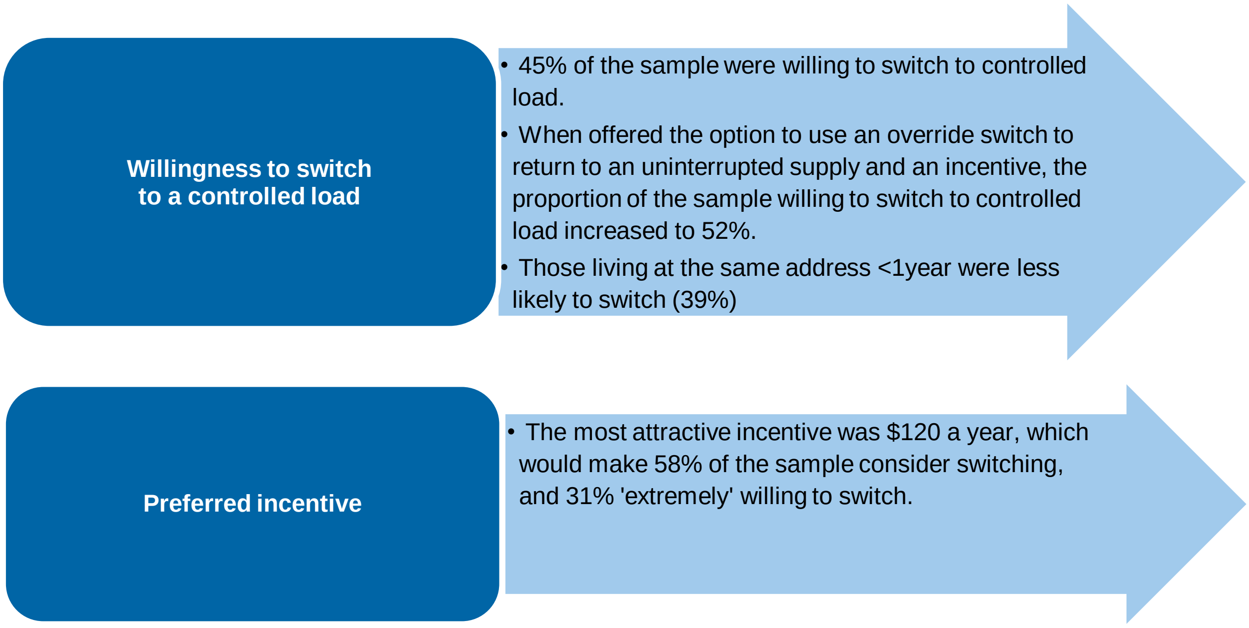


Figure 5: Market survey results for dynamic load control of small hot water systems

Motivations

Of those who were willing to allow remote switching, the most popular reason was that they thought it would help save on costs and reduce their energy bills. Of those who were not willing to allow remote switching, the most common reason was that they did not want to lose control over the water supply and considered it inconvenient.

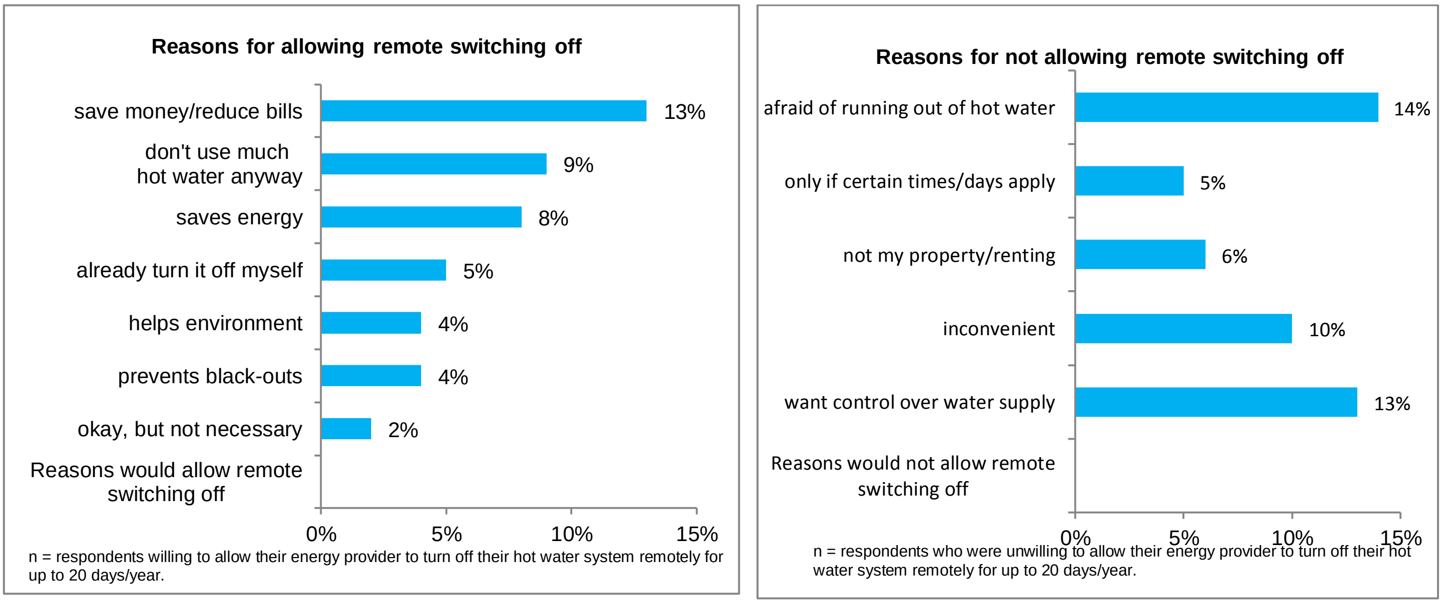


Figure 6: Motivations for allowing and not allowing switching off hot water systems

2.3.3 Phase 3: Larger customer trial

Following the pilot trial and positive market survey results which indicated that a satisfactory customer take-up rate could be achieved, Ausgrid undertook a larger customer trial.

The third phase involved approaching the general public in a selected area of the Ausgrid network area with the aim of obtaining up to 100 participants. The first task undertaken was to establish the criteria for area selection and to design a marketing approach.

The area selected had a reasonably high density of apartments and included customers in the Sydney suburbs of Chatswood, Artarmon and Lane Cove; all supplied by Chatswood zone substation. To better target communications towards customers likely to have a small electric hot water system, it was decided to make offers to customers who resided in apartments with a higher than average annual electricity consumption. This higher than average annual electricity consumption was used as an indicator that the apartments would be more likely to have electric hot water systems than gas hot water systems.

Customer marketing approaches

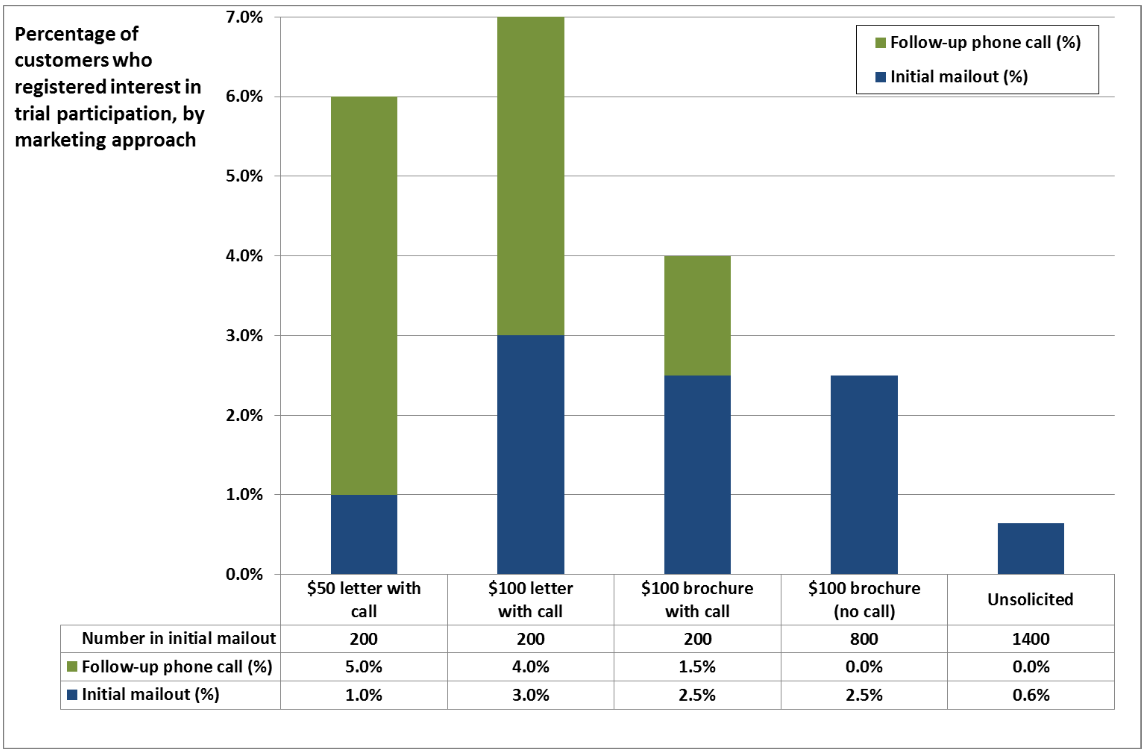
Letters and marketing brochures were sent out to 1,400 customers during winter 2012 and customers were asked to register their interest by filling out an online form or to call a dedicated phone number. To be eligible for participation customers needed to be the property owner and have an electric hot water system connected to continuous supply (not controlled load). The incentive was paid to the customer via cheque after the load control switch was fitted to their hot water system. Refer to Appendix A and B to see examples of the customer letter and marketing brochure which were sent to customers.

The marketing approaches were designed to test the take-up rates achieved using two different incentive amounts of $50 and $100, as well as testing a personally addressed letter versus a more expensive marketing brochure (which was also personally addressed). Follow up phone calls were also used to test their effect on the various take-up rates.

Customer response to offer

Of the customers contacted via the various methods, 64 registered their interest in participating (4.6%). In addition to those customers contacted via letter or brochure, an additional 9 customers were not directly contacted and heard about the offer by other means. Figure 7 shows the final results from the customer registrations categorized by the different marketing approaches used. Although the total sample sizes used in the program are considered small the following observations were made in regards to the results of the different marketing approaches tested:

- The simple letter was slightly more effective than the brochure for the same level of incentive of $100 and with no follow up phone calls.
- The $100 incentive was three times more effective at generating customer participation than the $50 incentive with no follow up phone calls.
- However, when follow up phone calls were considered the gap between the two incentive levels of $50 and $100 was much smaller, indicating that although incentive levels are important, marketing effort makes a significant difference in program take-up. Extra marketing effort, however, also results in higher program costs so both incentive levels and marketing costs need to be considered during program development.
- A total of 9 of the initial 64 customers (14%) who registered interest in the program were not directly contacted via letter or brochure and heard about the trial by other means.



	$50 letter with call	$100 letter with call	$100 brochure with call	$100 brochure (no call)	Unsolicited
Number in initial mailout	200	200	200	800	1400
Follow-up phone call (%)	5.0%	4.0%	1.5%	0.0%	0.0%
Initial mailout (%)	1.0%	3.0%	2.5%	2.5%	0.6%

Figure 7: Trial registrations of interest by marketing approach

Key Insights

A letter with follow up phones calls was the most effective marketing approach in encouraging customers to register their interest in the offer, with a 7% strike rate.

Barriers to customer response

There was a significant difference between the actual customer response to the offer (4.6%) and the results from the Phase 2 market research which indicated that 45% to 58% of respondents would consider taking up a load control offer for their small hot water system.

The reasons for such disparity between the market research responses and actual uptake may be due to the following factors:

- response bias occurring in the market research survey where the respondent consciously, or subconsciously, gives responses that they think that the interviewer or survey owner wants to hear. They may be likely to answer positively on questions that ask about intention to participate
- non-representative sampling that was used in the survey. The respondents were sourced from a survey panel, rather than a random sample selection of the population which may have more closely reflected the attitudes of the proportion of customers that were selected in the phase 2: customer trial.
- Sample size may also have been an issue, as the larger the sample size, the smaller the sampling error
- Measurement of actual uptake is not comparable with the “interested to participate” question asked in the survey, as questions that could have indicated certain barriers or challenges to participate were not canvassed in the market research survey, which may have influenced respondents attitudes towards expressing their interest to engage in a program. Refer to Figure 8 below. In addition, the unpredictable nature of the actual challenges which eventuated would have been difficult to build into the survey design without prior experience.

The follow up phone calls to around 600 customers also revealed some of the barriers to program take up (see Figure 8). The various reasons for customers not wishing to participate included:

- lack of customer interest in the offer (28%). Customer feedback included views that the trial was “too much hassle” and wanted to “leave it as is” and “don’t think it’s worth it”.
- customers who were interested but did not qualify as they were renting (18%)
- those who were worried about the size of the incentive (4%), running out of hot water (3%) or having to be home for the installation (1%).
- other (33%). When looking more closely at the ‘other’ reasons for not taking up the offer, as shown in Figure 8, it was found that many people wanted more time to read/consider the offer. Comments included: “need to talk to partner”, “haven’t read it yet”, “want to do it in my own time”, and “thinking about it”. **This indicates that the short offer period and structure of the trial was a deterrent to the take-up rate.**

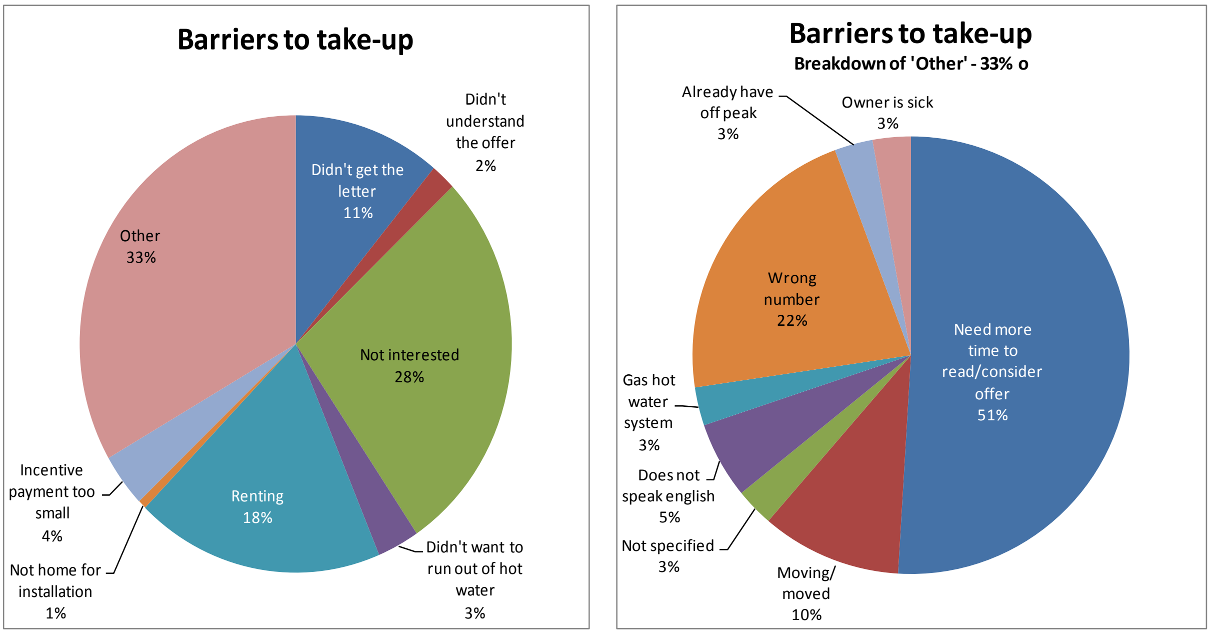


Figure 8: Customer barriers to participation

Customer participation results

Of the 64 customers who responded to the offer and registered their interest in participation only 44 customers (69%) went ahead with the installation of the load control switch due to a range of factors. The final participation rate was 3.1% (44 out of 1400 customers initially contacted).

The main reasons for cancelled installations (see Figure 9) was the difficulty experienced by the installer in contacting the customer (12%), jobs cancelled by the customer (9%) and customers ineligible for the trial as they were not the property owner (6%). There were also a smaller number of customers who had gas hot water systems (2%) and who were offered a connection to controlled load (2%) via an alternate hot water trial.

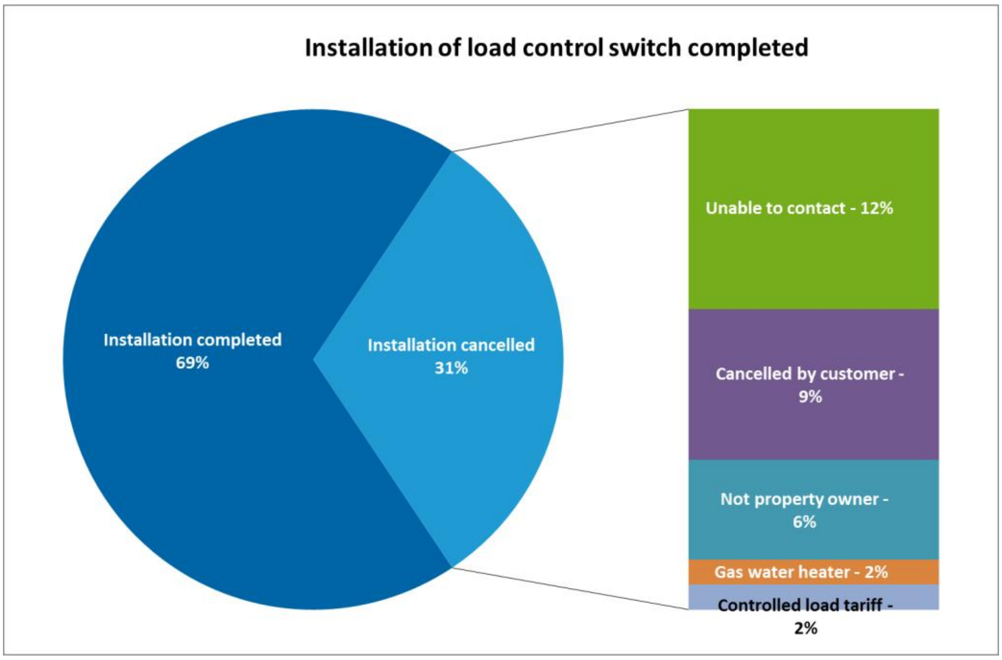


Figure 9: Final participation rates in the trial and reasons for not completing

Most of the load control switch installs were complete before the end of winter 2012. A single customer opted out early within days of the installation having been completed – possibly so as to receive the incentive payment.

Peak demand reduction results

The main trial period for customers was two winter periods (winter 2012, winter 2013) and one summer period (summer 2012/13). The control switches were installed on the electrical circuit to customer's hot water system and the power supply was turned off for 4 hours between 5pm to 9pm (AEST) on one weekday per week for the entire 18-month trial period.

A separate electronic interval meter was installed on a selected number of the customer installations to measure the hot water system electricity demand profile. Figure 10 shows the aggregated and averaged load profiles for summer and winter weekdays when the load control switch was operating and when it was not operating.

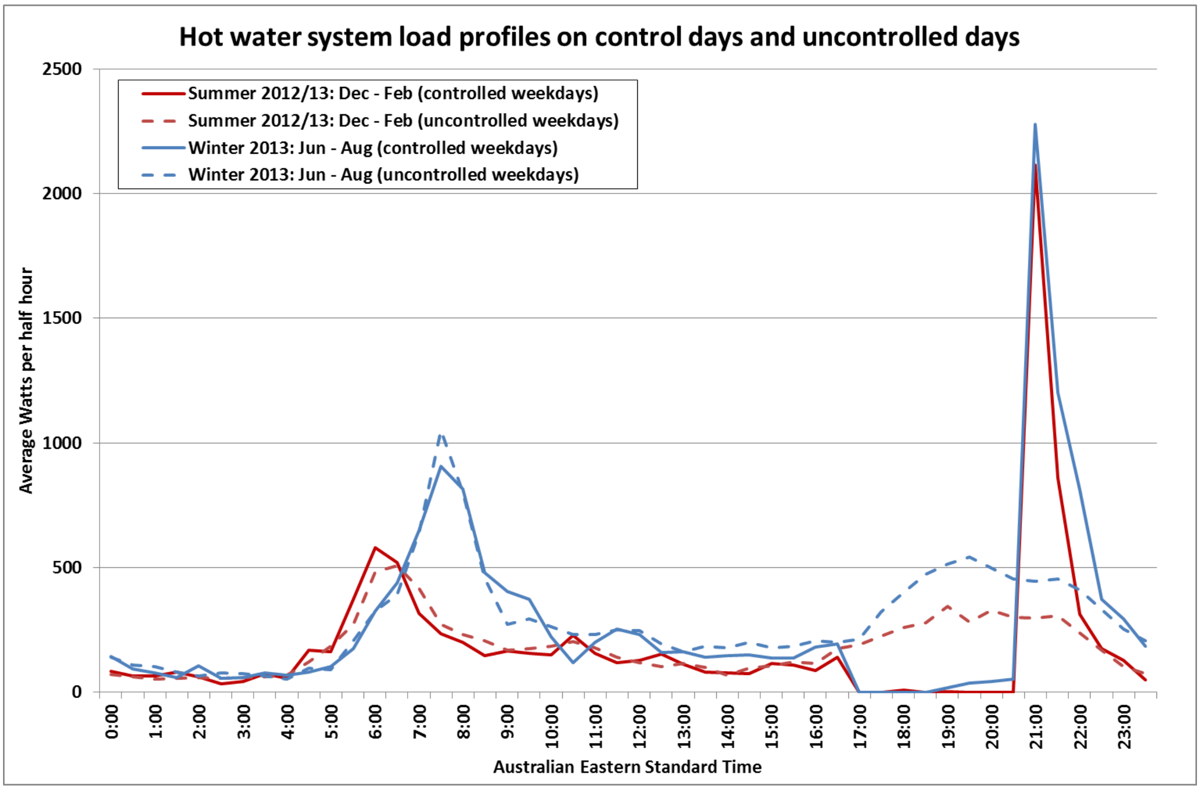


Figure 10: Averaged hot water system load profiles for 17 customers in the trial

Based on the results from these 17 customers, the peak demand reductions were calculated to be on average 274 Watts per customer on a summer weekday and on average 407 Watts per customer on a winter weekday during the 5pm to 9pm control period. This level of peak demand reduction per customer is quite promising and shows that reasonable demand reductions can be achieved by occasionally switching off electricity supply to a customer's small hot water system. The large restoration spike of load that occurs at the end of the control period occurs because all cylinders were scheduled to switch back on at 9pm, but in practice this would be managed by staggering the restoration of electricity supply.

During the trial, no negative feedback was received from the participants in regards to inconvenience caused by switching off the hot water cylinder and running out of hot water during the control period.

Key Insight

The results suggest that customers will tolerate the occasional control of their small hot water system for several hours on peak days for a modest financial incentive.

Prototype demand response enabling device

For the customer trial, time switches were used to control the electricity supply to the hot water system. However, the trial also developed a prototype load control device that could be remotely controlled more dynamically.

This prototype load control device utilised the mobile phone telecommunications network to dynamically control one of the participant's hot water systems via text message. This was done as a proof of concept development and only one device was commissioned for this purpose. The prototype was able to turn off the hot water system electricity supply via a relay installed on the hot water system electrical circuit thereby simulating the Demand Response Mode 1 (DRM1) functionality as described earlier in Table 4 (page 8) for the Australian Standard AS4755.3.3 for the demand response for electric water heaters.

Further development of this prototype load control device has continued under Ausgrid's *Cool*Saver programs where these demand response enabling devices have been used to activate the power saving modes of residential air conditioners on peak demand days using the AS4755 interface. Further information on Ausgrid's *Cool*Saver trials is found at www.ausgrid.com.au/dm.

2.4 Key project outcomes

This project has provided significant knowledge around the customer take up and acceptance of the load control of small hot water systems that are not eligible for Ausgrid's existing controlled load tariffs.

1. Customers reported no complaints due to insufficient hot water when the electricity supply to their small to medium hot water cylinders was switched off for 4 hours on the occasional day.
2. Although override was available, customers rarely used the option during load control events.
3. A simple directly addressed letter with follow-up phone call offered the highest customer take-up rate.
4. The higher incentive level of $100 offered only a modest improvement in customer take-up rate over the $50 incentive offer.
5. The average peak demand reductions achieved was about 270 Watts per system in summer and about 400 Watts per system in winter.
6. Total program costs including customer engagement and acquisition costs (e.g. marketing materials or customer contact) and the cost of supply and installation of the load control devices were high per kilowatt of demand reduction.

2.5 Demand Management solution viability

Analysis of customer data for the Ausgrid network area showed that there are around 50 zone substations with greater than 5,000 apartments, predominantly in the Sydney area. Some of the larger zone substations supply 10,000 to 20,000 apartments. Although a proportion of these may have gas hot water systems, many older apartment areas will have smaller hot water systems. Assuming a potential take up rate of 6% for an optimized marketing approach it might be possible to recruit up to 600 to 1200 customers in a single zone substation area on to a small hot water load control offer. This equates to a winter peak demand reduction of 240 to 480kVA or a summer peak demand reduction of 160 to 320kVA. These demand reduction values may be significant enough to be considered as part of a suite of demand management solution to address a network deferral project.

However, the costs per kilowatt were estimated to be greater than $2,000 per kVA primarily due to the upfront cost of the supply and installation of the load control device and direct customer incentives. The upfront costs would need to reduce significantly for this type of demand management solution to be cost-effective when compared to other viable network or non-network solutions.

A viable pathway is for the AS4755 demand response interface to be introduced by hot water system manufacturers. Standardized interfaces, control devices and control modes built into the hot water system could provide a lower cost installation option for controlling small hot water systems. However, a significant quantity of hot water systems that are 'demand response ready' and installed in customer homes would be required for such a solution to offer a material total peak demand benefit for a network investment deferral.

When AS4755 compliant hot water systems become available, Ausgrid would consider revisiting this solution to confirm the viability and cost effectiveness of the solution.

3 Subsidised controlled load connections

This project aimed to develop and trial new marketing approaches and offers to influence customers to connect their eligible hot water systems to one of Ausgrid's existing controlled load tariffs rather than continuous supply electricity.

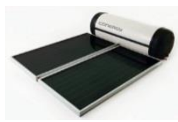
3.1 Project background

As mentioned earlier in the background (section 1), Ausgrid has around 500,000 customers with appliances connected to one of our controlled load tariffs. Since 2006, there has been a slow decline in the number of customers with a controlled load tariff with a total decline of around 6.5% over the 10 years between 2006 and 2016. This has mainly been due to a gradual shift away from electric storage hot water systems towards gas hot water systems and more efficient electric systems such as electrically boosted solar hot water systems and heat pump water heaters connected to continuous supply electricity.

However, we estimate that there are still up to 100,000 electric hot water systems in houses across Ausgrid's distribution area that are currently connected to continuous electricity supply that could potentially be connected to a controlled load tariff. These systems include electric storage systems (100 litres or more), electric-boosted solar systems and heat pump water heaters. These various electric water heaters can contribute up to 600 Watts to winter peak demand and 200-300 Watts to summer peak demand each year if left uncontrolled during peak times (Table 5).

There are higher electricity consumption requirements for heating water in winter when outside and water temperatures are lower, which means that peak demand contributions are also higher in winter.

Table 5: Average peak demand created by uncontrolled electric water heaters

Average peak demand created by electric hot water systems on continuous supply			
Type of system	Electric storage (>=100L) 	Solar with electric boost 	Heat pump 
Winter diversified peak demand	500 – 600 watts	300 – 400 watts	500 – 600 watts
Summer diversified peak demand	200 – 300 watts	50 watts	200 watts

*Diversified peak demand values estimated from interval metering data analysis of customer samples with known hot water system types

For a customer to connect their hot water system or other electrical appliance to a cheaper controlled load tariff, the electricity metering arrangement requires a separately metered electrical circuit with a load control device. The electrical works for installing load control and metering equipment and other associated electrical upgrades can be a significant upfront customer cost and is considered to be one of the barriers associated with customers not taking up these tariffs.

3.2 Project objectives

The subsidised controlled load connection project aimed to encourage customers to connect eligible hot water systems to an existing controlled load tariff (Off-Peak 1 or Off-Peak 2) by offering different subsidised connection offers.

This involved developing alternative ways to encourage existing customers in specific geographic locations to connect their eligible electric hot water system to one of Ausgrid's existing controlled load tariffs rather than continuous supply.

Specifically, the project would test different marketing approaches to offers of various levels of subsidy and measure the resulting effectiveness of the take-up rate of each approach.

3.3 Project results

This project was conducted in three phases. The first phase consisted of conducting market research to better understand the barriers for customers connecting existing large electric hot water systems (100 litres or greater) to controlled load tariffs and the potential customer take-up rates of a subsidised controlled load connection offer. The second phase involved making a subsidised connection offer to customers in several different geographic areas of Ausgrid's network area to see if a satisfactory take-up rate could be achieved.

The third phase aimed to explore an alternative customer acquisition approach which involved collaborating with NSW Land and Housing Corporation to offer NSW Housing tenants a subsidised connection offers with the objective of improving cost effectiveness.

3.3.1 Phase 1: Market research

The first phase of the project was conducted during mid to late 2011. In this phase, we explored why customers with large electric storage hot water systems were not currently connecting to controlled load and what barriers need to be overcome for customers to move to controlled load supply. In addition, research was conducted on the potential take-up rate of a 'flat fee' offer for customers to connect their hot water system to controlled load.

Figure 11 shows several key findings from the market research about the main customer barriers of switching to controlled load (off peak).

Key Insights

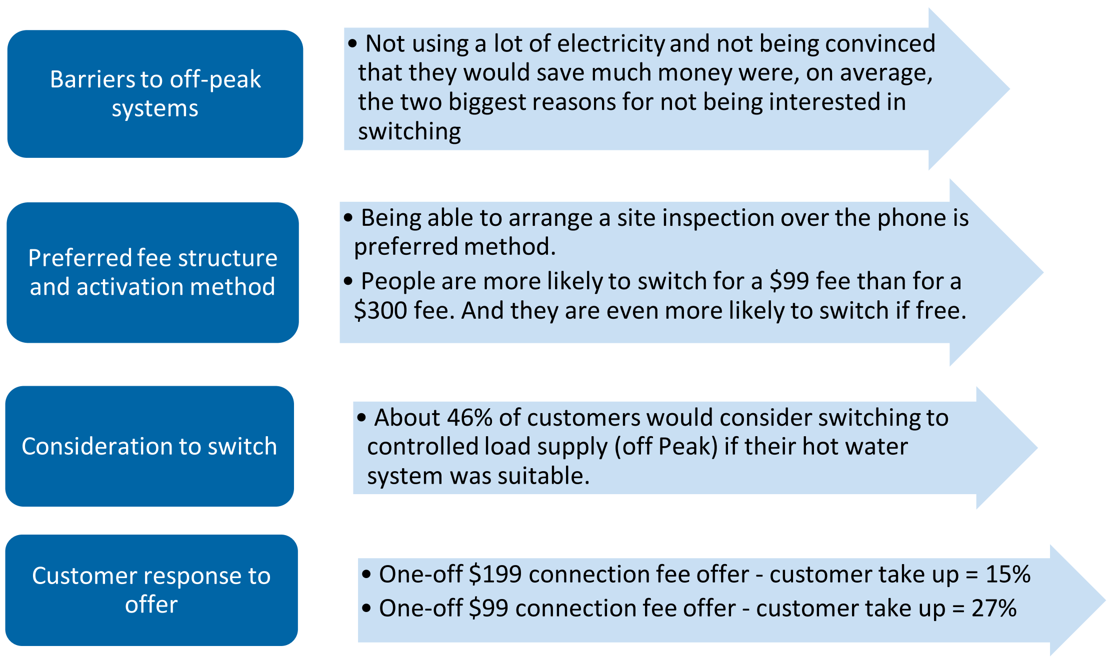


Figure 11: Market survey results

3.3.2 Phase 2: Subsidised connection customer offers

Four separate areas of the Ausgrid network area were chosen for the customer offer. These included suburbs in the Northern Beaches, Pennant Hills, Punchbowl and Sutherland areas. Marketing of the offer was targeted to customers residing in freestanding houses without an existing controlled load tariff and with a higher than average electricity consumption. A total of 14,800 customers across the four areas were approached via letter or a marketing brochure.

Customer marketing approaches

Based upon results from the market research phase, marketing materials were developed in order to test the actual customer take-up rate to a 'flat fee' controlled load connection offer of $199 and $99. Similar to the small hot water project described in section 2, a personalized letter and a more expensive marketing brochure were developed to test which marketing approach was more effective. Refer to Appendix C and D to see examples of the letter and marketing brochure.

The estimated annual savings for connecting a hot water system to controlled load (off peak) was provided to customers in the letter and brochure. See Figure 12 for an example of the content contained in the marketing brochure sent to customers.

Connecting to Off Peak electricity could cut your hot water costs in half

If you have an electric hot water system (electric storage, solar or heat pump), you may be able to reduce your hot water costs by more than 50%. You can do this by connecting your system to Off Peak electricity supply with a new meter. By switching to an Off Peak option, your system will only heat water at certain times of the day, saving on your energy bills.

How does it work?

For a limited time, we're offering a discounted installation fee of $199 (normally around $419) to switch to a suitable Off Peak electricity supply. Here's how Off Peak saves you money.

Electric hot water systems connected to continuous electricity supply ordinarily receive power 24 hours a day. This can cost more than 23c per kWh and up to three times more than Off Peak electricity supply, which heats water outside peak times.

On Off Peak 1 (around 9c per kWh, suitable for 250 litre tanks or larger), your system will only heat water overnight between 10pm and 7am. The running costs are similar or may even be cheaper than natural gas.

On Off Peak 2 (around 12c per kWh, suitable for 100 litre tanks or larger), your system will heat water for at least 16 hours a day. Off Peak 2 costs slightly more than Off Peak 1.

Off Peak 1 offers the best savings, but if you find you run out of hot water during the day, you can move to Off Peak 2 and there is no charge for switching.

Keep saving* year after year

In the first year, you'll want to take into account the installation fee. But as you use Off Peak year after year, the savings* really start to add up.

Use this table to compare savings* when swapping to Off Peak hot water from continuous electricity supply.

Estimated cumulative savings

	Electric Storage		Solar with Electric Boost		Heat Pump	
	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2
Year 1	$291	$178	No saving	No saving	$41	No saving
Year 2	$781	$555	$143	$65	$281	$179
Year 3	$1,271	$932	$314	$197	$521	$368
Year 4	$1,761	$1,309	$485	$329	$761	$557

Figure 12 – Example of subsidised off peak connection offer and cumulative bill savings

For most customers (84%), a flat fee of $199 (~$220 subsidy) was offered for the service of connecting their hot water system to a controlled load tariff, which included the meter installation, associated electrical works and required documentation. In addition, a smaller share of customers (16%) were offered a $99 flat fee (~$320 subsidy), representing better value to the customer. Some customers also received follow up phone calls one to two weeks after the mailout to check awareness of the offer, answer questions and encourage program registration. Customer registration was via the Ausgrid website or contact centre.

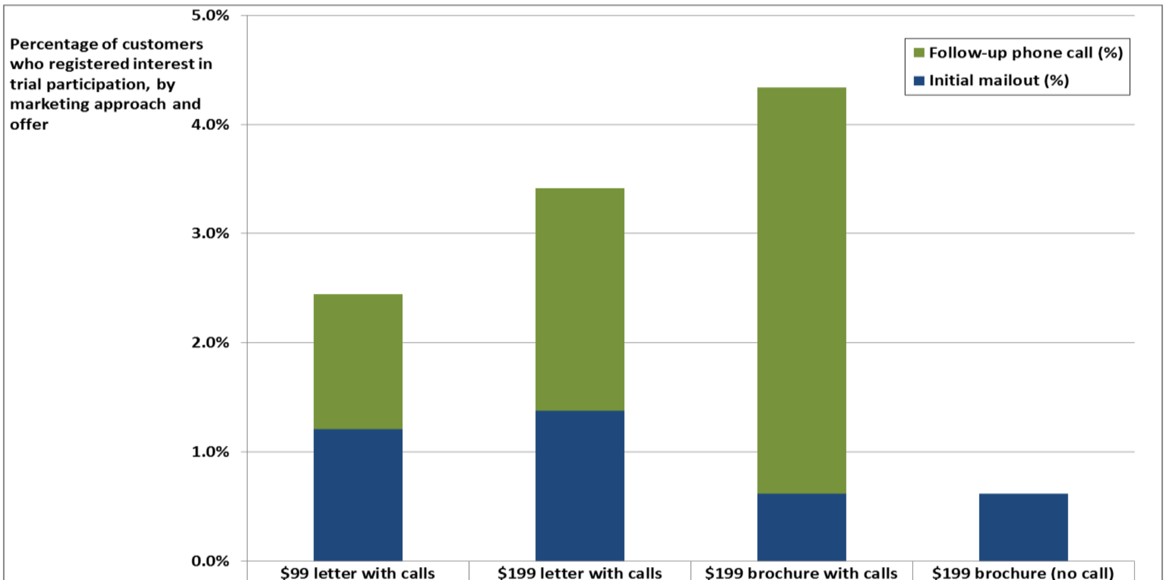
Customer response to offer

The total number of customer registrations after follow up phone calls was 282 (or 1.9%) and Figure 13 compares the results from the various marketing approaches (letter or brochure) and offer levels ($199 or $99). Some of the key observations were;

- The letter (1.4%) was more than twice as effective at influencing customer registrations when compared to the brochure (0.6%) for the same offer level of $199 with no follow up phone calls.
- There didn't appear to be a significant difference in customer registration rates for the $199 offer compared to the $99 offer for customers who received a letter with no follow up phone calls.
- Similar to the small hot water trial (section 2), when follow up phone calls were taken into consideration the registration of interest increases significantly, more than doubling the customer registrations in this project.

Key Insight

Follow up phone calls was highly effective at improving the customer response rate.



	$99 letter with calls	$199 letter with calls	$199 brochure with calls	$199 brochure (no call)
Number in initial mailout	2400	2400	5000	5000
Follow-up phone call (%)	1.2%	2.0%	3.7%	0.0%
Initial mailout (%)	1.2%	1.4%	0.6%	0.6%

Figure 13: Actual take-up rates with and without follow-up call

Barriers to customer response

There was a significant difference between the actual customer response to the offer (1.9%) and the results from the Phase 1 market research which indicated that 15% to 27% of respondents would consider taking up the $199 or $99 connection offer. Similar to the small hot water systems project, market research surveys are useful to provide quantitative indications about general attitudes towards particular topics and issues, however they are not a good predictor of actual participation, namely because of differences in sampling representation, sample size errors and response bias that can occur when non-representative samples are selected.

Phone calls to around 800 customers helped identify some of the reasons for not taking up the connection offer, as summarized in Figure 14.

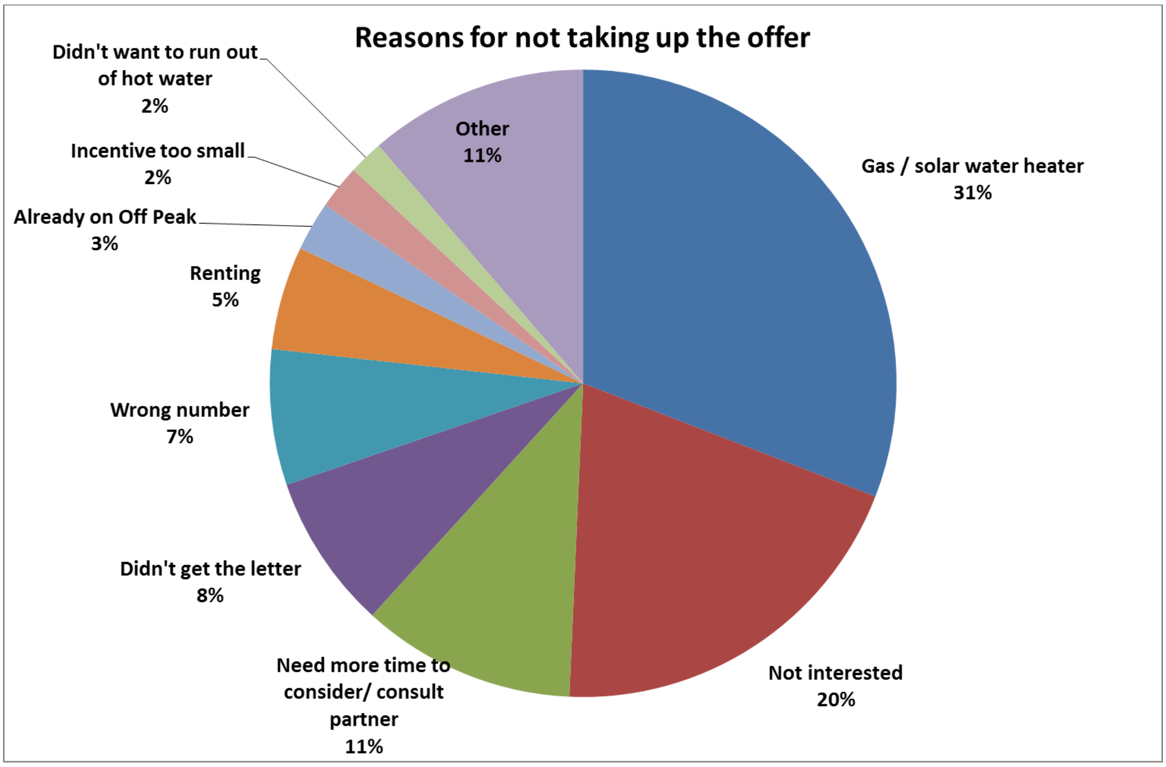


Figure 14: Reasons for not taking up the subsidised controlled load connection offer

As shown in Figure 14, when we review the reasons for not taking up the offer we found that:

- around a third of the customers who had received the offer had gas or solar gas hot water and were therefore not eligible to participate in the program. This highlights the difficulty in identifying our target audience when there is a lack of information on the type of hot water systems our customers currently have.
- there were also a number of misconceptions and information gaps that created barriers to take up. Customer feedback included “Ausgrid is not my retailer, I am with someone else”, “I already have off peak hot water” and “I don’t want my appliances to be faulty”. A large number of customers also wanted more time to consider the offer.

Customer participation results

Of the total 282 customers who registered their interest in taking up the subsidised controlled load connection offer, only 104 went ahead with the equipment installation which was just over one third of customers (37%) who registered. This gives an overall participation rate of 0.7% of the initial customer’s approached (104 of 14,800).

Of the jobs cancelled, one of the key reasons for cancelling was that customers were not prepared to pay the quoted amount for additional works/ upgrades required for non-standard and more complex installations. The flat fee connection offer applied to standard installations only. Other reasons included; the tank was smaller than 100 litres and therefore did not qualify for the controlled load tariff, customers took up the offer after it had closed, the site was not suitable and customers did not want to move to time-based pricing. The final results of customer participation rates from those who registered interest are shown in Figure 15.

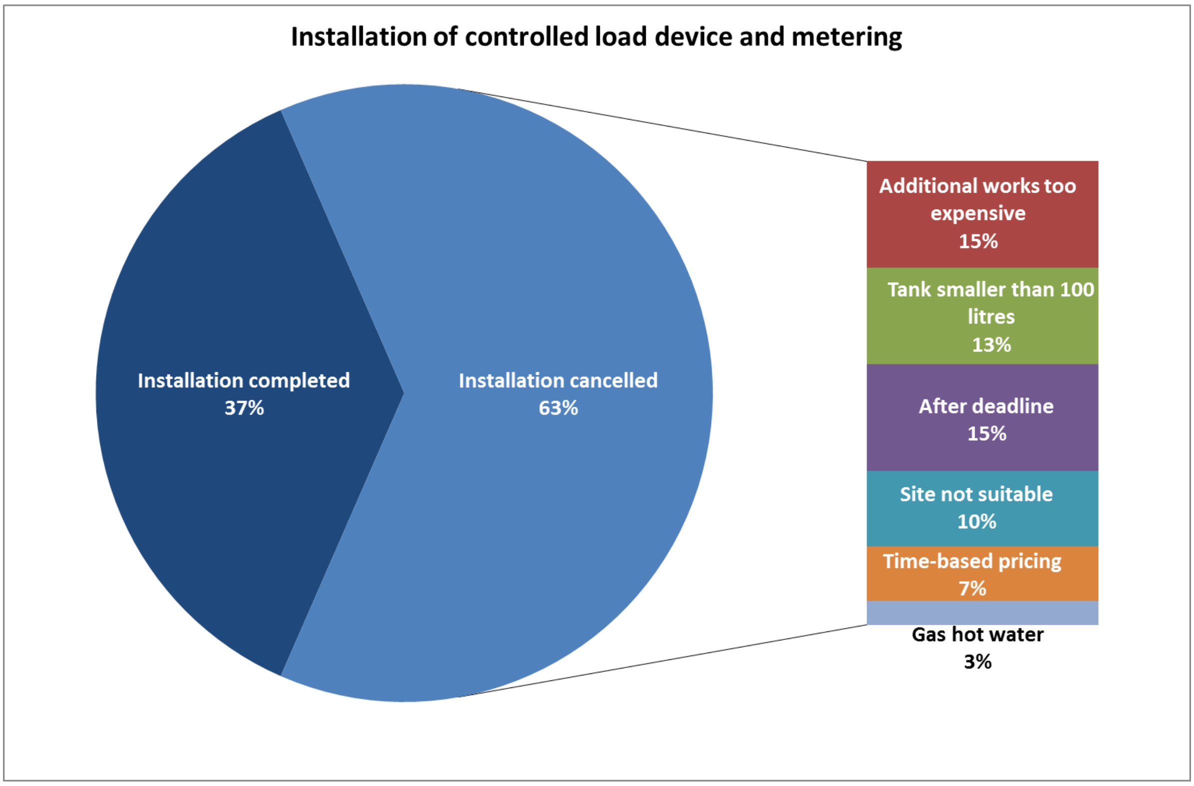


Figure 15: Final participation rates for the subsidised controlled load connection offer

From these results, one of the main lessons learned has been that there is a significant gap between making customer offers and then customers going ahead with an installation. Ausgrid is able to make initial contact with our customers to make an offer, but the limited resources available to project manage the trial and manage the individual requirements of some customers’ installations may be a contributing factor to slowing down the ongoing customer acquisition process that occurs once an offer is made. A deeper understanding has been gained about the resourcing and time allowance that is required through the customers’ engagement in the early stages of the trial, including providing customers time to consider the offer or refer to someone more qualified to provide information and clarify their understanding before proceeding.

3.3.3 Phase 3: Subsidised connection offers to NSW social housing tenants

Given the high cost of customer acquisition and relatively low take up rates of the phase 2 customer offer, an alternative approach was investigated to explore an alternate cost-effective customer acquisition approach. In addition, it was also desired to target an offer towards low income and vulnerable households where the reduction in electricity bill costs could make a bigger difference to reducing living cost pressures.

This alternative approach involved collaboration between Ausgrid and NSW Land and Housing Corporation (LAHC) who own and manage NSW government assets including 144,000 social housing properties across NSW. NSW LAHC hold details of the hot water system types and sizes at most of the properties they manage allowing a more efficient identification process of properties that have a large electric storage hot water system so are more likely to be interested in connecting to a controlled load tariff.

For this phase of the project, an agreement between Ausgrid and NSW LAHC was signed which allowed data sharing and identification of around 100 homes in three Sydney Local Government Areas that had a large electric storage system without a controlled load tariff. The distribution of letters, management of customer inquiries and scoping visits by an electrician and any associated electrical works for connecting hot water systems to a controlled load tariff was managed by NSW LAHC and Housing NSW.

A total of 127 potential customers were identified and contacted by letter, of which 79 (62%) expressed interest in taking up the subsidised controlled load connection offer. The high acceptance rate was considered to be primarily due to the initial offer made to customers which was a conversion to controlled load at no cost, provided that the costs of the electrical work were under a reasonable threshold. Of the 127 potential sites, 99 had no controlled load equipment in place and 28 had controlled load equipment already in place but with zero consumption recorded over a year indicating that the hot water system was no longer connected to the controlled load tariff.

Scoping visits by an electrician were conducted for all 79 sites and it was identified that while the stand alone cost of installing a new meter could be subsidised, the costs of the additional works required to achieve switchboard compliance at the majority of sites was too expensive. This meant that nearly all sites that did not already have controlled load equipment in place were deemed too expensive and above a reasonable level of subsidy (>$500). Similarly, apartment and townhouse sites were ruled out due to the fact that the hot water circuits are typically remote from the main meter board, making the electrical work necessary for conversion too expensive. These types of installations would be better suited to a load control offer similar to the small hot water systems project described in section 2 of this report. As a result of the costs associated with the additional electrical works, 69 of the 79 sites were found not to be feasible under this project's cost targets.

Key Insight

Additional costs for electrical work due to non-standard installations were a significant barrier to completion of installations for customers in both the Phase 2 and Phase 3 parts of the project.

Of the remaining 10 sites, 9 of the 10 interested customers with existing controlled load metering were reconnected at a minimal cost of about $100 per site. This represents 32% of the original 28 sites with existing controlled load metering and equipment, which is a satisfactory level of take-up for this sub segment of customers that were approached.

Overall, a total of 9 out of 127 customers approached (7%) reconnected an eligible size hot water system to the controlled load tariff. The results from this pilot indicate that there is potential for customers to reconnect to controlled load metering and equipment that is already present. However, the upfront metering and installation costs associated with installing a new controlled load metering circuit was cost prohibitive in the vast majority of cases even when a customer has an eligible hot water system size. This conclusion was also one of the findings in the phase 2 customer offer as evidenced by the result that 15% of customers who were interested in taking up the offer didn't go ahead with the final installation because of the additional cost.

3.4 Key project outcomes

This project has provided guidance on the take-up rates and typical barriers for customer take up of a controlled load tariff for their domestic hot water system. Methods for identifying customers with eligible hot water systems were tested as part of the project in order to better target marketing approaches and increase customer acquisition rates. Key lessons learned were:

1. Our limited knowledge about the type of hot water system at a customer's premises makes it difficult to target customer offers to those with eligible electric hot water systems. Even when a customer has an eligible hot water system for a controlled load tariff, there are a range of other factors that reduce the potential customer take-up of these tariffs.
2. The additional costs associated with electrical work for non-standard installations were found to present a barrier for a significant number of customers who registered interest in the offers but did not proceed with the installation of controlled load equipment.
3. Without follow-up phone calls, the personally addressed letters to customers were three times more effective at eliciting a customer response than sending the marketing brochure.
4. Follow up phone calls were found to be effective in increasing customer registrations of interest. For letters, registrations doubled and for the marketing brochure, registrations increased by a factor of six.
5. There was a modest increase in the take-up between the two levels of subsidies offered.
6. A key insight was the challenging nature of the sales process from making an initial offer to customers, booking installations and then following up with customers. Many customers would like to think through the offer, speak to someone qualified to provide more information – sometimes on more than one occasion, consider the offer and then be assured that they have the knowledge required to proceed to the next step. To adequately provide this level of customer support would have required additional project resources and additional costs.

3.5 Demand Management solution viability

Due to the low final take-up rates offered by this solution the predicted overall demand reduction for a typical network demand management project would be very low.

For example, a typical winter peaking zone substation in the Sydney area has around 2,000 to 3,500 houses without an existing controlled load tariff. Based on the results from the project and by optimizing the most effective marketing approaches an overall take-up rate of 2% might be achievable resulting in an overall winter peak demand reduction of between 25 and 42 kVA. Network deferral projects typically require reductions that are multiple megawatts, so for a 1 megawatt peak demand reduction requirement this demand management solution would only contribute 2 to 4% of the reduction. Furthermore, we estimate that the cost per kVA reduction would be in the range of $1000 to $1500 per kVA, which is much more expensive than other demand management solutions such as power factor correction, demand response from larger non-residential customers or embedded generation.

Consequently, this solution is unlikely to offer a viable demand management solution for a network deferral project at this time.

If conditions in future alter the expected effectiveness of such a solution (e.g. smart meters, other emerging technologies or improved customer targeting), Ausgrid would consider revisiting this solution to confirm the viability and cost effectiveness.

4 Controlled Load 2 summer scheduling

The aim of this project was to achieve summer peak demand reductions by optimising the controlled load schedule of existing Controlled Load 2 customers over the summer period.

4.1 Project background

Direct load control has been used by Australian electricity distributors to control residential electric storage hot water system for over 50 years. In return for allowing control of their electric hot water systems, customers are offered cheaper controlled load tariffs.

The majority of Ausgrid's controlled load tariff customers have 'ripple' load control devices either separate to or within the metering equipment located at the customer's meter board. Ripple signals are sent along the power lines at different times of the day to activate these switches to turn on or off depending on the controlled load tariff a customer is on and the ripple channel grouping they have been assigned to. By grouping customers onto different channels, the restoration times of electricity supply to these channels can be staggered so that the electricity load is not all restored at the same time. The signals that activate these switches are sent from ripple signal injection equipment located at zone substations and this equipment is controlled by ripple injection zone controllers either individually or by a central control system located at the Ausgrid network control room.

Ausgrid currently has around 153,000 customers on the Controlled Load 2 tariff, predominantly controlling domestic hot water systems. Historically, peak demand in most parts of the network occurred in winter and so this tariff was originally intended for shifting load outside of peak times in the winter period. Typically these hot water cylinders are switched off between the hours of 5pm to 8pm on working weekdays throughout the year with a restoration period of load following afterwards, typically between the hours of 8pm to 10pm.

Although winter peaking areas are still present in the Ausgrid network area, the majority of the network peaks in summer. Currently about 75% of zone substations are either summer peaking or have similar levels of summer and winter peak demand. Summer peaks typically occur earlier in the day than winter peaks and can be more variable dependent on the location in the network. Summer peak times typically occur between 2pm to 8pm and there can still be a significant amount of Controlled Load 2 load that is operating and not switched off in this time period.

By extending the shut off period of this load earlier in the day and for a longer time during the summer months it is possible to potentially reduce overall summer peak demand between the hours of 4pm to 6pm.

Figure 16 shows the estimated load profile for the Controlled Load 2 customer base on the top 5 summer peak days in 2011. This total load profile was estimated by scaling separately metered data from around 26,000 Controlled Load 2 customers. Although the Controlled Load 2 customers with interval meters may not be fully representative of all customer load on this tariff, the figure indicates that there is the potential for around 20 to 25 Megawatts of reduced summer peak demand across the network between the hours of 4pm to 6pm AEDST if the hot water heaters are turned off earlier in the day during summer.

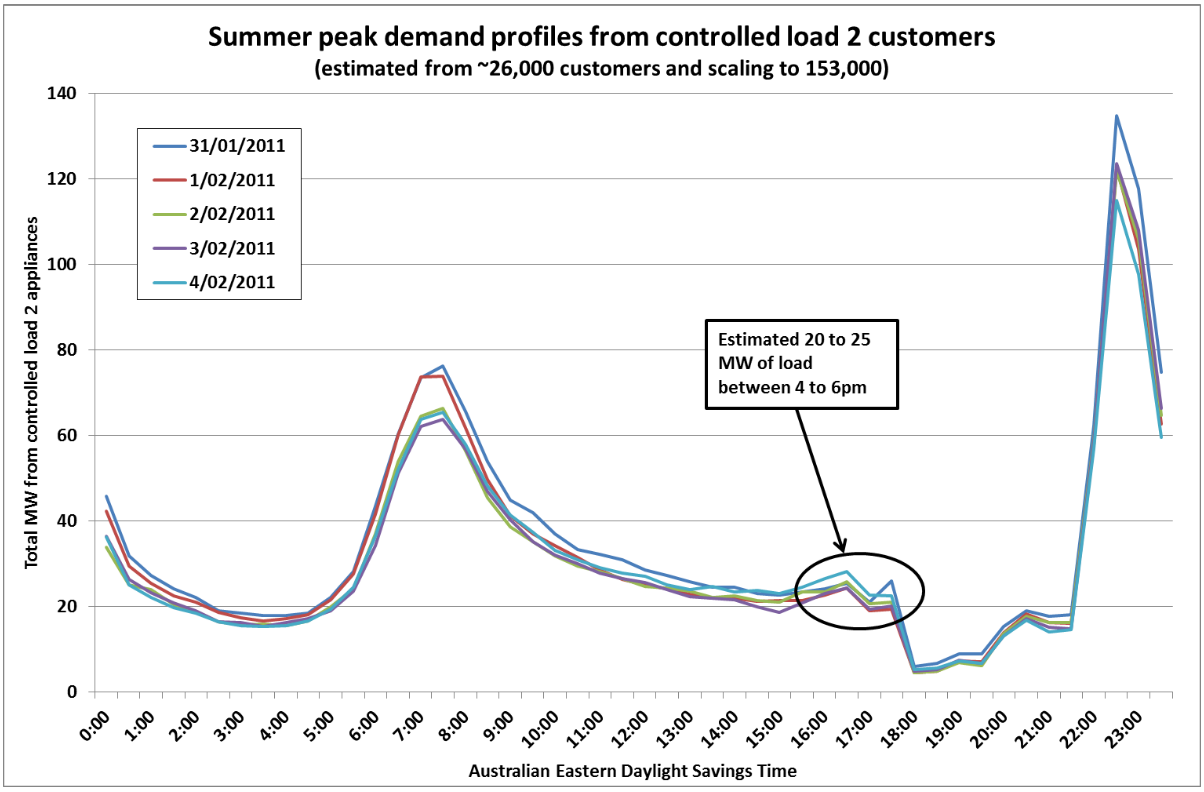


Figure 16: Summer peak load from Controlled Load 2 customers

4.2 Project objectives

The main objective of the project was to investigate the potential issues and barriers for implementing a summer scheduling regime for Controlled Load 2 customers to reduce peak demand during the summer afternoon period. Potential barriers identified before the project commenced were:

(a) **Customer response** from fewer hours of Controlled Load 2 electricity supply for their hot water system during the summer months. The hot water demand requirements during the summer are typically less than in winter due to temperature effects (water and ambient air). Consequently, it was envisaged that customers would not notice a difference in the supply and temperature of hot water; but was an important measure as part of the project. While any changes to the control schedule during the summer adhered to the terms and conditions of the Controlled Load 2 tariff, the change may affect customer's expectations of how the control should be scheduled. The possible impact on customers was assessed through a review of customer complaints to our call centre.

(b) **Load control operational issues** due to the schedule changes required for the summer period and then back to the standard regime for the rest of the year. For example, a summer schedule could be implemented between 1 November to 31 March and a winter/ shoulder season schedule for the rest of the year. Operational issues also include how to implement the load control schedules with the existing "ripple" load controllers across all areas of the Ausgrid network.

(c) **Measure the peak demand reduction** achieved from the schedule change and use to estimate the peak demand reduction potential across the Ausgrid network.

4.3 Project results

The project was conducted in two phases with the first phase designed to test the summer load control schedule change in two or three areas of the Ausgrid network area over the summer 2013/2014 period. The second phase was dependent on the outcomes of the first phase and involved making the summer load control change to a broader area of the Ausgrid network area over the 2014/2015 summer period.

4.3.1 Phase 1: Three zone substation trial (Summer 2013/14)

For the first phase of the project, three zone substations in the Hunter region were selected in order to implement the Controlled Load 2 summer schedule change. These zone substations were Cardiff, Edgeworth and Mount Hutton zone substations and the selection criteria included:

- The zone substation was summer peaking with a large percentage of residential load.
- The zone substation had a significant number of Controlled Load 2 interval meter customers to assist in measuring and verifying the peak reduction benefits.
- The zone substation was in the Newcastle load control region where the ripple control system equipment enabled easy implementation of the seasonal change.

Phase one of the project was completed during the 2013/14 year and involved changing the summer control schedules for the Controlled Load 2 ripple channels over the period from 1 November 2013 to 31 March 2014 for the three zone substations. The ripple control schedules implemented over the summer period for these zone substations involved turning off electricity supply to the Controlled Load 2 load from 2.30pm in the afternoon (AEDST), and leaving the timing of the restoration of electricity supply to the original restoration times, occurring generally between 8pm to 10pm (AEDST) depending on the ripple channel.

Peak demand reduction results

Figure 17 shows the average Controlled Load 2 electricity demand profiles from 140 customers in Cardiff zone area before and after the schedule had been changed. The results show that the load is reduced by about 180-250 Watts per customer on average between 2:30pm to 6:00pm due to the off time being brought forward to an earlier time.

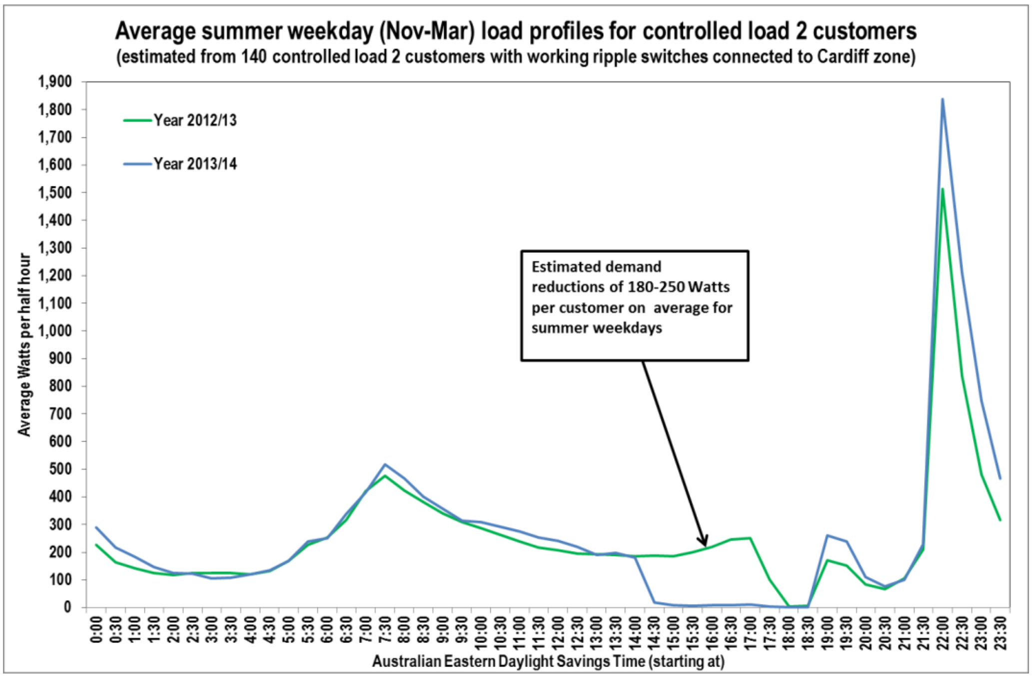


Figure 17: Actual load profiles before and after the Controlled Load 2 summer schedule change (Cardiff zone)

The results in Figure 17 show that the average summer demand reductions between 2:30pm to 6:00pm for every summer working weekday between 1 November and 31 March was 225 Watts per customer. To estimate a range of potential demand reductions on hotter summer days more typical of peak demand times, we also analysed the effects of varying the definition of the summer peak period looking at different scenarios as listed in Table 6.

Table 6: Summer peak demand estimates depending on peak period definitions

Case	Description	Date range	Watts reduced per customer
1	Extended summer (weekday only)	Nov – Mar	225
2	Normal summer (weekday only)	Dec - Feb	217
3	Top 10 hottest days (weekday only)	Dec - Feb	168
4	Top 3 hottest days (weekday only)	Dec – Feb	155
5	The hottest day (summer peak)	18 Jan 2013	141

An estimate of around 170 Watts on average is considered to be a reasonable assumption of the estimated demand reduction per customer on a summer peak day. Note that this estimate is based upon an assessment of operational ripple load control equipment.

Key Insight

Modifying the summer schedule for Controlled Load 2 customers results in a summer peak demand reduction of about 170 watts per customer with operational ripple load control equipment during the afternoon period.

Customer response

No negative feedback from any of the more than 4,000 Controlled Load 2 customers in the three trial areas was received during the first phase of the project and no operational issues with implementing the load control schedule change were encountered.

4.3.2 Phase 2: Newcastle load area implementation (Summer 2014/15)

Following the completion of the first phase, the project continued to the next phase with the objective of implementing the Controlled Load 2 summer schedule over a broader area of the Ausgrid network.

Several areas were considered, but due to technical reasons it was decided to implement the change over the whole of the Newcastle load area in the Hunter region (the same region as phase one but over a broader area). The load control schedule changes could be more easily implemented through the zone controller system in this region than other parts of Ausgrid's network. The Newcastle load area consists of 28 zone substations with a total of around 36,000 Controlled Load 2 customers being supplied from these zone substations (or around one quarter of all Controlled Load 2 customers).

Peak demand reduction results

Results from an analysis of interval meter data from around 3,500 customers indicated that:

- diversified demand reductions per customer on summer weekdays was about 230 Watts per customer between the hours of 2:30pm to 6:00pm, for customers with operating ripple load control equipment. This was similar to the phase one results.
- the average demand reduction was about 190 Watts per customer during the 10 hottest summer working weekdays which is comparable but slightly more than the 168 Watts per customer estimated in phase one of the project.

- an overall demand reduction of 4.0 Megawatts across the Newcastle load area was estimated for the summer afternoon period of 2:30pm to 6:00pm. This is around 110 Watts per Controlled Load 2 customer when including those customers that have time switches and other operational issues.
- when scaling up the aggregate results from phase two of the project to the whole Ausgrid network, we estimate that the total potential afternoon summer peak demand reduction is around 18 Megawatts, which is similar but slightly less than the original estimate of 20-25 Megawatts.

Customer response

No significant customer complaints or inquiries were received due to the change in operation times, with only two customers noticing a significant change which required investigation. One of these customers had an electrically boosted solar hot water system and had noticed the earlier off times as they tended to switch on the electric booster in the afternoon when they arrived home. The second customer had a smaller hot water cylinder that was still eligible for the Controlled Load 2 tariff but noticed a difference in hot water performance. Out of 36,000 customers on the Controlled Load 2 tariff in the trial area, this only represents 0.006% of customers.

4.4 Key project outcomes

This project has provided valuable lessons about the optimization of existing load control schedules for reducing summer peak demand. Lessons learned include:

1. The project results demonstrate that changing the load control schedule for Controlled Load 2 customers during summer can effectively reduce network peak demand on summer afternoons between the 2:30 and 6:00pm period.
2. Where the load control equipment was operating normally and could be controlled more flexibly and dynamically by Ausgrid's ripple load control system, the demand reductions were approximately 150 to 200 Watts per customer.
3. The solution was shown to be reliable and low cost, utilising Ausgrid's existing equipment and infrastructure with no significant impact identified by customers.
4. The second phase of the project achieved an estimated 4.0 Megawatts of summer peak demand reduction during the summer afternoon period across 28 zone substations.

4.5 Demand Management solution viability

Across the whole Ausgrid network the summer afternoon peak reduction achieved by changing the load control schedules is estimated to be 18 Megawatts.

The demand reductions were on average 140 kW per zone substation and up to 300 kW for zones with a higher penetration of Controlled Load 2 customers. The amount of demand reduction per zone would be considered small in terms of the total demand requirements needed for a typical network deferral. However, the solution is very low cost and would be considered to be a cost-effective option as part of a suite of demand management options used to address a network deferral project where the need was during the summer afternoon period of 2:30pm to 6:00pm.

5 Summary of key project outcomes

Electric storage water heaters are still one of the biggest residential electrical loads in many homes in Ausgrid's network area and due to their thermal storage characteristics are well suited to load control and load shifting demand management solutions. Traditional controlled load tariffs have been available for customers with larger electric storage tanks for over 50 years.

The projects outlined in this report set out to explore innovative approaches to reducing the impact of peak demand from residential hot water systems using load control solutions. Below is a summary of the key project outcomes:

1. Customers will tolerate the occasional control (once per week) of their small storage (<100 litres) hot water system for several hours on peak days for a modest financial incentive. However, costs associated with the customer acquisition and supply and installation of the load control equipment were too high for this approach to be a competitive non-network solution. A potential lower cost solution to controlling hot water systems directly at the appliance would be if the Australian Standard AS4755.3.3 for the demand response interface for electric water heaters is widely adopted by hot water system manufacturers in the future.

2. A range of barriers to customer take-up of controlled load tariffs hampers the viability of using this approach to defer network investment. Barriers such as the cost of installing new load control and metering equipment and the difficulty in identifying viable customers results in high unit costs and very low peak demand reduction potential for the typical network area associated with demand management opportunities.

3. For the two projects that included customer offers, a personally addressed customer letter was more effective than a more expensive marketing brochure in generating customer interest. Furthermore, follow up phone calls were highly effective with customer registrations more than doubling in number. The trial survey results indicate that ongoing sales support and extended offer periods might assist in improving customer take-up performance.

4. The Controlled Load 2 summer scheduling project demonstrated that optimisation of control schedules was a reliable and cost effective way to reduce summer peak demand with no noticeable negative feedback from customers.

Appendix A Customer letter: Project 1

11 July 2012

<Title> <First Name> <Last name>
<Address 1>
<Address 2>
<Suburb> <State> <Postcode>

Dear <First Name>

Your electricity distributor would like to pay you $100

You are invited by Ausgrid (your electricity distributor) to take part in a new service trial – and we'll pay you $100 upfront if you participate.

The trial will test the impact of a new service using hot water switches. These switches will enable us to remotely turn off your hot water heater for a few hours only on days when the electricity network is experiencing high demand.

You probably won't notice the difference

You'll still have the hot water that is stored in your tank to use when your system is turned off. Plus, you'll always have the option to press the override switch if you run short of hot water. In fact, most of the customers who have already trialled this service didn't notice any difference at all.

The trial will run for 18 months and will help us identify better ways to manage your electricity supply for the benefit of the electricity network and the whole community.

Register online or call us to receive a cheque for $100

If you own your own home and have an electric storage hot water system that is not already on an Off Peak tariff, you are eligible to take up this offer. Simply register online at **ausgrid.com.au/hotwatertrial** or call **1800 648 326**.

We'll arrange a convenient time to send a qualified electrician to your home to fit the control switch. You will need to be home at this time, but in most cases it will take less than 30 minutes to fit.

You'll receive a cheque for $100 in the post shortly after the switch is fitted. This offer is available until 31 December 2012 - please call soon if you want to take part.

Yours sincerely,

Manager Demand Management & Sustainability

PS If you're not sure if you're eligible to take part and receive your cheque for $100,
please call **1800 648 326** anyway and we'll be able to tell you over the phone.

Appendix B Marketing brochure: Project 1

Ausgrid

We'll pay you <$100> to take part in a trial

Dear <Renae>

You are invited by Ausgrid (your electricity distributor) to take part in a new service trial – and we'll pay you <$100> upfront if you agree to participate.

The trial will test the impact of a new service using hot water switches. These switches will enable us to remotely turn off your hot water heater for a few hours only on days when the electricity network is experiencing high demand.

You probably won't notice the difference

You'll still have the hot water that is stored in your tank to use when your system is turned off. Plus, you'll always have the option to press the override switch if you run short of hot water.

In fact, most of the customers who have already trialled this service didn't notice any difference at all. The trial will run for 18 months and will help us identify better ways to manage your electricity supply for the benefit of your household, the electricity network and the whole community.

Register online at ausgrid.com.au/hotwatertrial or call 1800 648 326 now to receive a cheque for <$100>

If you own your own home and have an electric storage hot water system that is not already on an Off Peak tariff, you are eligible to take up this offer.

Simply register online at **ausgrid.com.au/hotwatertrial** or call **1800 648 326**. We'll arrange a convenient time to send a qualified electrician to your home to fit the control switch. You will need to be home at this time, but in most cases it will take less than 10 minutes to fit.

You'll receive a cheque for <$100> in the post shortly after the switch is fitted. This offer is only available for three months, so please call soon if you want to take part.

Yours sincerely,

Manager Demand Management & Sustainability

PS If you're not sure if you're eligible to take part and receive your cheque for <$100>, please call **1800 648 326** anyway and we'll be able to tell you over the phone.

- **Register online at ausgrid.com.au/hotwatertrial or call 1800 648 326 to take part in this free service trial**
- We'll fit a control switch to your hot water system for an 18 month trial period
- You'll receive a cheque for <$100> in the post up front
- There's no cost to you, but be quick – this <$100> offer ends soon

Who is Ausgrid?

Ausgrid is your electricity distributor. We manage the electricity network throughout Sydney, the Hunter and the Central Coast including the poles, wires and equipment that delivers electricity to your home.

We're committed to meeting our customers' energy needs and by taking part in this trial you'll be helping to shape the future of energy use in Australia.

Your electricity distributor
would like to pay you <$100>

Mr Sam Sample
123 Sample Street
SAMPLEVILLE ZZZ 9999

If undelivered please return to GPO Box 4009 Sydney NSW 2001

Ausgrid

POSTAGE
PAID
AUSTRALIA

Appendix C Customer letter: Project 2

30 August 2016

Full Name
Address 1
Address 2
Suburb State Postcode

Dear <First Name>

You could cut your hot water costs in half with off peak electricity

If you have an electric hot water system (electric storage, solar or heat pump), you may be able to reduce your hot water costs by more than 50%. You can do this by connecting your system to off peak electricity supply with a new meter.

How does it work?

For a limited time, we're offering selected customers a **discounted installation fee of $199** (normally around $419) to switch to a suitable off peak electricity supply. Here's how off peak saves you money.

Electric hot water systems connected to continuous electricity supply ordinarily receive power 24 hours a day. This can cost more than 23c per kWh and up to three times more than off peak electricity supply, which heats water outside peak times.

On Off Peak 1 (around 9c per kWh, suitable for 250 litre tanks or larger), your system will only heat water overnight, for at least 6 hours, between 10pm and 7am. The running costs are similar or may even be cheaper than natural gas.

On Off Peak 2 (around 12c per kWh, suitable for 100 litre tanks or larger), your system will heat water for at least 16 hours a day. Off Peak 2 costs slightly more than Off Peak 1.

Off Peak 1 offers the best savings, but if you find you run out of hot water during the day, you can switch to Off Peak 2 and there is no charge for switching.

Keep saving year after year

In the first year, you'll want to take into account the installation fee. But as you use off peak year after year, the savings really start to add up. Use this table to compare savings* when swapping to Off Peak hot water from continuous electricity supply.

Estimated cumulative savings

	Electric Storage		Solar with Electric Boost		Heat Pump	
	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2
Year 1	$291	$178	No saving	No saving	$41	No saving
Year 2	$781	$555	$143	$65	$281	$179
Year 3	$1,271	$932	$314	$197	$521	$368
Year 4	$1,761	$1,309	$485	$329	$761	$557

Your new meter

When your new meter is installed, you'll automatically be moved on to a time of use network tariff.

With time of use, you pay different amounts for electricity over three different time periods – Peak, Shoulder and Off Peak. Prices are cheaper in Off Peak and Shoulder periods – that's 82% of the time (there is no peak period on weekends and public holidays), and more expensive during peak periods. Most households already use around 78% of their electricity during Shoulder and Off Peak periods.

Our research shows that more than 70% of households are better off on time of use pricing compared to standard domestic electricity rates. Please contact your retailer to find out about your electricity rates and what other pricing options may be available. Some retailers allow you to remain on standard domestic electricity rates, even if you have an advanced meter installed and are on a network time of use tariff.

Check your electricity bill to see if you're already connected to Off Peak 1 or Off Peak 2. If not, you may be able to get connected by calling **1800 648 326** or visiting **www.ausgrid.com.au/offpeak**.

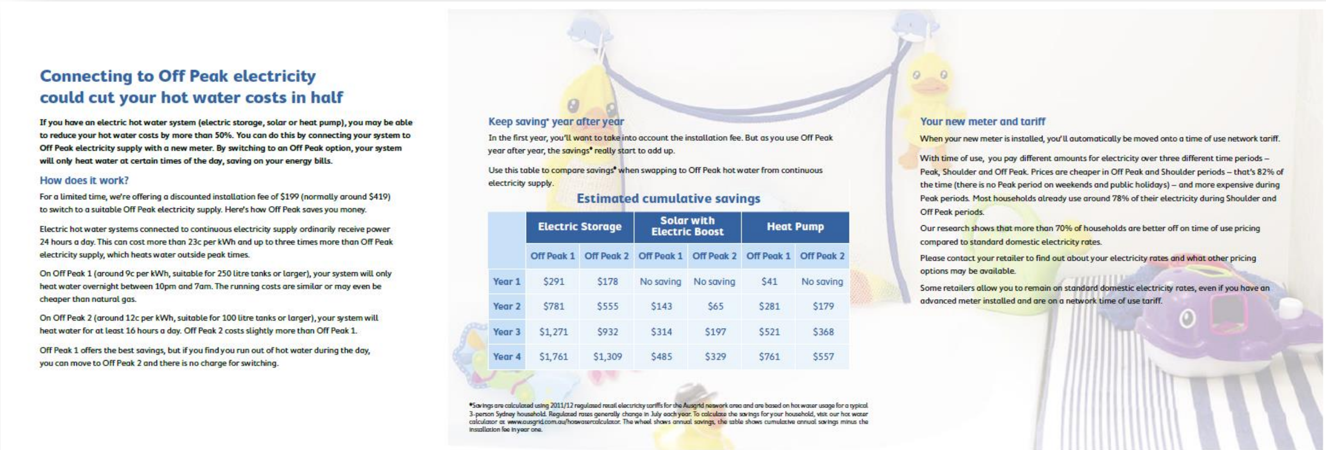
This offer is available until 30 September 2012.

Yours sincerely,

Manager Demand Management & Sustainability

*Savings are calculated using 2011/12 regulated retail electricity tariffs for the Ausgrid network area and are based on hot water usage for a typical 3-person Sydney household. Regulated rates generally change in July each year. The table shows cumulative annual savings minus the installation fees for year one. To calculate the savings for your household, visit our hot water calculator at www.ausgrid.com.au/hotwatercalculator.

Appendix D Marketing brochures: Project 2



Connecting to Off Peak electricity could cut your hot water costs in half

If you have an electric hot water system (electric storage, solar or heat pump), you may be able to reduce your hot water costs by more than 50%. You can do this by connecting your system to Off Peak electricity supply with a new meter. By switching to an Off Peak option, your system will only heat water at certain times of the day, saving on your energy bills.

How does it work?

For a limited time, we're offering a discounted installation fee of $199 (normally around $419) to switch to a suitable Off Peak electricity supply. Here's how Off Peak saves you money.

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Off Peak 1 offers the best savings, but if you find you run out of hot water during the day, you can move to Off Peak 2 and there is no charge for switching.

Keep saving* year after year

In the first year, you'll want to take into account the installation fee. But as you use Off Peak year after year, the savings* really start to add up.

Use this table to compare savings* when swapping to Off Peak hot water from continuous electricity supply.

Estimated cumulative savings

	Electric Storage		Solar with Electric Boost		Heat Pump	
	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2	Off Peak 1	Off Peak 2
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Year 4	$1,761	$1,309	$485	$329	$761	$557

*Savings are calculated using 2011/12 regulated retail electricity tariffs for the Ausgrid network area and are based on hot water usage for a typical 3-person Sydney household. Regulated rates generally change in July each year. To calculate the savings for your household, visit our hot water calculator at www.ausgrid.com.au/hotwatercalculator. The wheel shows annual savings, the table shows cumulative annual savings minus the installation fee in year one.

Your new meter and tariff

When your new meter is installed, you'll automatically be moved onto a time of use network tariff.

With time of use, you pay different amounts for electricity over three different time periods – Peak, Shoulder and Off Peak. Prices are cheaper in Off Peak and Shoulder periods – that's 82% of the time (there is no Peak period on weekends and public holidays) – and more expensive during Peak periods. Most households already use around 78% of their electricity during Shoulder and Off Peak periods.

Our research shows that more than 70% of households are better off on time of use pricing compared to standard domestic electricity rates.

Please contact your retailer to find out about your electricity rates and what other pricing options may be available.

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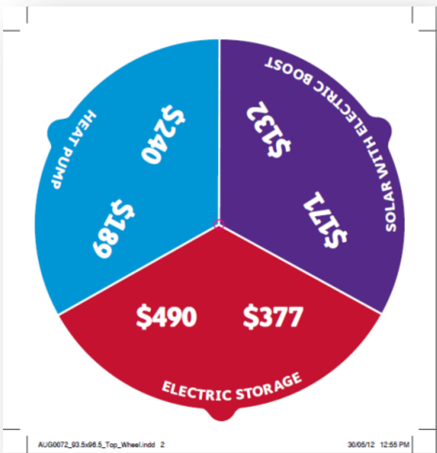

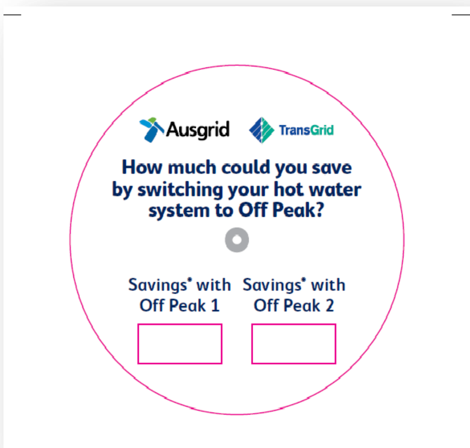

Contact us

For further information on
Ausgrid's Demand Management process,
recently completed screening tests, and reports,
refer to www.ausgrid.com.au/dm

For general enquiries contact
Ausgrid's Demand Management team at:
demandmanagement@ausgrid.com.au

or write to us at:
Manager Demand Management
Ausgrid
GPO Box 4009
SYDNEY NSW 2001