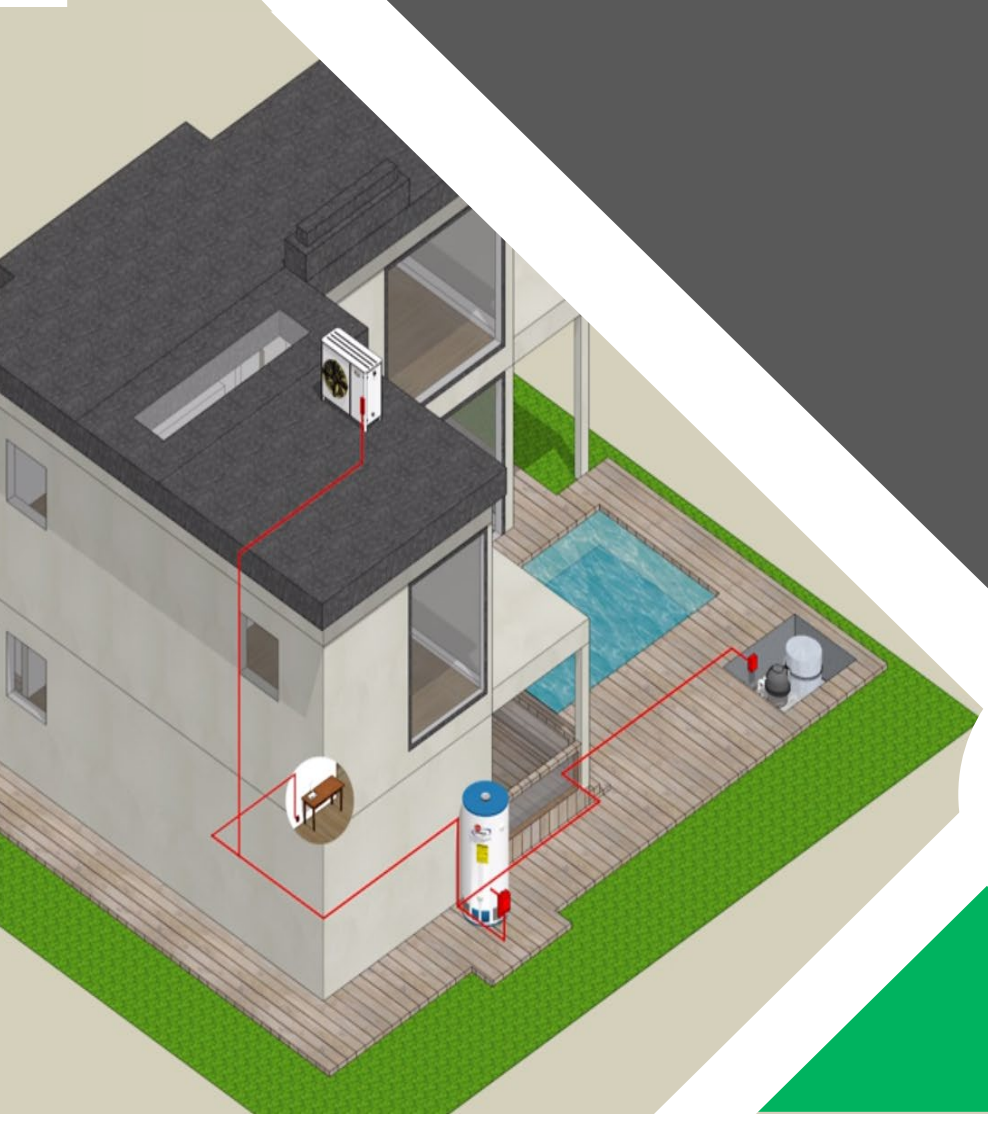
ARENA – ADVANCING RENEWABLES PROJECT (ARP)

SA SMART NETWORK Project

Lessons Learnt Closeout Report

Bringing SA Hot Water Load Under Active Control

May 2024



Project Summary	
Project	SA Smart Network Project
Project Numbers	ARENA: 2019ARP023 SA DEM: FA-00181
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Project Control	
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Date	**May 10, 2024**

This Project received funding from ARENA as part of ARENA's Advancing Renewables Project and the South Australian Government's Demand Management Trials Project.

Acronyms

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
API	Application Programming Interface
ARENA	Australian Renewable Energy Agency
CET	Combined Energy Technologies
DER	Distributed Energy Resources
DNSP	Distribution Network Service Provider
DRSP	Demand Response Service Provider
FCAS	Frequency Control Ancillary Services
HWS	Hot Water Systems
HEMS	Home Energy Management System
kW	Kilowatt
kWh	Kilowatt Hour
MC	Metering Coordinator
MP	Metering Provider
MW	Megawatt
NEM	National Energy Market
PV	Photovoltaic
OPCL	Off Peak Controlled Load
SA	South Australia
SAPN	South Australia Power Networks
VPP	Virtual Power Plant

Contents

Executive Summary

This is the final 'Lessons Learnt' report for the SA Smart Network project. The project was halted due to challenges in meeting the required customers numbers as stipulated in the original scope.

As a result, many of the learnings in this final 'Lessons Learnt' report relate to sales and identifying (and resolving) possible impediments to sales uptake. Detail is also provided on learnings relating to metering exchange and possible ways to manage chip shortages.

The learnings captured are summarised below and explored in greater detail in the body of the report and should be used to inform the setup of other ARENA projects, particularly with reference to sales.

Lessons Learned	Insights	See further detail
1. **Retailer-led sales approaches are not suitable for projects of this type**	The design of the project, particularly the sales/marketing of the PowerStore product was heavily dependent on the acquisition strategy of the partner retailer. However, the energy retailer expected to struggle to deliver the projected volume of sales, which would have risked the broader aims and goals of the project. During the project, learnings from other VPP initiatives suggested that a better channel to market was via equipment resellers and installers. These channels can sell hardware but struggled to manage the complexities of retail energy contracting, tariff changes and meter exchange at the point of sale. This highlighted the need to separate the sale of physical product from the retail energy contracting process. Selling products of this type are better suited to Point-of-Sale transactions via dealers, or electricians rather than energy retailers.	*Section 1*

2. Sales strategies need to be agile to accommodate the market positioning of a complex product	The PowerStore product is costly and can be difficult to sell. The selling process was made more difficult due to several pre-conditions placed on the project such as: • the prerequisite for a specific split between non-solar and solar customers • the use of specific energy retailers • a very specific mix of product sales Such requirements were agreed on initiation of the project. However, learnings and feedback from the project and customers suggest that modifying some of these pre-conditions should improve sales outcomes. Furthermore, realising the difficulty in achieving the forecasted sales, testing the technical capabilities of active load management and FCAS participation could have still proceeded even without the planned quantity of smart hot water systems. Particularly with the close of the AEMO VPP Demonstration.	*Section 2*
3. Non-Participation in REPS was a hindrance	The Retail Energy Productivity Scheme (REPS) is a South Australian government initiative which supports customers to reduce their energy costs. Devices or solutions part of the scheme can avail of significant rebates/incentives that impact their final price to customers. Heat pumps were and are part of this scheme, whilst smart hot water systems such as PowerStore are not.	*Section 3*
4. Positioning the PowerStore as a battery was effective	Customers seemed to appreciate the core value proposition and messaging that they were purchasing an intelligent water heater that could store energy, thereby helping them to reduce their energy bills	*Section 4*

5. Customers prefer rebate in an upfront payment	Customers prefer upfront rebate payments particularly on large expense items.	*Section 5*
6. Sales channels need to be well supported and incentivised	An increasingly diverse channel mix including sales and installation partners, plumbers and electricians needed support to sell the product. The project increased the frequency and type of training, upskilling partners so that they had the training to better sell (and support) the product. As noted, the product is complex and costly. Multiple partners are needed to support its sale and installation, including Rheem, Retailers and Metering support. During the course of the project, improvements were made to the coordination and communication between these partners, in order to improve the customer experience at the point of sale and installation. Better engagement with Rheem also enhanced the ability of installers to deal with customer queries and issues. Redefining the incentives program and better aligning margins to the sales effort has driven better engagement with channel partners.	*Section 6*
7. Meter exchange processes need to be defined	At installation, the exchange of metering had been clunky and cumbersome. The process necessitated multiple visits of various providers including Metering Coordinators (MCs), Metering Providers (MPs) and installation partners. The project has defined a new process for installers to follow, which streamlines the process, and improves installation times and the customer experience.	*Section 7*

8. Ensure the supply chain is optimised to manage the flow of chips	Previously it was highlighted that semi-conductor chip shortages were impacting the rollout of devices. Over the last 2 years, this was exacerbated by the global geopolitical environment. The project took steps to mitigate the impact of such shortages. • New designs, better leverage generic components • New procurement processes are less reliant on more difficult-to-source chip components.	*Section 8*

Table 1: Lessons Learned – Executive Summary.

1. Retailer-led sales approaches are not effective in driving sales for such complex products

At the initial design of the project, it was assumed that most of the product sales would be through the Retail Energy channel partner, who would actively promote PowerStore amongst its own customer cohort. The retail partner would play the role of key acquisition partner and channel to the market. Their opportunity was to bundle in a new or revised energy contract in with the sale of the PowerStore product.

However, it was decided that this design would fail to deliver the required customer numbers. The retailer was concerned about delivering the expected product sales from its own customer base, which was low in SA (15% of the market). Learnings from other ARENA-funded VPP trials also suggested that dealers/installers who had relationships with customers were better suited to selling more expensive products such as PowerStore.

The project did decide to use Dealers and Installers as the primary sales channel. This still created an issue as there was still an energy contracting component to every sale of a PowerStore. Dealers/Installers familiar with selling hot water systems now struggled with selling a PowerStore product that was an energy solution with the associated contracts, tariffs, and metering requirements.

Learning – Sell via the Dealers/Installers

Learnings from this project and other ARENA VPP projects suggest that the best channel to market is the Dealers and Installers. These channel participants have pre-existing relationship with the customers and are better equipped at selling high-cost products.

However, such channels need support in selling other components of the energy solution i.e. the requirements to move onto Time of Use (ToU) tariff and switch to a partner retail energy contract.

Learning – break the connection between the sale of the PowerStore product from the retail energy contract

Dealers and Installers are effective at selling PowerStore Products. Other VPP initiatives have demonstrated the efficacy of such channels. However, they struggle to engage with the customer on the retail energy contracts, tariffs, metering requirements etc.

It is worth considering a retailer agnostic approach, where the sale of the physical product is made completely independent of the retail energy contract. If a retailer signs up for the project and contributes as a preferred participant, strong prerequisites need to be built into the project design around the promotion and sales of products to their internal customer base.

Learning – Consider removing any requirement for the customer to change their retail electricity contract

Customers were required to sign two separate contracts to be part of the trial - one with a participating project retailer for an eligible retail tariff and the other with Rheem/CET for participation in the virtual power plant and usage of the home energy management software. This added to complexity at point of sale.

Furthermore, there should be no requirement for a customer to move from a standard flat rate tariff for the household to a ToU to participate in the program. This is an issue for non-solar customers who need to be convinced of the benefits and savings associated with going on to a household ToU tariff. The tariff rewards behavioural changes in how electricity is consumed in the dwelling, if such change does not occur then there is limited scope for savings. It is easier to sell the benefits of the ToU to a solar customer who can see the benefits manifest in their bill, often without behavioural change.

Learnings from other ARENA projects also suggest that customers could remain on their household Flat tariff with the use of the DER devices i.e. solar hot water system managed separately by the retailer via a ToU model. This has a limited impact on the quality of the data collected or internal retail operational processes.

Concluding Comments

The project was challenged to arrive at the final number of sales. The late decision to move sales responsibility from the Retail Energy channel (yet leaving the requirement to change to a Project Retailer) was disappointing and severely hampered acquisition. The project did pivot to a hardware approach but was forced to leave many of the energy contracting requirements in place. It may have been more appropriate to be completely retailer agnostic and remove the requirement for a customer to change to a new retail contract to participate in the trial.

2. Sales strategies need to be agile to accommodate the market positioning of a complex product

The project on initiation was tasked with exploring alternative approaches for shifting the timing of and demonstrating active control over 2,400 residential hot water systems within South Australia.

A range of technologies and product offerings was developed to maximise participation from customers, assess customer preferences for participating in hot water demand management, and demonstrate a low-cost and scalable solution to providing active control. The project plan stipulated that the project must deliver these products in the following mix.

- PowerStore: 200 PowerStores in solar homes and 200 PowerStores in non-solar homes
- PowerStore Lite: 500 PowerStore Lites in solar homes and 500 PowerStore Lites in non-solar homes
- Retrofit devices: 500 Retrofit devices in solar homes and 500 Retrofit devices in non-solar homes
- Air Conditioning System Adapter: Install 200
- Pool Pump Adapter: Install 200
- HEMS: Interface that enables active control of the hot water systems.

A much smaller testing fleet would still have provided enough connections points to validate the commercial and technical viability of the concept.

The conditions of sales were agreed on initiation of the project, however, learnings and feedback from the project and customers suggested a more flexible agile approach to sales should have been envisaged particularly if the technical and knowledge outcomes for the project were still met.

Learning – Sales and Channel strategies need to be agile and flexible to accommodate the market positioning of an expensive and complex product

- Consider relaxing the requirement to retail a set mix of products to a specific split of solar and non-solar customers: Such preconditions inhibit sales. The project believes the sales should be guided by the preferences of the customers. This will reflect true customer preferences.
- Furthermore, the project queries whether the success of the project should be judged on the sale of 2,400 units. The original assumption being that a fleet of this size can then be tested for FCAS services on the real-time market. The project suggests that if FCAS testing can occur off-market to AEMO specs on the fleet acquired then the initial outcomes of the project can still be realised. This has no impact on funding as customer subsidies are on a prorate basis anyway.

- An alternative approach to setting specific customer acquisition targets could also be considered. This could set deadlines for customer acquisition and the commencement of testing, perhaps with modest minimum volume targets. This is pertinent in the environment of competing with sales of heavily subsidised heat pumps under REPS. Other trial programs around Australia are typically testing with smaller fleets of 50 to 1,000 participating homes.
- Sales of new installations could also continue during the testing phase of the project. The ability to add CER and homes to and to make changes to existing homes in an operating VPP fleet will be a natural requirement of VPPs offering grid support services. Reflecting this in the structure of the project will provide extra learning and accelerate the successful completion of the project outcomes.

Concluding Comments

The project was challenged to arrive at the final number of sales. Changing several of the pre-conditions of the project could have expedited or at least made acquisition targets easier to realise without impacting the technical or knowledge outcomes of the project.

3. Non-Participation in REPS was a hindrance

The Retailer Energy Productivity Scheme (REPS) is a South Australian government initiative that supports customers to reduce their energy costs whilst also maximising the benefits to the power system to deliver a smarter, more affordable, reliable, and sustainable energy future.

Households and businesses can receive free or discounted energy efficiency and energy productivity activities from energy retailers participating in the REPS. Typical activities include installing energy-efficient lighting, or water-efficient shower heads, or helping save water heating costs. Heat pumps are also part of the REPS scheme.

The flexible, controlled load PowerStore water heaters were not eligible for significant REPS credits and could not compete effectively with heat pump water heaters.

- Heat pump water heaters are being sold in South Australia for as little as $39 fully installed. These water heaters attract both STCs and REPS credits. This makes it difficult for PowerStore to compete.
- Retailers also have REPS obligations and reserve their customer contacts for the communication of REPS related promotions and price increases.
- Large, potential sales channel partners are also contracted to deliver REPS credits for retailers. These sales channel partners focus on REPS opportunities and would not participate in the project until significant REPS credits were made available for PowerStore.
- The REPS targets for the retailers increase over time so their focus for promoting any appliance is about achieving their REPS obligations. They will not spend time, money or limited customer contact opportunities on PowerStore without REPS credits.

Between Federal and State incentives for heat pumps, a pop-up industry has emerged since 2020. Low cost imported and often problematic (fit for purpose, marketing claims, installation safety, regulatory compliance) heat pumps can be sold to consumers for less than $100 due to the importers funding the product, sales channel and installation completely from the Government incentives. Figure 1 explores this dramatic growth.

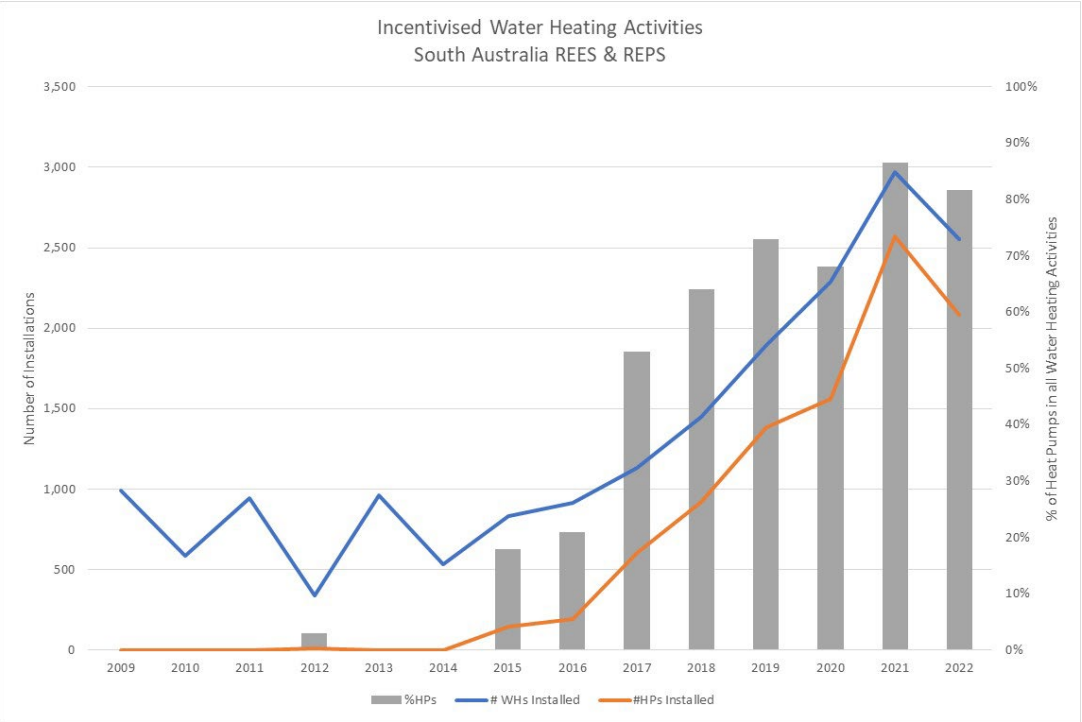


Figure 1: Growth in Heat Pumps 2019 - 2022

Heat Pumps vs PowerStore water heaters

1. Heat pumps have been subsidised/incentivised by the Government of South Australia for a number of years under the REES and now the REPS programs.
2. Under both programs the larger electricity retailers are obliged to secure credits for complying activities, which include the installation of heat pump water heaters.
3. While the REES targets were held flat between 2017 and 2020, the REPS targets increased from the REES targets by between 5% and 16% per year from 2021 to 2023.
4. With the increasing targets, the electricity retailers have restricted their customer contacts to focus on REPS activities. In the case of water heaters, they will only promote heat pumps because of the REPS credits.
5. The retailers run tenders each year to purchase REPS credits from resellers/installers of heat pumps. This is lucrative for those resellers, so they focus on heat pumps.
6. We failed to get promotion from the Project (electricity) Retailers or from a couple of the major water heater resellers in South Australia because they were completely focussed on achieving their REPS credit targets.
7. The Green Energy Markets chart below shows the growth in air sourced hot water heat pumps (ASHP) by state over the last two years. Although the scale is not helpful, you can clearly see the significant growth in South Australia through 2022 – the main period during which we were trying to accelerate sales for the project.
8. A whole industry has developed around the subsidies with 'pop-up' companies selling through direct marketing and bypassing the traditional plumbing merchant channel.

9. With close to $2,500 of subsidies from the federal and South Australian programs, and the lower cost sales channel, heat pumps are being sold in South Australia for under $100, fully installed.
10. Rheem became aware of the growing problem in 2021 and commenced discussions with the South Australian Department for Energy & Mining (DEM) (project Steering Committee around July 2021) about a submission via the Minister's office to have PowerStore included as a high credit earning activity under REPS, equivalent to heat pumps. These discussions continued until late 2021 or early 2022, including DEM reviewing drafts and revisions of a submission.
11. In February 2022, a submission was made to the Minister's office. It was acknowledged and forwarded to DEM for review the same day.
12. In March 2022, the Government of South Australia changed through the State election. Rheem contacted the new Minister's office and resent the submission in April 2022.
13. Since April 2022, through to late 2022, Rheem followed up with both the Minister's office and DEM for a response to the submission. To date (December 2023) no decision has been communicated to Rheem from either DEM or the Minister's office.
14. The inability to compete with heavily subsidised heat pumps in South Australia is one of the major reasons for low customer acquisition and early mutual termination of the project.
15. Other problems with the project structure, along with proposed solutions, were detailed in the November 2022 request for variation. The requested changes were deemed too significant and rejected, leaving only mutual termination as an alternative to orderly conclusion of the project.

Learning – Seek participation in REPS

The project was initiated knowing that it would not be participating in the REPS schemes. However, it quickly became apparent that customers saw the PowerStore product as an equivalent to cheap heat pumps that were part of the scheme, even though such product deliver significantly fewer consumer and grid benefits than the PowerStore product.

Retail partners perceived sales were being stifled by the REPS support available to competitive products. Heat pumps were also promoted by the media, with a particular focus on installation discounts available via REPS.

The project suggests that as it became apparent that REPS participation was an issue, an opportunity should have been explored to extend participation to the PowerStore product. The SA Smart Network project is as much about delivering and acting upon learnings as it is about delivering commercial outcomes.

One retailer and several sales partners have suggested that participation in REPS at the same subsidy level as heat pumps would have added much to marketing efforts to position the PowerStore product.

Concluding Comments

Our sales and marketing partners believed that other products sch as heat pumps were able to exploit their position in the REPS scheme to compete against the PowerStore products.

Though not apparent at project initiation, it quickly became apparent that market efforts were struggling against a cheaper product supported by incentives and a broad media campaign. It is unfortunate that the project was not able to use this learning to gain participation into REPS.

4. Positioning the PowerStore as a battery was effective

The Solahart PowerStore® was primarily marketed as an electric smart water heater (ESWH) that enabled customers to capture and utilise excess solar energy generated by their PV system to heat water in their household.

However, during the project, the marketing and positioning around the product evolved. The PowerStore was increasingly marketed as an energy storage device, boasting a capacity of over 13kWh. Some marketing materials included the line, "...it's like having battery storage at a quarter of the cost." This was not intended as a direct comparison pitting the PowerStore against home BESS, but rather to provide perspective on the amount of energy that PowerStore could capture and store.

Though a formal customer insights survey was not yet conducted when the project terminated, the anecdotal evidence shows that customers seemed to appreciate the core value proposition and messaging that they were purchasing an intelligent water heater that could store energy, thereby helping them to reduce their energy bills.

5. Customers prefer the rebate in an upfront payment

The rebate structure was originally phased into two ‘cash back’ amounts, one on sign-up and a second paid after remaining in the program beyond August 31, 2022. The experience of the project, however, has shown that separating the rebates in this way did not create a sufficiently strong customer incentive to sign-up to the trial.

With a view to further driving customer uptake, Rheem elected to switch the rebate structure to a single payment that was fully paid to customers upfront. This simplified the acquisition process particularly around the initial contracting of customers. This change resulted in some additional risk being worn by Rheem (namely in the event the customer does not stay in the VPP program long term) however this was considered an essential change to ensure the project achieves its rollout volume objectives.

Concluding Comments

Customers prefer upfront rebate payments particularly on large expense items. An upfront payment simplifies the sales process and enhances customer experience at the point of sale.

6. Sales channels need to be supported and incentivised

The process of selling and signing up customers for the project has been previously highlighted as challenging. Due to concerns about customer acquisition through the retail energy partner, the project was forced to adapt its sales approach and drive volumes through the Dealer/Installer channels. An additional retailer was also onboarded, and plumbers were added to the sales mix. The planned launch of the Retrofit product also added a new electrical installation channel that equally needed support.

The project did evolve its approach and did pick up some learnings on channel support that could be applied to other projects.

Learning – Channels need to be supported with constant training and communication

As the project was forced to ramp up the sales activities of alternative channels, training and communication had to be modified. Such channels were more acquainted with selling a physical product and were struggling to market and sell the concept of PowerStore as an energy management system.

Training was enhanced in several ways.

- Improvements were made to the training pack, incorporating more visual and process steps.
- More frequent, shorter training sessions were developed for partners. Training to support plumbers selling the product was delivered in mid-July and Rheem noticed an improvement in knowledge of the product as well as a reduction in installation issues.
- A learning management system to support online training was planned.
- Communications between project partners and Rheem, and project to customers was enhanced. The communication of the energy prices in early July 2022, demonstrated to the project the need to better co-ordinate messaging. Some customers were confused and sought an explanation on why their energy bills were rising whilst they were participating in the project. All parties also set up processes to manage interactions and review marketing events, with nominated contacts and contact details and regular catchups. Improvements were made to data-sharing processes between each retailer and Rheem/CET.
- Escalations to retailers were managed via the common processes within each company, with Rheem managing these centrally to improve the customer experience.
- Channel partners were introduced to key contacts at Rheem who could be called upon to deal with issues. Rheem also provided one-on-one support to partners on their initial sales and installations.

Learning – Channel partners need to be incentivised to sell.

Previously, the project set firm guidance on the price of the final water heater. Given the complexity of the sale and installation, Dealers felt that the resultant margin was not commensurate with the effort to do the sale and installation.

Rheem then changed their process to provide high-level guidance on the cost of the heater and expectations on the margin; dealers and plumbers are generally left to decide on the appropriate price for the final installed system. Margin became less of an issue for channel partners, who became more motivated to sell.

Concluding comments

Partners commented favourably on the improvements in training while better access to key resources at Rheem was particularly well received.

The project acknowledges that it was difficult and time-consuming in establishing such sales channels and supporting channel partners. Going forward, particularly when retailing a complex product, sales planning and forecasting need to better anticipate the effort required to establish complex sales functions, particularly if alternative sales channels are required to drive customer numbers.

7. Meter exchange processes need to be defined

Once a smart electric water heater is installed there is often a requirement to replace the current electricity meter or upgrade it to a smart meter (post cool-off period). This is the case in non-solar homes that often are serviced by older analogue meters. A smart water heater needs a separate meter element, which needs to be coordinated by a smart electricity meter (typically a type 4a meter in the market). This process involves a retailer, the smart water heater installer, and a metering coordinator (MC typically managed by an energy retailer), who manages the upgrade of the smart electricity meter. A further complication is that the MC may subcontract the meter exchange to a Meter Providers (MP).

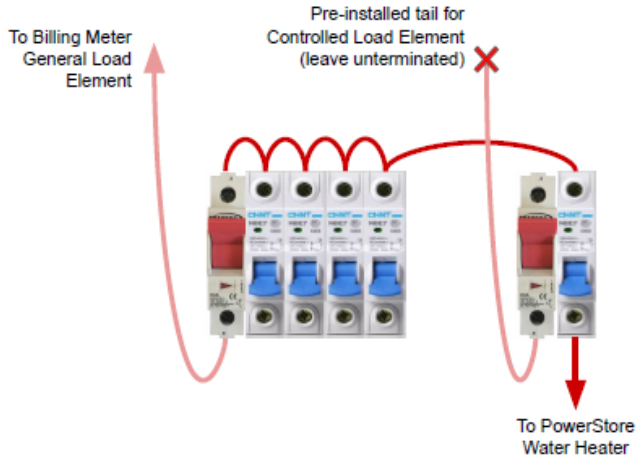
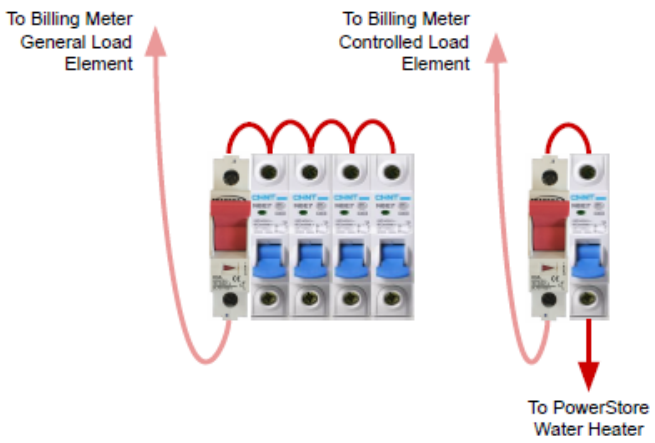
Learnings – Meter exchanges need to be managed as they can contribute to poor customer satisfaction levels.

Managing and co-ordinating the replacement of old analogue meters with smart meters (Type 4a) has been cumbersome, with MCs arriving on site following an installation often failing to complete the meter replacement as they cannot connect the smart meter to the water element. This often entails a return visit by the water heater installer, to provide guidance to the MC on the replacement and how to connect to the smart water element. Unsurprisingly, this adds to the complexity of the installation process and provides for a poor customer experience.

After several challenging installations, the project made changes to the installation process on the suggestion of AGL (for their connections), particularly the handover to MCs.

- Installers now put a pre-prepared connection on the smart water meter circuit so that the MC can use this line and terminate it into the controlled load of the smart electricity meter. Previously, MCs that came on-site to upgrade the electricity meter, were unsure how they could connect to the water heater circuit.
- Installers also clearly label such connection points so that the MC knows the precise point to connect the smart meter to the pre-wired circuit. To date, this process improvement has enhanced the meter exchange process and reduced the requirement for multiple visits from the installer and MCs.

The process involves three steps, (see appendix b for a graphical depiction of the process).

Steps	Activities
First site visit (Installer)	• Connect PowerStore to General Load Circuit • Install Main Switch for Controlled Load Circuit with a pre-prepared tail to be terminated at the Controlled Load output of the new Smart Meter once installed.  Figure 2: Initial Connection Points
Second site visit (MC)	• MC coordinates metering exchange (or update) on request from the customer's energy retailer
Third site visit (Installer)	• Move PowerStore from General Load circuit to Controlled Load circuit  Figure 3: Final Connections

Concluding Comments

The changes to process have recently occurred. Installers noted that they are less likely to be called back multiple times to clarify with the MCs the connection between the smart meter and the smart water heater circuit.

8. Ensure the supply chain is optimised to manage flow of required chips

During the project, Rheem and Combined Energy Technologies experienced the effects of the current global shortage of semiconductors ('chips') needed to manufacture its smart electric water heaters and the HEMS hardware. This shortage was exacerbated by supply chain issues caused by the Covid-19 pandemic and the war in Ukraine. Transport of components was hampered and testing was made more difficult.

Learnings – reduce reliance on specific semi-conductor chips

The project attempted to squeeze as much performance out of the semiconductor chips that they procured. They have also strived to reduce reliance on specific chips, endeavouring where possible to rearchitect systems and processes that can be delivered by more generic and readily available chips.

As the project was fundamentally about adding intelligence to devices, it was increasingly necessary to have multiple designs for products particularly as they were tied to specific chips or technology i.e., power meter (i.e., redesigning it to use an alternate chip).

The project also started procuring chips not based on specific technical properties but more on the availability of pin component alternatives in the market. Accordingly, the project was no longer at the mercy of chip shortages. A real positive for the project was that Rheem felt it could engineer its way out of issues and use more generic components and design systems that were tolerant of more common chips and not dependent on highly specialised components.

Concluding Comments

In broader terms, the project has learned that any device that is reliant on smart chips, should always build in a 'design' redundancy so that it allows for flexibility of hardware, particularly semiconductors.

Appendix A: Project Information

Project Background

Water heating is a significant electricity sink, ***comprising 25% of household energy use in Australia*** (the second largest segment of household energy consumption behind space heating and cooling). As a large energy-using appliance that can be "time-shifted", many DNSPs offer a controlled load tariff that is applied to electric water heaters during off-peak times (referred to as Off-Peak Controlled Load, OPCL), so that they can draw electricity at a predictable time and a cheaper rate. In South Australia, this load is set through static time switches to operate overnight between 11 PM and 7 AM. Similar timings for OPCL exist across all NEM regions.

This off-peak timing is based on historic centralised generation and transmission network loads which have become outdated due to high penetrations of residential solar in the network. With growing rooftop PV penetration, significant volumes of electricity are being generated such that grid demand during the middle of the day is being reduced to record low levels, creating the "duck curve" (see Figure 1 below). In addition, PV uptake has increased variability in the range of power flows that the network must be able to support (i.e. demand transience due to cloud cover, fluctuations in demand between the middle of the day and the late afternoon) and can cause power quality issues such as high voltages when PV systems are at peak output. This can limit the renewable energy hosting capacity of networks unless costly network solutions are employed (e.g. transformer taps, voltage regulators, load compensators) or customers are incentivised to shift load through energy storage or demand management incentives.

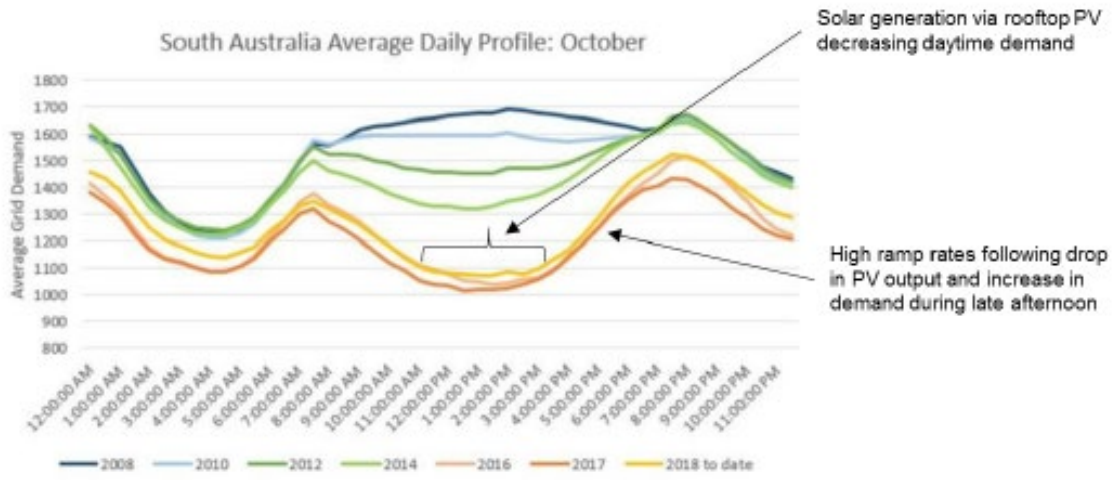


Figure 4: Impact of solar PV on daily demand profiles in South Australia.

SA Power Networks (SAPN) has over 300,000 off-peak hot water storage loads throughout its distribution network. Assuming an average water heater power draw of 3.6 kW, this equates to 1,080 MW of untapped DER load, with a total average daily

energy consumption of between 3 – 4.5 GWh (based on 10 - 15 kWh of water heating per tank per day - weather and seasonally dependent). This represents a significant energy storage capacity across South Australia, and more widely the NEM, yet to be harnessed.

In South Australia, currently, electric hot water systems on controlled load are switched on at a fixed time via mechanical time switches at the customers' premise, or in switches that have been incorporated through electronic meters. SAPN's control over electric water heaters is limited to these time switches, which cannot be controlled dynamically or remotely, thus timing cannot be varied without manual adjustments for each customer. Furthermore, all hot water systems are currently running at their full load rating when heating, at a significant ramp rate which has previously driven spikes in electricity prices in SA.

Rheem's Smart Network project aims to demonstrate how this significant energy resource could potentially be brought under control using novel technology developed through 5 years of innovation in variable power water heating and home energy management systems. The project aims to test different strategies to shift the timing of water heating to consume excess solar PV generation during the day.

Project Overview

The SA Smart Network project aims to explore alternative approaches for shifting the timing of and demonstrating active control over hot water systems within South Australia.

The project will explore the potential for 2,400 residential hot water systems along with (at a minimum) 200 air conditioning systems and 200 pool pumps to provide aggregated demand response within a Virtual Power Plant (VPP) to deliver wholesale market value to participating customers. The project will test the potential to derive further wholesale value and deliver Frequency Control Ancillary Services (FCAS), in addition to bill optimisation for trial participants.

Furthermore, the project will investigate hot water control by testing a range of technologies and product offerings, developed to maximise participation from customers, assess customer preferences for participating in hot water demand management, and demonstrate a low-cost and scalable solution to providing active control. This will include the development and commercialisation of a retrofit device that can be added to existing water heaters.

The project also involves collaboration with Combined Energy Technologies (CET), a leading provider of home energy management systems (HEMS) in providing active control over the hot water systems, SA Power Networks in developing a network tariff to incentivise hot water load shifting and a number of Project Retailers to develop a range of product offerings to achieve customer participation in the aggregation/orchestration of hot water systems within the VPP and to pass back value derived in the wholesale market to participating customers.

The Project will involve the development, deployment, and demonstration of three solar-smart electric water heater solutions (PowerStore, PowerStore Lite and a Retrofit

device) and two load control adapters, one for air conditioning systems and one for pool pumps. These devices will all be integrated with CET's HEMS. These products are described in the table below.

Technology	Quantity	Description
PowerStore	200 PowerStores in solar homes 200 PowerStores in non-solar homes	The PowerStore is a solar-smart electric water heater that was released by the Recipient to the market in Q3 2018. The PowerStore product can provide 15kWh of thermal energy storage and offers dynamic adjustments to its power demand on the network. The PowerStore will be available to customers who are replacing their hot water systems or to customers with new installations looking for a sophisticated and state-of-the-art HWS (with the benefits mentioned earlier).
PowerStore Lite	500 PowerStore Lites in solar homes 500 PowerStores Lites in non-solar homes	The Recipient is developing the PowerStore Lite which is designed to be a lower-cost deployment solution to the PowerStore. It will not offer the full functionality of the PowerStore, however, it will still offer active control. The PowerStore Lite will be available to customers who are replacing their hot water systems and customers with new installations.

Technology	Quantity	Description
Retrofit device	500 Retrofit devices in solar homes 500 Retrofit devices in non-solar homes	The Retrofit device will be developed to be retrofitted to existing hot water systems, targeting households that are not replacing their hot water systems. The devices will be low-cost and allow for rapid deployment and will be available to solar and non-solar homes. The device will enable active control of existing hot water systems targeting customers with suitable water heater systems that are willing to upgrade to the new technologies to take advantage of savings and assist with grid stabilisation.
Air Conditioning System Adapter	200	The air conditioning adapter will be developed to interface with existing air conditioning systems. These devices will be targeted at existing customers within the project to further increase the value of their solar smart electric water heater and Home Energy Management Systems
Pool Pump Adapter	200	The pool pump adapter will be developed to function with pool pump systems. These devices will be targeted at existing customers within the project to further increase the value of their solar smart electric water heater and Home Energy Management Systems

Technology	Quantity	Description
HEMS	The HEMS will be integrated with the PowerStore, PowerStore Lite, Retrofit and load control adapter devices	CET's Home Energy Management System (HEMS) is the interface that enables active control of the hot water systems and other DER using Power Line Telecommunications (PLT) and allows the CET/Rheem cloud-based application (Virtual Power Plant) to monitor and control household loads to shift the load into the solar period, to lower energy costs for consumers and to participate in stabilising the grid.

Table 2: Project technologies

Project Objectives

The project seeks to demonstrate that hot water systems can provide aggregated demand response within a Virtual Power Plant (VPP) and deliver potential wholesale and Frequency Control Ancillary Services (FCAS) value to participating customers.

The objectives for the Project will be achieved through the following outcomes:

- Improved understanding of the feasibility of different approaches for shifting hot water load to provide network value in South Australia, including the development of new tariff structures that reward electricity consumption aligned with VRE generation.
- Improved understanding of the incorporation of hot water load within a broader demand management package (through the inclusion of other household controllable loads or DER types), as well as assessing customer preferences for different incentives.
- Understanding the potential savings that solar and non-solar customers could receive on electricity bills because of active control of hot water systems or load shifting and proposed new tariff structures (Time of Use tariffs).
- Test the potential wholesale energy and potential FCAS value of aggregated hot water systems and other DER types as part of a VPP, with visibility for SAPN and the Australian Energy Market Operator (AEMO).
- Advance the commercialisation of a locally retrofit device to control hot water load in SA.

Project Stakeholders & Participants

The Project partners with Rheem Australia are:

- Combined Energy Technologies (CET) - will develop the Home Energy Management System (HEMS) interface that will enable active control and aggregation/orchestration over the hot water systems.
- South Australia Power Networks (SAPN) - will develop a network tariff structure to incentivise hot water load shifting and promote the use of active control for such devices.
- Project Retailers – will develop a range of product offerings to achieve customer participation within the VPP and to pass on the value derived from the wholesale market to participating consumers.
- Marchment Hill Consulting – will be responsible for the Knowledge Sharing deliverables for the duration of the Project.

Appendix B: Meter exchange process

PowerStore smart meter circuit selection process with key decision points highlighted.

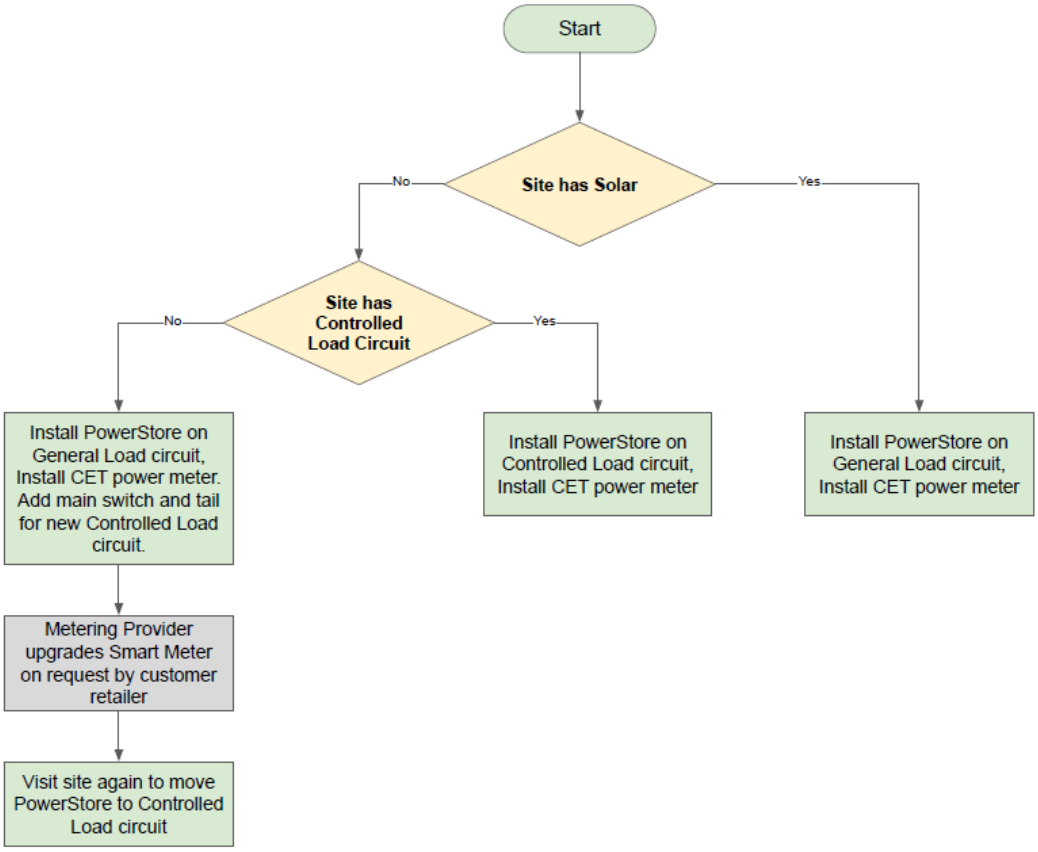


Figure 5: Updated Connection Process identified by new retailer