Stage 3 Knowledge Sharing Report

Simply Energy VPPx

August 2021 – Public Report

MARCHMENT HILL CONSULTING

Acronyms

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
API	Application Programming Interface
ARENA	Australian Renewable Energy Agency
DER	Distributed Energy Resources
deX	Decentralised Energy Exchange
DNSP	Distribution Network Service Provider
DMO	Distributed Market Operator
DSO	Distributed System Operator
ESS	Energy Storage System
FCAS	Frequency Control Ancillary Services
ISO	Independent System Operator
kW	Kilowatt
kWh	Kilowatt Hour
MW	Megawatt
NEM	National Energy Market
PV	Photovoltaic
SA	South Australia
SAPN	South Australia Power Networks
SE	Simply Energy
VPP	Virtual Power Plant

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.

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Executive Summary

About the Project

VPPx is an ARENA-funded project that is building the first virtual power plant (VPP) to integrate with a distributed energy market platform. The VPP is now hosting over 1,300 energy storage systems delivering 6MW of flexible capacity to the South Australian (SA) electricity grid.

Commenced in March 2018, the project is led by Simply Energy and involves close collaboration with a consortium of project partners including platform provider GreenSync, energy storage system (ESS) provider Tesla and distribution network service provider SA Power Networks (SAPN). GreenSync's Decentralised Energy Exchange (deX) trading platform is being developed as part of the project. deX enables the 6MW fleet of flexible capacity to provide wholesale energy services, frequency control and ancillary services (FCAS) and potentially network support services whilst maintaining network security and stability for the local distribution network.

The ambition and sophistication of VPPx is providing valuable insights on the integration and orchestration of distributed energy resources (DERs) using VPPs based on real-world experiences, including customer willingness and preferences to participate. This includes the operation, architecture and responsibilities of the parties interacting within a distributed energy marketplace and trading platforms such as deX. These learnings are intrinsic towards the integration of DERs into electricity systems around the world as they become more decentralised.

Report Overview

This third and final Knowledge Sharing report provides updates on the VPPx market rollout and technical learnings. It also explores the benefits delivered across different stakeholder groups and provides detailed results of multiple VPP customer satisfaction surveys.

The key outcomes from Stage 3 of the VPPx project are:

- The VPP fleet expanded further to exceed its original rollout target.
- The project completed FCAS trials and successfully registered for FCAS markets.
- Dispatch testing provided additional technology learnings.
- The economic benefit has been captured across stakeholders.
- Customer satisfaction and feedback was captured – with positive results.

These outcomes are summarised further below with full detail provided in the main body report following.

The VPP Fleet Expanded Further to Exceed its Original Rollout Target

A summary of ESS sales and VPP integration at the end of Stage 3 is shown in Table 1.

	VPP Sales Target	ESS Sales Achieved	ESS Integrated into VPP
VPP Participation:	1,200	1,363 (114% of target)	1,361 (99.9% of fleet)
Accounting for churned customers		Plus 115	Plus 115
Total		**1,478** **(123% of target)**	**1,476** **(123% of fleet)**

Table 1: VPPx customer participation volumes.

In order to test customer price sensitivity, a planned rollout of C&I DR assets was instead directed towards additional battery sales at reduced subsidy levels. The results of this test (which included 3 different price points ($1,275, $2,550 and $2,500 plus $1,000 up front payment) for VPP subsidy levels) demonstrated the high price sensitivity of customers, clearly indicating that finding a competitive price level is critical to driving residential battery storage uptake and attracting participating in a VPP.

➢ Further details of sales progress are discussed in **Section 2** of this report.

The Project Completed FCAS Trials and Successfully Registered for FCAS Markets

Extensive DER and fleet testing was conducted during the second half of 2020 to register the project to participate in FCAS markets. Testing was undertaken at a frequency band between 49.99 Hz to 50.01 Hz. It was noted that customers noticed changes to the performance of their batteries during testing periods. A key learning from this is that any future potential impacts on battery performance should be communicated in advance to participating customers.

The VPPx program was granted FCAS market access by AEMO on 16th October 2020 for 3MW and on 30th June the capacity was raised to 4MW (only the Tesla Powerwall fleet where capable of meeting AEMO requirements for FCAS) of contingency FCAS in all 6 markets:

Contingency FCAS frequency “raise” markets:

- Fast Raise
- Slow Raise
- Delayed Raise

Contingency FCAS frequency “lower” markets:

- Fast Lower
- Slow Lower

- Delayed Lower

The VPPx started trading in FCAS markets on 20th October 2020. Since then to the end of June 2021, Simply Energy generated approximately $483,000 of FCAS revenue.

➢ Details of benefits accruing from the FCAS market are discussed in **Section 3** of this report.

Dispatch Testing Provided Additional Technology Learnings

The key learnings from Dispatch Testing were:

- The average dispatch effectiveness for the VPP throughout the year was 61% (i.e. on average 61% of the VPP fleet met the requested dispatch signal). Increasing dispatch effectiveness of the VPP would contribute to reactive power, real power and frequency support for the grid. Dispatch effectiveness improves during the course of a daytime period and is improved further as local voltage levels decline during the early evening.
- While the majority of battery systems responded to the dispatch requests, the aggregated fleet was unable to provide its maximum available output due to technical constraints including export limitations, excessive grid voltage and to a lesser extent, communication issues.
- Battery performance was also evaluated in terms of ability to provide reactive power, real power and frequency support for the grid. Results demonstrated that VPP-enabled batteries can contribute to strengthening the resilience of the grid, but that local grid limitations result in constraining the ability of the batteries to respond to market demand.
- Tests were also undertaken on the seasonal variations in operating conditions to better understand these variations and how they impacted the operation of the ESS. The solar generation potential, electricity demand and usage behaviour change significantly across different seasons of the year, creating seasonal variation in the local grid conditions.
- Voltage variations observed at the inverter during dispatch:
  - 10am dispatches: Average voltage increase of fleet was ~6 volts. Voltages during the Q4 10am test showed a 7 volt increase on dispatch which took the average fleet voltage to 250-251 volts. The Q1 dispatch showed a similar level of voltage increase but was not as severely constrained.
  - 2pm dispatches: Average voltage increase was ~5 volts and appeared to reach or exceed 250 volts. Q3 reached the highest at 253 volts however the Q3 starting point appears around 3 volts higher than other quarters.
  - 6pm dispatches: Average voltage increase during dispatch was ~4 volts which took the average fleet voltage to 245 volts. The 6pm discharge proved to be the most efficient of the dispatch periods considered.

➢ Further details of additional technology learnings are discussed in **Section 4** of this report.

The Economic Benefit Has Been Captured Across Stakeholders

The Economic Assessment considered the value the VPPx generates (both quantitative and qualitative benefits) across a number of stakeholder groups including customers, project partners, DNSPs, Simply Energy and the broader NEM.

Value generated for <u>customers</u>

Change after ESS installation	Energy (kWh)	Est. value ($) p.a.
Energy exported to the grid	117.1 less	$210.84 per year less FiT revenue (net cost)
Energy imported from the grid	166.9 less	$879.23 per year cost savings (net benefit)
	Net customer value:	$799.08 - $210.84 = **$668.39 saved per year**
Payback period		
Out of pocket upfront ESS investment cost, after SA HBS rebate and Simply Energy subsidy which is paid over a time period to the customer	$2,714.13 (sales weighted average)	
Payback period (ave.)	**4.0 years**	

Table 2: Customer savings and payback period

Value generated for <u>Simply Energy</u>

- Wholesale market benefit was generated at an average of $115/p.a. per Tesla Powerwall wholesale arbitrage from Jan 2019 to June 2021.
- Approximately $483,000 of FCAS revenue was generated from October 2020 to end of June 2021, however FCAS revenues are volatile. Typically, $16k to $25k for every four weeks period but as high as ~$145k (March 2021) driven by network outages and higher wholesale energy prices.
- Opportunities to extract benefits from wholesale energy markets are limited, for example the market requires the VPP to remove availability of FCAS from its market offers if it wants to participate in the wholesale market. This requires forward planning and removes the ability of the VPP to provide an immediate response to wholesale energy market price volatility. FCAS has therefore become more critical.
- The VPPx has also been a strong customer acquisition program for the broader Simply Energy retail business, with 80% of VPP customers being new to Simply Energy (representing over 1,000 new customers). Only a small number of these new customers (115) have since exited the VPPx project, with many of these still staying with Simply Energy for retail electricity. This ‘stickiness’ is likely due to the strong degree of customer satisfaction experienced by VPPx participants.

Value generated for Distribution Network Service Providers (DNSPs)

- Capability to reduce daytime solar excess.
- Capability to respond to emergency generation curtailment signals.
- Insights into local network voltage levels.

Value generated for the NEM

The Simply Energy VPP fleet has generated value for the NEM by demonstrating the benefit of aggregated behind the meter capacity to respond to frequency disturbances, increasing self-consumption of solar PV generation that would have otherwise spilled into the local distribution system, responded by exporting energy in times of high demand and high price events in the NEM.

Simply Energy has contributed 3MW of FCAS into each of the six contingency FCAS markets from late October 2020 and as of late June 2020 will be contributing 4MW of contingency FCAS. Whilst FCAS has been the primary market that the VPP has operated in since October 2020, the VPP has traded 8.6MWh of energy into the market since late 2018. In addition to this the market has benefitted from an average of 166kWh reduction in grid demand per month per VPP customer.

Value generated for project partners (Tesla and GreenSync)

Tesla:

- Total of 967 Powerwalls sold representing 71% of the total VPPx battery fleet.
- Uptake driven largely by the ability for VPP customers to extract additional value from the battery beyond solar self-consumption or time-of-use tariff optimisation – and thereby lowering the cost of ownership.
- Tripled the number of Powerwall Certified Installers in South Australia to ensure sufficient geographical coverage and installation capacity to meet customer demand.
- Providing real-world learnings and supporting product development to enhance capabilities, reliability and scalability of the Powerwall product.

GreenSync:

- Provided the context and impetus to develop the deX platform and interfaces for DER registration, network DERMs management retailer VPP and ultimately deploy it into production as a commercial product
- Allowed platform scaling to manage thousands of diverse DER devices to be registered and controllable.
- Laid the foundations for deX in South Australia and has facilitated the realisation of subsequent initiatives in the State ie SA Smarter Homes

➢ Further details of the economic assessment are discussed in **Section 6** of this report.

Customer Satisfaction and Feedback Was Captured – with Positive Results

The project captured feedback from customers via two sources:

1. A customer survey led by Simply Energy, and
2. A "Virtual Power Plan Users Survey" conducted by AEMO.

The surveys both explored customer preferences and motivations for participation in the program, and their levels of satisfaction with the project to date. Key results from the surveys include:

- The Net Promoter Score (NPS) of Simply Energy VPPx customers is 64.8. This is very strong when compared against typical utility NPS scores (typically negative).
- Overall user satisfaction sits at an average of 8.8 out of 10 (correlating with the strong NPS score).
- The main factor in influencing consumer uptake of residential home battery systems and participation in VPP programs is the level of subsidy available. This aligns with the results of price sensitivity testing we conducted to test customer responses to changes in subsidies (see Section 2.7). Applying different levels of VPP benefit payments (based on the size of the energy storage system inverter and reflecting the benefit of the battery type to the VPP) is therefore an effective way to drive uptake in preferred technology and tailor the composition of the VPP fleet.
- COVID-19 did not have a material impact on the level of demand for home battery storage systems and VPP participation.

➢ Further details of the Customer Satisfaction and Feedback obtained are discussed in **Section 7** of this report.

1 About the Project and Report Overview

1.1 About the Project

Australia currently has highest per-capita uptake of behind the meter rooftop solar in the world. South Australia is one of the leading states in this transition, with a rooftop solar penetration rate of 34%. Overall, 52% of South Australia's total electricity supply comes from intermittent wind and solar PV generation[1]. This creates both risks and opportunities for the management of the electricity system in Australia and, specifically, South Australia.

One key opportunity is to harness the technical capabilities of DER to create a large amount of flexible, controllable electricity supply and demand to help balance the electricity system whilst driving towards a high renewable energy future. Additionally, there are also commercial opportunities to create products and services that help consumers gain control over their energy costs and support their environmental objectives.

Recognising the opportunities in this changing energy landscape and the alignment with its own sustainability objectives, Simply Energy has initiated collaborative efforts to evaluate the technical and commercial feasibility of a sizeable DER fleet, aggregated on the innovative GreenSync deX platform, where customers can actively participate in managing their energy needs.

Simply Energy and its project consortium initiated VPPx in March 2018, seeking to enrol 1,200 residential ESS across South Australia into a VPP. GreenSync's deX platform was to be further developed and integrated with the VPP to support access for additional value streams, DER visibility and constraint management by the local distribution network service provider, South Australia Power Networks (SAPN). Through this consortium, the partners intended to evaluate the technical feasibility and develop commercially viable solutions for the integration of DER into the electricity network.

Prior to this third (and final) Knowledge Sharing report, the first report was published in March 2019 and covered the establishment and initial sales, marketing, integration and operation activities. The second report was published in June 2020 and focussed on capturing the progress and lessons learned from Stage 2 of the project, incorporating progress up to February 2020.

1.2 Report Overview

This third and final Knowledge Sharing report covers:

Sales Update (Section 2)

A final update on the expansion of the ESS Fleet, including completion of all installations and onboarding of all participant DERs onto the VPPx.

Completion of FCAS Trials and Registration for FCAS Markets (Section 3)

Status update on the completion of FCAS Trials and Registration for FCAS Access.

[1] South Australia Electricity report by AEMO. Accessed online at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2019/2019-South-Australian-Electricity-Report.pdf

Technology Learnings (Section 4)

Additional technology learnings regarding ESS technical integration and operational activities.

Suitability of Regulatory Frameworks (Section 5)

Commentary on the suitability of regulatory frameworks for incentivising efficient economic outcomes from VPPs and any potential changes required to improve outcomes.

Economic Assessment (Section 6):

Outcomes of an economic assessment that considered:

- Value generated for customers.
- Value generated for Simply Energy.
- Value generated for DNSPs.
- Value generated for the NEM.
- Value generated for project partners (Tesla).

Customer Satisfaction and Feedback (Section 7):

Outcomes of surveys to capture VPP customer satisfaction and feedback

2 Sales Update

2.1 Sales and Integration Numbers

As the project closes, sales have closed at 1,363 (post-churn) on an initial target of 1,200. A planned investment in the rollout of C&I DR assets was instead directed towards additional battery sales at reduced subsidy levels to test price sensitivity.

Of the total sales, 1,361 of these have been successfully integrated into the VPPx program. While there was a ~3 month lag between sales and installs during Phase 2 (2019-2020), as the project closes out this has reduced considerably due to meter exchanges and droplet installations improving as well as the launch of a new online back office application to support installers.

	ESS Rollout Target	ESS Rollout Achieved	ESS Integrated into VPP
VPP Participation	1,200	1,363 (114% of target)	1,361 (99.9% of fleet)
Accounting for churned customers		*plus* 115	*plus* 115
Total		**1,478** **(123% of target)**	**1,476** **(123% of fleet)**

Table 3: Customer Acquisition numbers

2.2 Offers and Sales Channels

Simply Energy tested multiple product offerings, marketing approaches and sales channels to attract customers to its VPP offering. Figure 1 below offers a timeline comparison between the release of various offers and the rate of VPP uptake. This shows that as the project progressed and tested different offers and different marketing and sales channel approaches, customer uptake progressively increased. The key contributing factors in this timeline is the introduction of the Complementary offer and the SA HBS. The below commentary provides a more in-depth timeline.

Figure 1: Simply Energy VPP Product offer timeline.

2.3 S.M.A.R.T Storage offer

Simply Energy launched the S.M.A.R.T Storage offer in May 2018. This offer consisted of a subsidised bundled energy storage system (ESS) and “all you can use” electricity commodity offer to South Australian households with an existing solar PV system. The subsidised ESS was a 13.5 kWh Tesla Powerwall which required the customer to contribute $7,299 upfront (this price included a $5100 subsidy discounted from the total cost of the Tesla Powerwall and installation). Customers were then offered a fixed electricity offer of $2/day for all grid electricity consumed for a fixed, 5-year term. Additionally, customers were also offered the choice of a consumption-based market variable rate with feed-in-tariff for a 5-year term.

Uptake of the S.M.A.R.T Storage offer was slow with only 46 VPP offers sold at the end of 2018. Problems encountered included:

- The sales process was too long and was significantly impacted by the time required to explain the technical nature of the product with customers.
- The product was considered too expensive by customers; especially the $2/day offer.
- Installation was complex and problematic, with delays between sales and installations.
- Competition VPP programs in the market and home battery subsidies in South Australia made the market confusing for customers, who were trying to find the best offer that suited them.
- Multiple marketing channels were tested for the product, however they failed to convert into sales.

2.4 Complementary BYO Offer

In an attempt to enable customers to access both the SA HBS subsidy and the Simply Energy VPP subsidy, Simply Energy introduced a new "BYO Model". Under this arrangement, Simply Energy initially partnered with four solar PV sales and installation companies (installers) accredited for the SA HBS. Customers who purchased an eligible battery (one of the five batteries specified below) from this select group of installers would receive the SA HBS subsidy and would "BYO" their home battery to the VPPx to receive an additional $5,100 subsidy which is paid through monthly credits. Initially the monthly credits, called VPP Access Credits, was $3.50/day on the customer's account over 4 years, up to a total of $5,100. This resulted in significant positive uptake in customer interest and forthcoming sales. VPP Access credits were later increased to $7/day for 2 years, up to a total of $5,100.

Under the $7/day offer the project began to see a significant increase in sales. This was attributed to the addition of the SA HBS subsidy, the inclusion of 4 new eligible battery types as well as the use of installers as a referral sales channel. Simply Energy also made changes to its website to better attract battery/VPP searches. This BYO model also enabled the simplification of the sales process whereby installers could respond with their expertise in the sale and installation of the eligible battery and Simply Energy could respond to the sale of the electricity and VPP participation.

With the announcement of significant reduction in the SA HBS subsidy in March 2020, the project experienced a significant uptake of the VPP Offer with an average 190 sale per month over the February-April period selling out the remaining available offers under the program arrangement, generating a "waiting list" of customers eager to take up a VPP offer.

2.5 Reduced Subsidy Offers

To accommodate the high demand, and with the support of ARENA, Simply Energy was able to extend the VPP offer beyond 1200 batteries and provide a final Reduced Subsidy Offer. The project offered two reduced subsidy offers:

- $7/day for 1 year, up to a total of $2,550 for eligible energy storage systems with larger 5kVA inverters (i.e. Tesla, LG Chem and Eguana systems), and
- $7/day for 6 months, up to a total of $1,275 for smaller 3.3kVA or less inverters (i.e. Sonnen and Varta systems).

The following months from May 2020 to July 2020 the project experienced a sharp decrease in customer take-up, down to an average of 45 sign ups per month demonstrating the price sensitivity of customers when considering the purchasing of a home battery storage system. This also reflected the competitiveness of the VPP market in South Australia. The presence of competing VPP offers, particularly for Tesla Powerwall 2 storage systems which provided comparable discounts to our $2550 subsidy offer, but paid upfront, meant that more customers were opting for the other deals. In addition, the peak in sales during the March-April period due to the imminent reducing in the SA HBS subsidy led to a general downturn in activity across the market in the immediately following months.

With the sharp decline in customer interest and in an effort to finalise VPP offer sales the project released a final, limited offer which included a bonus $1000 upfront payment. This offer was only open to customers purchasing the larger 5kVA inverters (i.e. Tesla or Eguana systems) as these had been deemed the highest value systems for the VPP. Solar Edge/LG Chem were excluded due to software cost complexity and Sonnen systems were excluded from this offer due to the added cost and complication of the need to install a VPP enablement device (droplet) to successfully integrate these systems into the Simply Energy VPP. This approach was aimed at testing how price differentiation could help VPP operators to target a more optimal asset mix in their fleet. Each referring installer was given an allocation of the remaining available offers to provide to their customer base.

2.6 Technology Offerings

Five battery types and three DER controllers were available within the eligible home battery product range these included:

Energy Storage System

- ✔ Tesla
  - Tesla Powerwall 2
- ✔ Sonnen
  - sonnenBatterie eco 8.0/10,12,14
  - sonnenBatterie eco 8.2/10,12,14
  - sonnenBatterie eco 9.43/12.5,15
- ✔ Varta
  - Pulse 6
- ✔ LG Chem
  - RESU10H-R coupled with the AC Coupled SolarEdge HD Wave SE5000H-AUSACNNN2
- ✔ Eguana
  - Evolve 0513

DER Controllers

- ✔ GreenSync – deX Command
- ✔ Tesla – Gridlogic
- ✔ SwitchDin – StormCloud
- ✔ SolarEdge Grid Services platform

2.7 Customer Responses to Changes in Subsidies

The single key factor in customer uptake of Simply Energy's VPP offer has been price. The level of subsidy provided for the battery purchase and the VPP offer has varied significantly across the project timeframe and this has been reflected in the sales performance.

The sales profile over the 12 months from August 2019 is shown in Figure 2 below.

Key features of this profile include:

- At the beginning of 2020 there was a drop in sales coinciding with the Christmas and New Year holiday period.

- From February sales progressively started to pick up in line with sales numbers pre-school holiday period.
- On the 6th March the SA Government announced a $2,000 reduction in their HBS subsidy, which was to come into effect on the 14th April. This announcement generated a sharp increase in sales. The project's sales forecast had been targeting 1200 sales by early June but by late March the project was reaching the 1200 sales and when this information became known to customers, it increased demand even further as customers rushed to secure a subsidised place in the trial before they sold out. As a result, a waiting list of interested customers was created to manage demand. The imminent withdrawal of a benefit proved to be a far greater incentive than the initial announcement of a benefit, as the SA HBS and Simply Energy VPP subsidies had been in market for well over a year prior to this spike in demand.

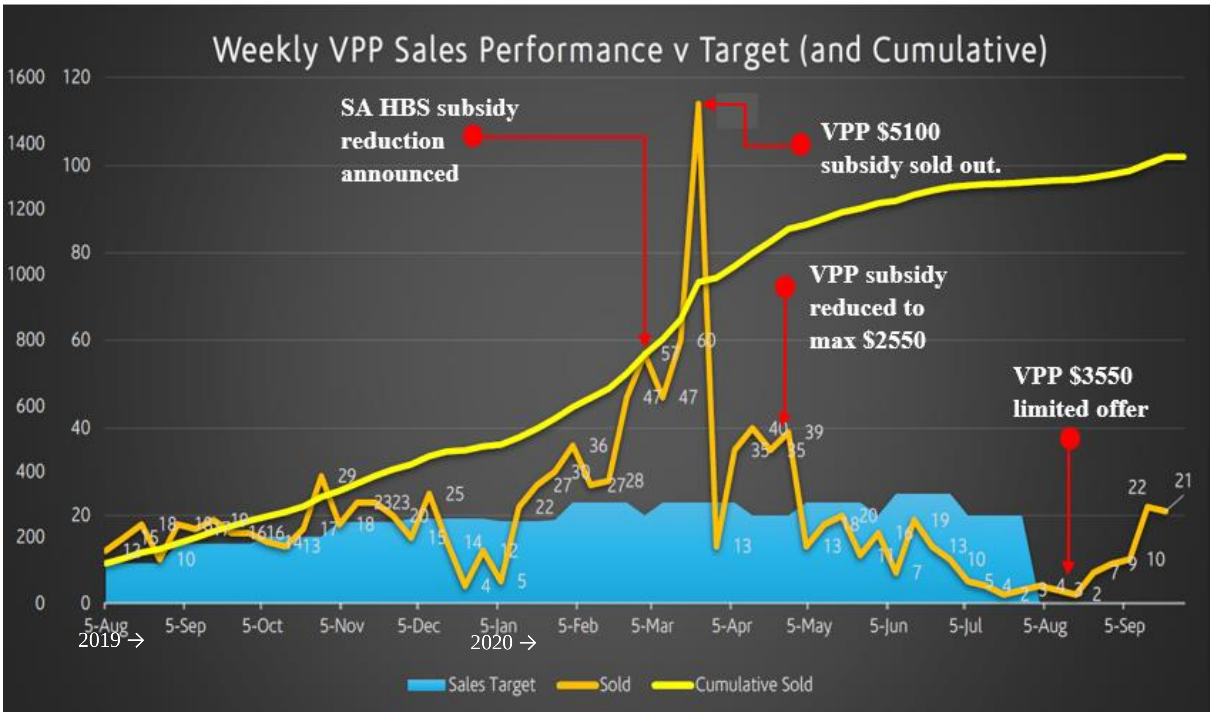

Figure 2: Weekly sales performance for the Simply Energy VPP offer.

- The significant drop at the end of March shows when the sales were placed on hold. Over the month of May the project team worked through the waiting list to allocate the remaining sales for the full subsidy, BYO offer.
- In May the new reduced subsidy offer was launched. Customers reacted to a further reduction on subsidy with sales significantly reducing over time to one or two sales a week, indicating that these offers were uncompetitive.
- In late August, the final offer was launched with an extra $1000 to be paid upfront. There was an immediate increase in sales as customers responded to the increase in subsidy.

The overwhelming battery of choice for customers in the Simply Energy VPP is the Tesla Powerwall, making up over 71% of the installed battery types in the Simply Energy VPP to date. This proportion is likely to grow as a Tesla's received higher levels of subsidies at the end of the program, resulting in more sales.

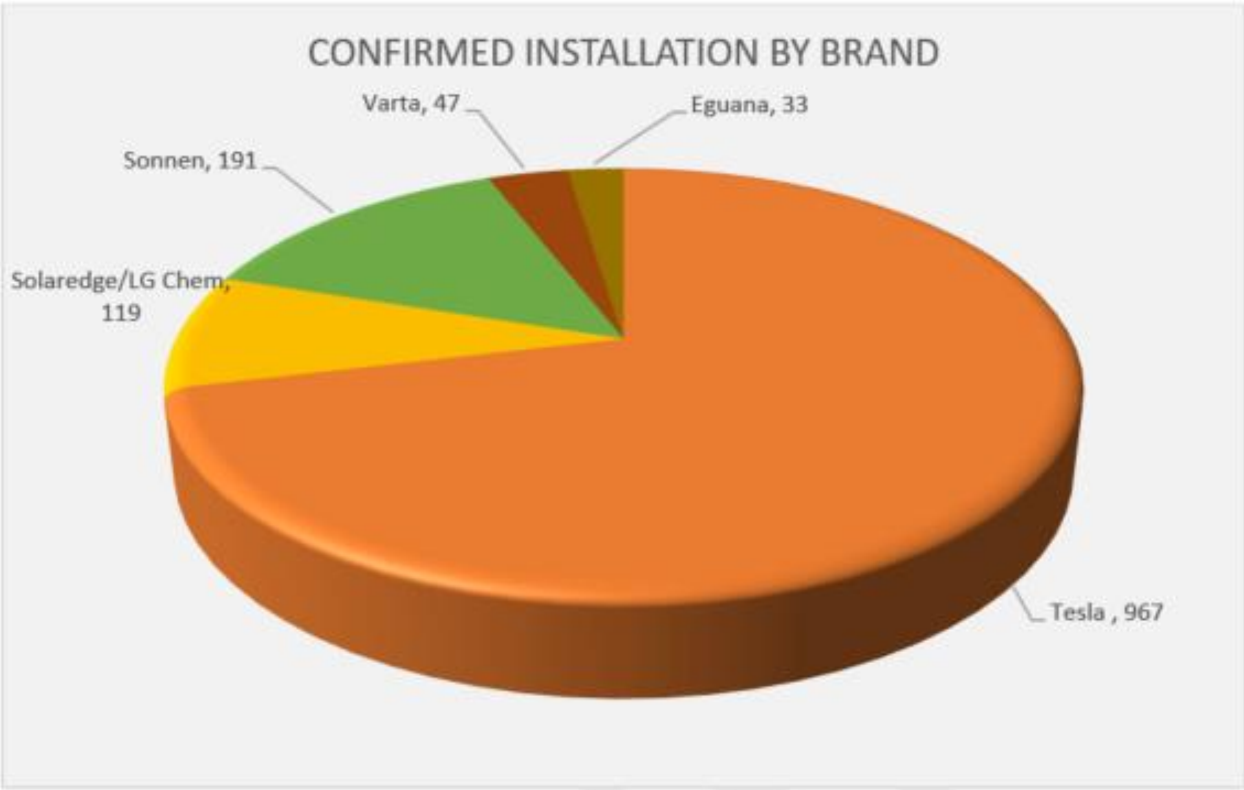

Figure 3 shows the distribution of confirmed installations by battery type with a strong preference for Tesla Powerwalls (as at June 2021).

The impact of the reduced subsidy offers on the sales of each battery type is shown in Figure 4.

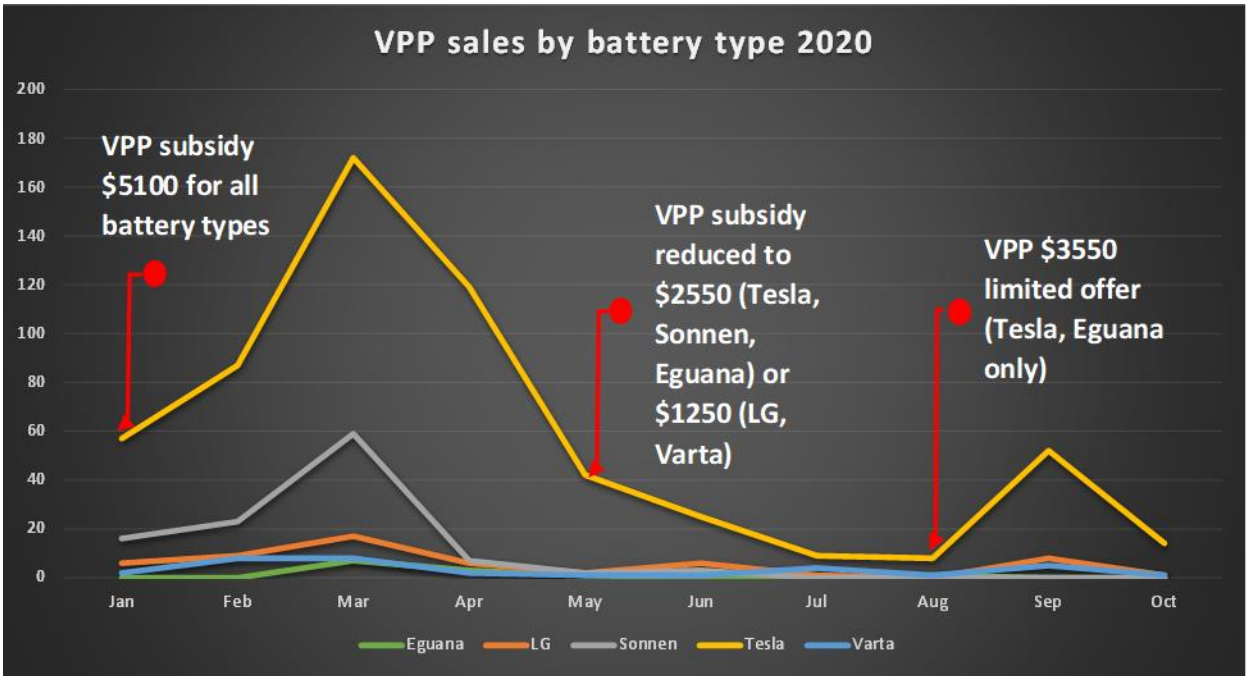

Figure 4: VPP sales by battery type in 2020.

This shows how the reduced subsidy offer significantly reduced the sales of all battery types, but particularly the Tesla Powerwall units, as other offers in the market proved to be more competitive.

The $1,000 increase in VPP subsidy in late August made the offer competitive once more for customers looking for a Tesla Powerwall, resulting in a significant lift in sales. The Sonnen systems, which were excluded from the $1,000 bonus offer did not see any increase in sales. This contrasts to the sales spike in March when Sonnen was the second most popular battery across the range as it received the same subsidy levels as the Tesla Powerwall. Interestingly, the Eguana systems also did not see any increase in sales in September even though they too were eligible for the $1,000 bonus payments. This is likely to be due to the price premium of the Eguana systems over the Tesla Powerwall.

These results clearly indicate that finding a competitive price level is critical to driving residential battery storage uptake and attracting participating in a VPP. It also shows how VPP operators can differentiate customer incentives based on the value of the asset to the VPP to optimise the composition of their fleet.

3 Completion of FCAS Trials and Registration for FCAS Markets

During second half of 2020, extensive testing occurred as a necessary element of registering the fleet with AEMO to provide FCAS. The project aimed to get as many frequency response capable DERs registered as possible so as to maximise the initial MW registration with AEMO. In normal day to day operation, the VPP has operated with a 0.7% droop setting which essentially means that each DER should be discharging 5kW should the frequency fall to 49.5Hz and charging 5kW if the frequency increases to 50.5Hz – a proportional response is provided below 50.5Hz or above 49.5Hz. In reality, there is generally some flow to or from the battery from loads within the home or from the solar PV, so a delta response is provided by each DER.

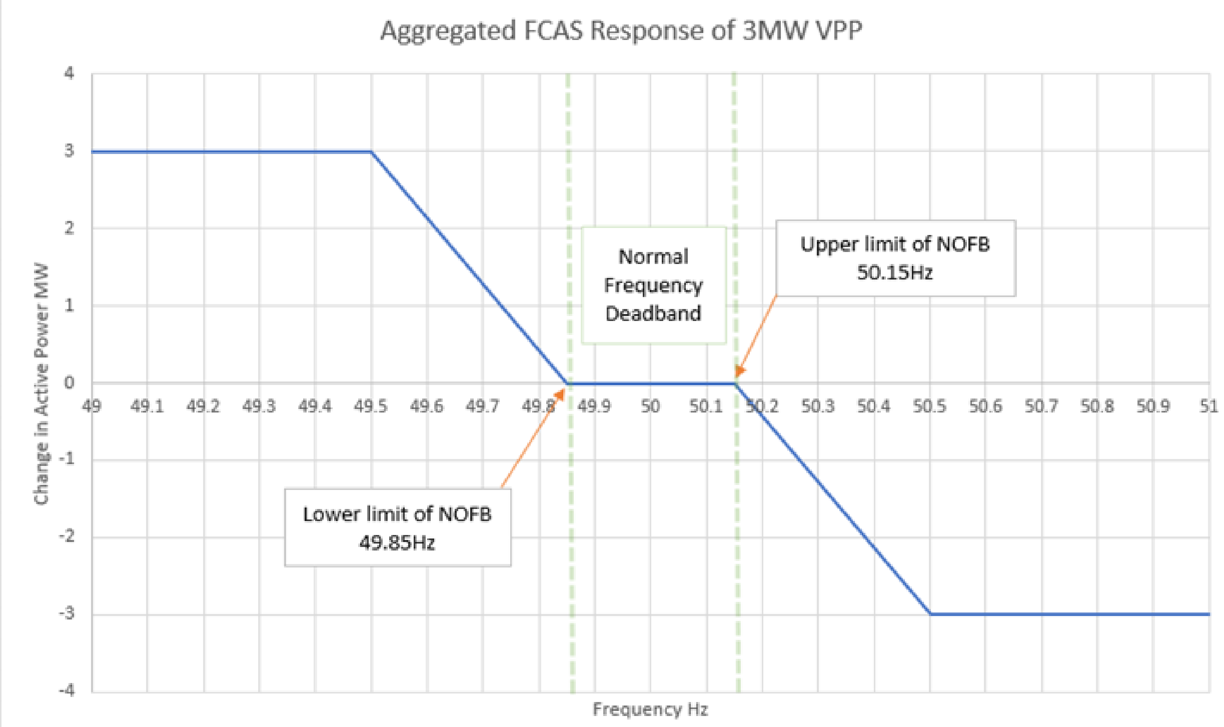

Figure 5: Anticipated response from the aggregated fleet during normal operation.

AEMO offered the option of conducting a frequency injection test to the DER aggregation which would have involved artificially changing the frequency on each DER or, narrowing the frequency deadband within the software to capture an event using a real-world change in frequency. Following consultation with the manufacturer of the DER's it was concluded that a frequency injection test would not be possible and that the narrowing of the frequency deadband was the suitable approach.

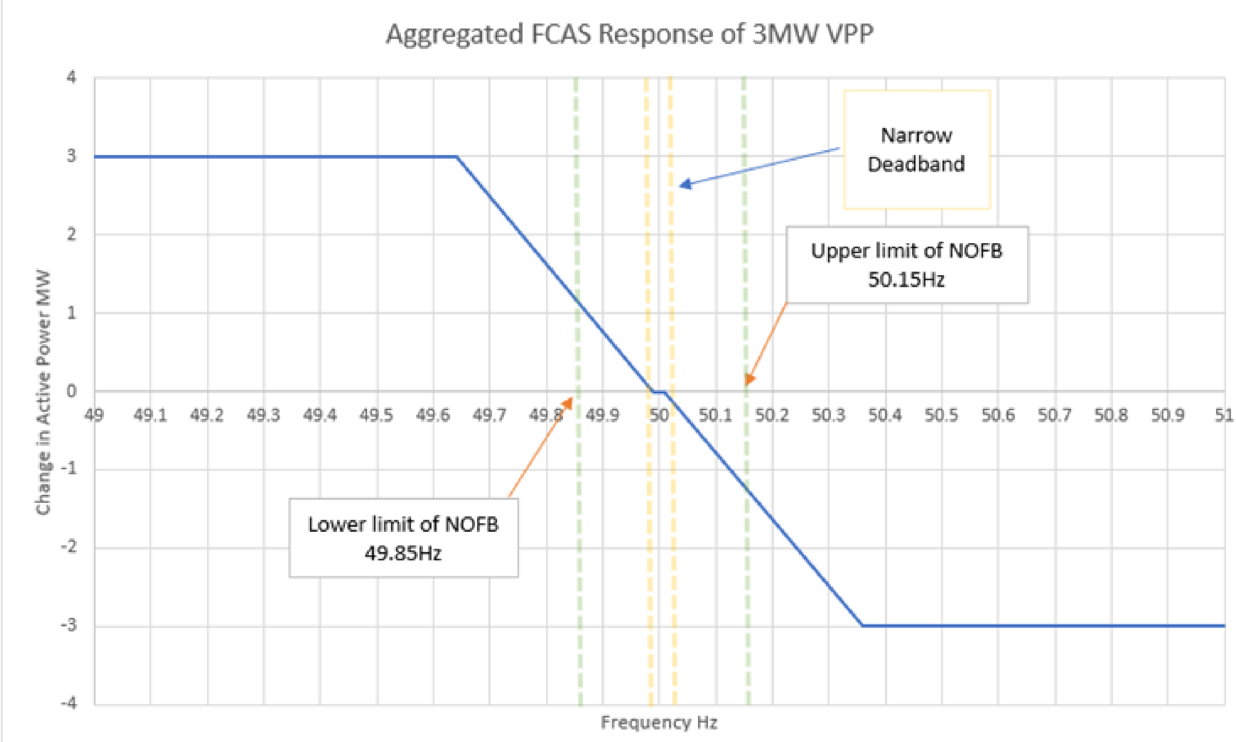

Figure 5: Anticipated response from the aggregated fleet during testing, using the narrow deadband.

In addition to learnings relating to the ability of the fleet to respond to frequency disturbances, another key learning was the customer response during testing periods. Because the frequency testing band was so narrow the DER responded significantly, and customers noticed, suspecting their ESS was faulty and raising concerns.

Some high-level analysis using historic frequency change alerts from our market monitoring software packages provided us with some insight as to which periods of the day were most susceptible to a frequency event. During our September 2020 testing we found this to be between 10:00 and 16:00 AEST. In light of this, we limited testing to weekdays between the hours of 10:00 and 16:00 AEST and communicated our intention to test with customers via SMS to try and alleviate any concerns regarding the operation of their battery.

The graph following shows the fleet response from frequency excursion during a test on the 30th September 2020. During the test, Simply Energy applied the narrower deadband of 49.99 Hz-50.01Hz to simulate that how the fleet would respond during a typical contingency event. The test saw 739 Tesla Powerwall systems enabled for frequency response and responded in aggregate to the frequency event. In this fleet wide test initially, there was raise service activated followed by a lower service few minutes later.

As can be seen from the response, the aggregated fleet did over deliver whilst conducting raise services, this should be expected as the fleet consisted of 739 Tesla Powerwalls, each of which was providing its own proportional response rather than providing a response to specific whole megawatt, as is required by the market. As the individual batteries would've been charging from solar PV (at 10:59 AEST), they were more capable of providing a positive (delta) response. Conversely, when the frequency passed through the deadband above 50.01Hz, most of the aggregated fleet would have been charging from solar PV, meaning that the fleet was marginally less capable of providing lower services than raise services, hence the required battery power and battery power are much closer from around 400 seconds.

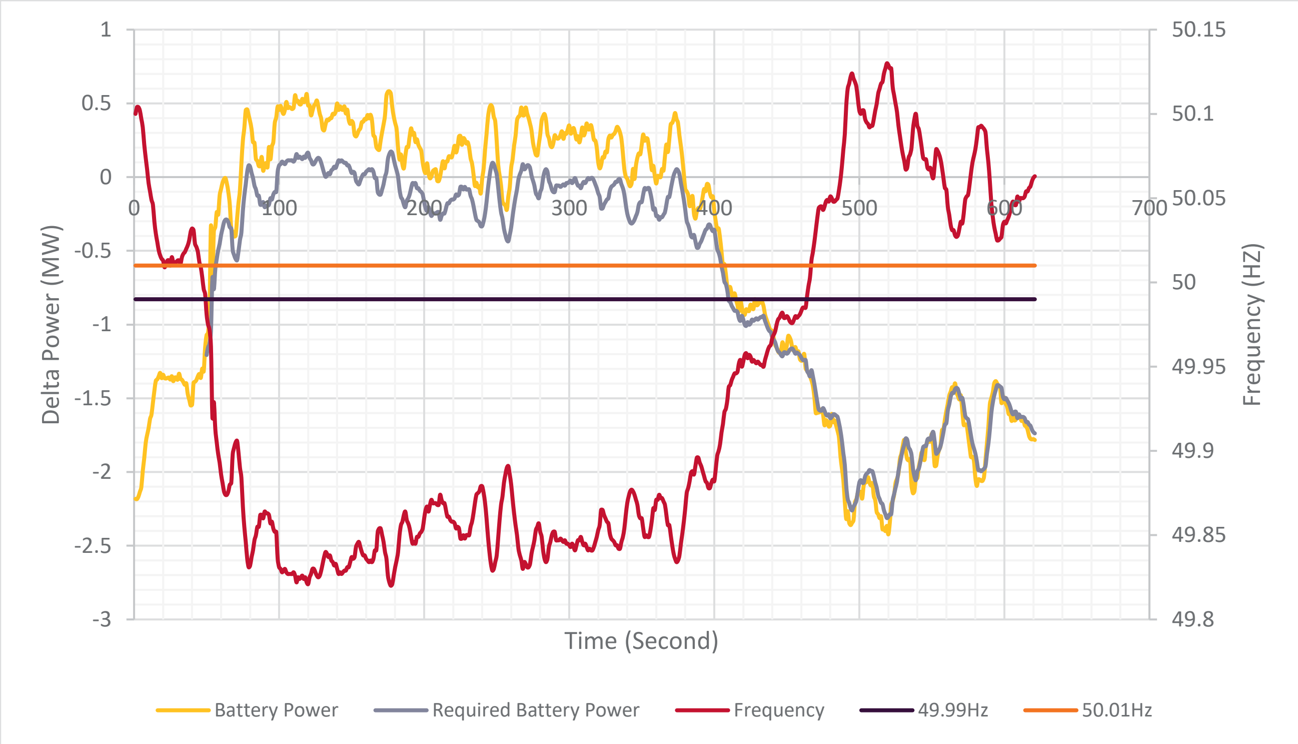

Figure 7: Fleet frequency response

The above fleet response was used to successfully register into the Contingency FCAS markets on 16th October 2020 for 3MW of contingency FCAS capacity, with trading starting 20th October 2020. The VPPx program has been granted FCAS market access for 3MW of contingency FCAS in all 6 markets:

- Contingency FCAS frequency “raise” markets: Fast Raise, Slow Raise, Delayed Raise
- Contingency FCAS frequency “lower” markets: Fast Lower, Slow Lower, Delayed Lower

4 Technology Learnings

4.1 Dispatch Testing

4.1.1 Dispatch Testing Key Learnings

The VPP was dispatched with a greater fleet size in comparison to Stage 2, allowing Simply Energy to test changes to its functionality. In all events, the home battery systems responded to the dispatch requests, but the aggregated fleet was unable to provide its maximum available output due to technical constraints including export limitations, excessive grid voltage and to a lesser extent, communication issues. As per seasonal testing, an average dispatch effectiveness for the VPP was 61% (i.e. on average 61% of the VPP fleet met the requested dispatch signal). Increasing dispatch effectiveness of the VPP would contribute to reactive power, real power and frequency support for the grid.

In addition to the effectiveness of the individual storage systems to optimise self-consumption, the performance of batteries has been evaluated in terms of their ability to provide reactive power, real power and frequency support for the grid. The test results demonstrated the technical capability of batteries to respond to the functions tested by the VPP within the limitations of voltage, export limits and technology design. The results show that VPP enabled batteries can contribute to strengthening the resilience of the grid, but that local grid limitations result in constraining the ability of the batteries to respond to market demand.

Tests were also undertaken on the seasonal variations in operating conditions to better understand these variations and how they impacted the operation of the ESS. The solar generation potential, electricity demand and usage behaviour change significantly across different seasons of the year, creating seasonal variation in the local grid conditions.

4.1.2 Dispatch Testing Approach and Results

Whilst the team had been able to conduct testing prior, we wanted to explore how the fleet behaved during dispatches at different times of day and during different quarters of the year.

Our understanding of how the DER's work in general led us to hypothesise that during the Q1 that the DER would be less capable of dispatching by 6pm due to the increased solar self-consumption by the likes of air conditioners.

We also believed that the 10am dispatches wouldn't deliver as a reliable dispatch than those later in the day, primarily due to it being shortly after the morning peak demand and the solar PV having only generated for a few hours.

Dispatch Testing was undertaken on a random workday each quarter. During each of the days the fleet of ESS were instructed to dispatch as much as possible. The fleet was made up of Tesla Powerwall, Eguana Evolve, LG Chem/Solar Edge, Varta and Sonnen ESS installations. The results of the testing are detailed below.

The following shows testing results at 10am on a weekday with the Q1 (Jan-Mar) discharge peaking at an average of -3,483W. The Q2 test at 10am shows that it performed the poorest of all the 10am tests, peaking at just -1,854W. When comparing the range of dispatch outcomes for the 10am dispatch (-2180W to -3483W) against the 2pm (-2398W to -3592W) and 6pm (-2777W to -4169W) dispatches, the 10am dispatch appears to have performed the poorest, supporting our hypothesis.

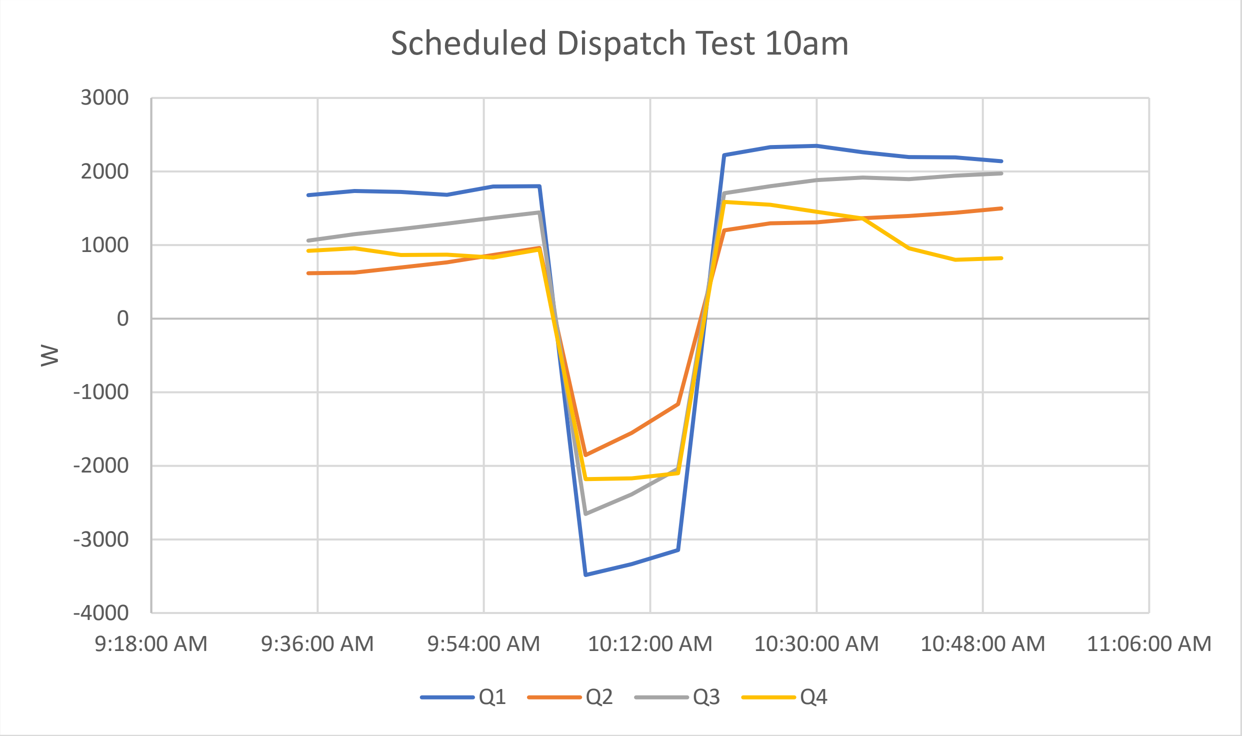

Figure 8: Scheduled Dispatch Test 10am

The following chart demonstrates how the dispatch efficiencies change throughout each 5-minute period of the dispatch as well as throughout the year, on average the fleet provided 48% of its nameplate power capacity at 10am. These efficiencies have been normalised against the average ESS size in Wh. Note that 100% would depict each DER inverter delivering its nameplate capability.

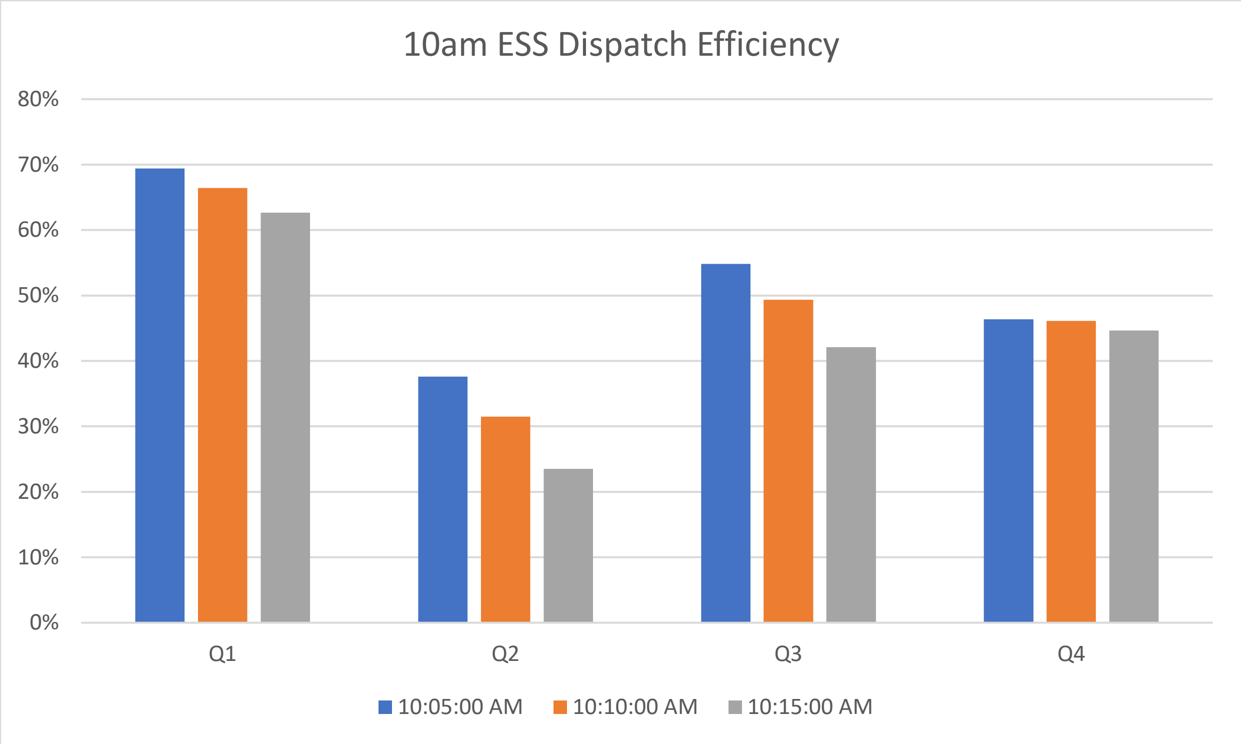

Figure 9: 10am ESS Dispatch Efficiency

Compared to the 10am tests, the 2pm tests throughout the year follow a much more linear performance, with Q1 performing the best and Q4 performing the poorest.

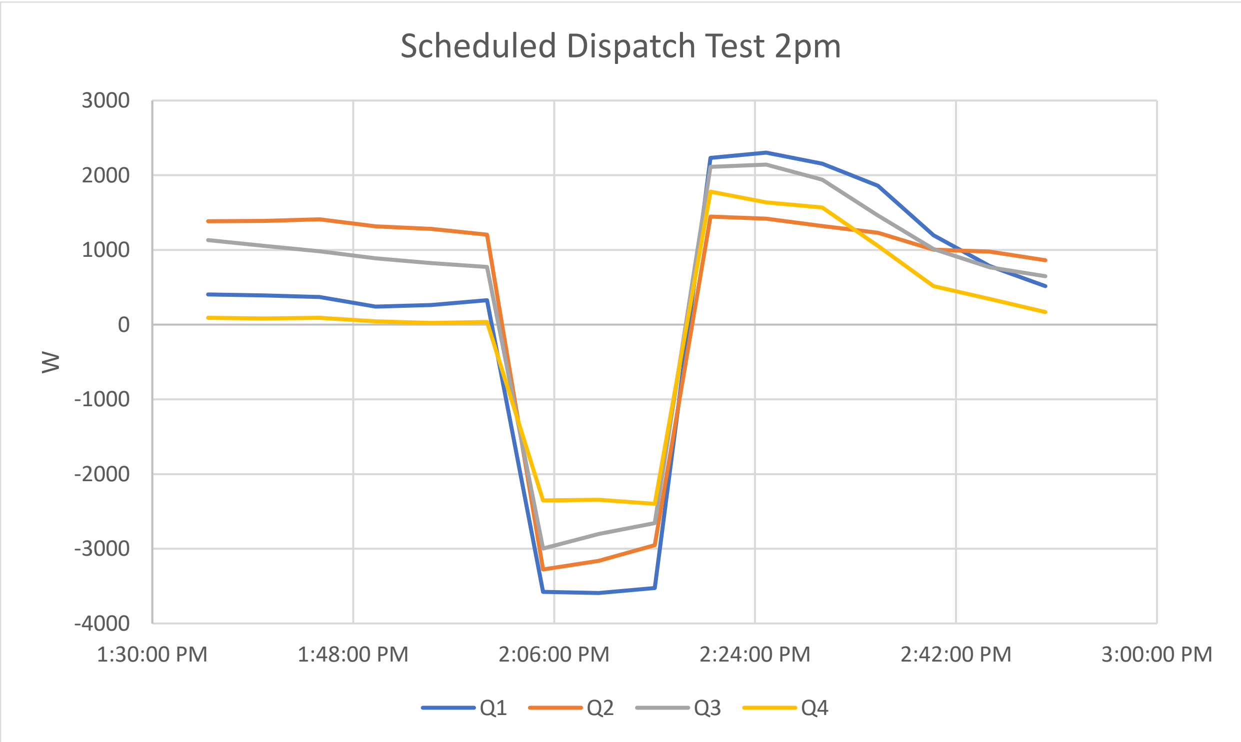

Figure 10: Scheduled Dispatch Test 2pm

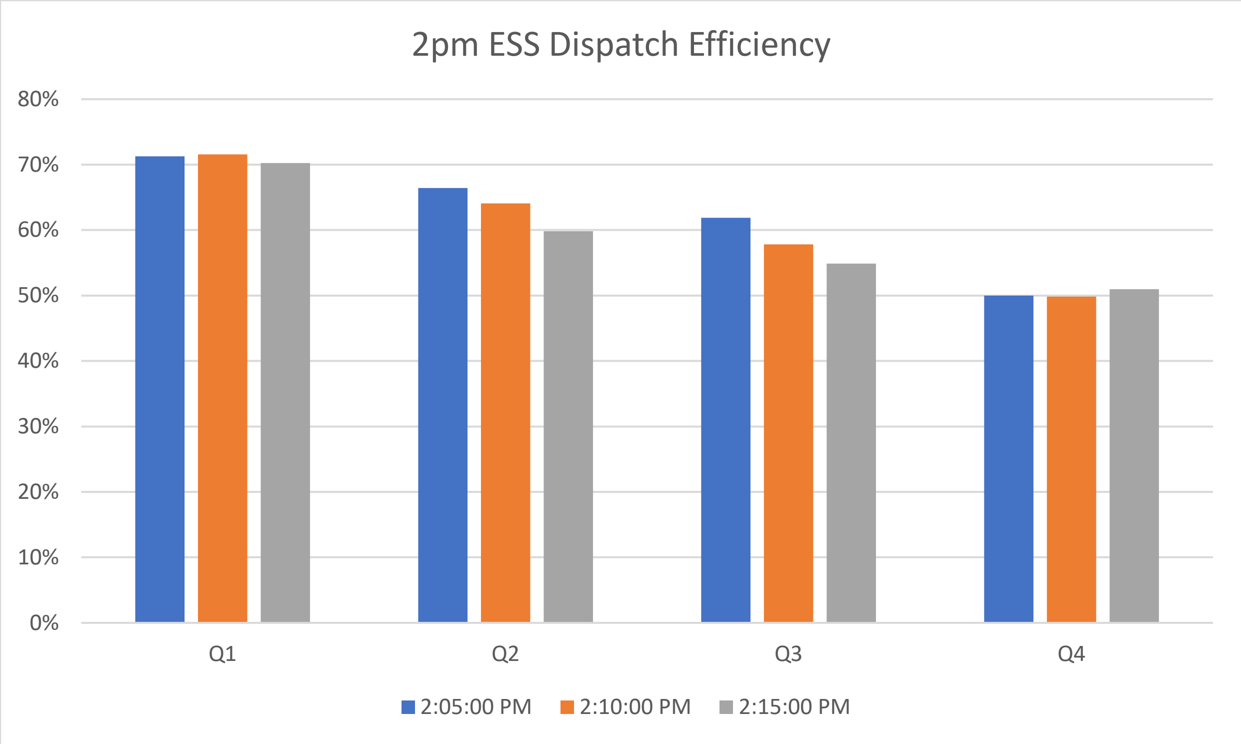

Figure 11: 2pm ESS Dispatch Efficiency

The average dispatch efficiency at 2pm has shown that the VPP could provide 61% of its nameplate power capacity.

The testing at 6pm shows that it is the period of the day when VPP Operators can expect to be the most effective with their dispatches into the grid. Q4 again shows to have been the least effective period for the 6pm dispatches. The 6pm dispatches showed that on average, the VPP was capable of providing 75% of its nameplate power capacity throughout the year.

This result is somewhat surprising as we did expect to see the Q1 dispatch perform least favourably due to the increased likelihood of solar PV generation having been self-consumed in the home. Site export limits may have impacted the ability of the battery to export to the grid if the solar PV continued to generate when the storage was at capacity.

Voltage readings were also taken in an effort to determine whether rising voltages may have had an impact, we detail the results in a later section.

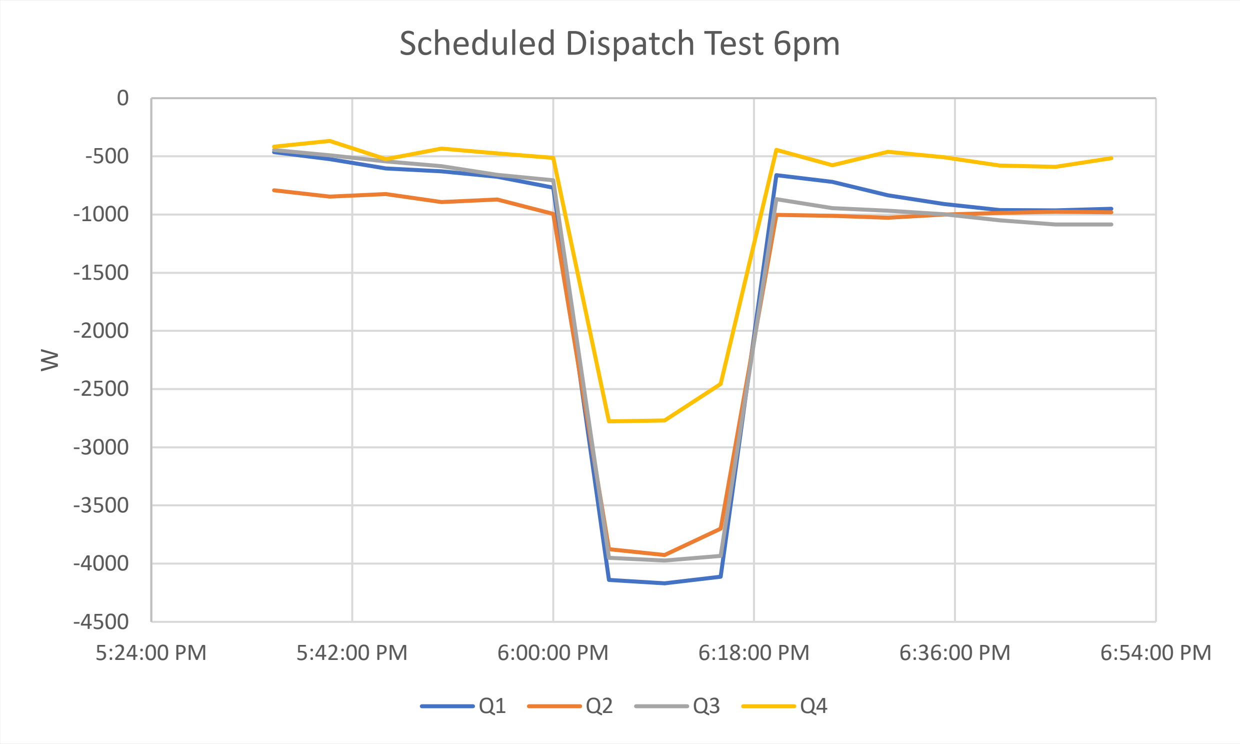

Figure 12: Scheduled Dispatch Test 6pm

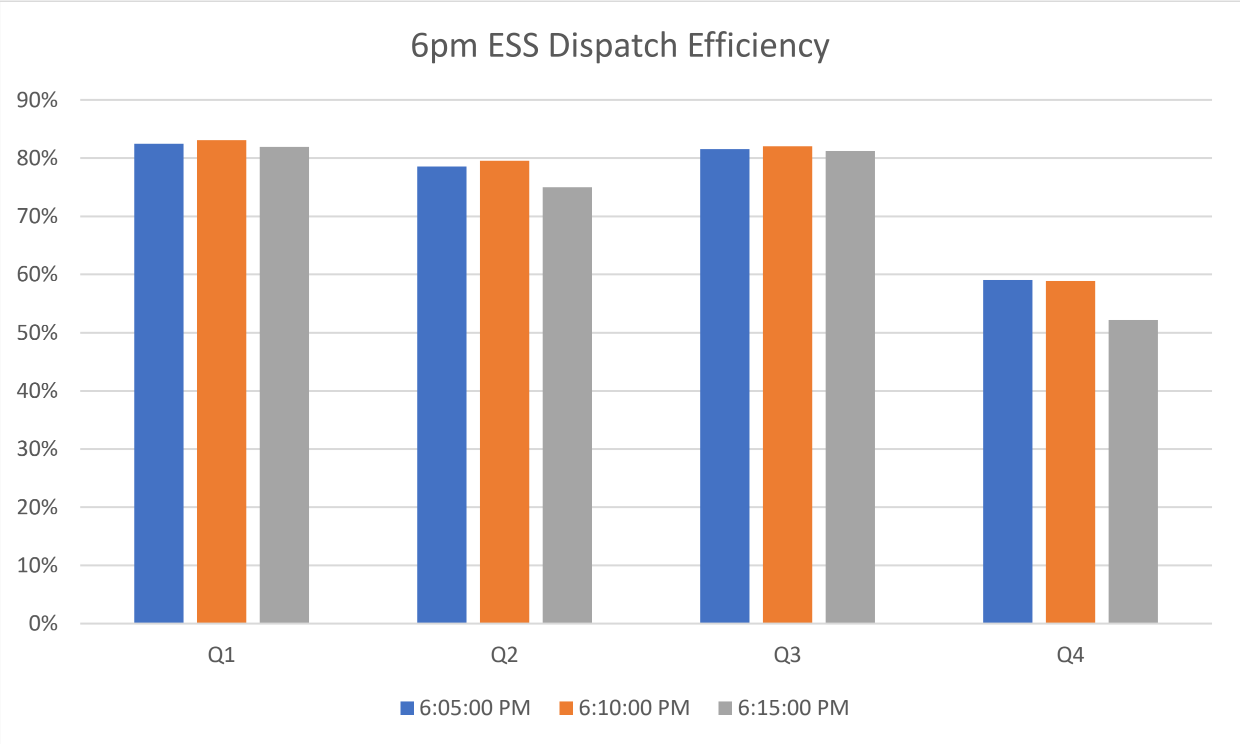

Figure 13: 6pm ESS Dispatch Efficiency

Conclusion from this testing is that whilst battery energy storage systems are effective at being able to schedule dispatches at certain times, there is a significant degree of variability in their dispatch efficiencies both throughout the year and at different times of day. To create a meaningful level of firm dispatchability throughout the year, the following approaches could be adopted by an aggregator looking to create a firm dispatch response.

1. Over contracting the number of ESS to balance out the suspected shortfall periods
2. Invest in DER forecasting and incorporate all known constraints to better understand what can be utilised
3. Create customer offers that incentivise the purchasing of larger ESS inverters/batteries
4. Constrain the customers use of the DER (via customer offers) to give preference to the aggregator

4.1.3 Dispatch Testing: Voltage Variations Observed During Discharge

The impact of Solar PV and VPP's on voltage has been a popular discussion point amongst DNSP's over the last couple of years so one area of testing that Simply Energy undertook was to collect the average voltage recorded on the fleet during discharges. The hypothesis for this testing was that dispatches taking place around 2pm, coinciding with low demand and high solar PV exports onto the local distribution network.

Variations in voltage were recorded during the quarterly dispatch tests, each undertaken at 10am, 2pm and 6pm for a maximum duration of 15 minutes.

The following chart shows the voltage observations from the 10am discharge test. Voltages during the Q4 10am test show a 7 volt increase on dispatch which took the average fleet voltage to 250-251 volts. Some ESS would have been impacted by this level of voltage and would have had their discharge constrained. The Q1 dispatch also has a similar level of voltage increase but does not appear to have been constrained as severely.

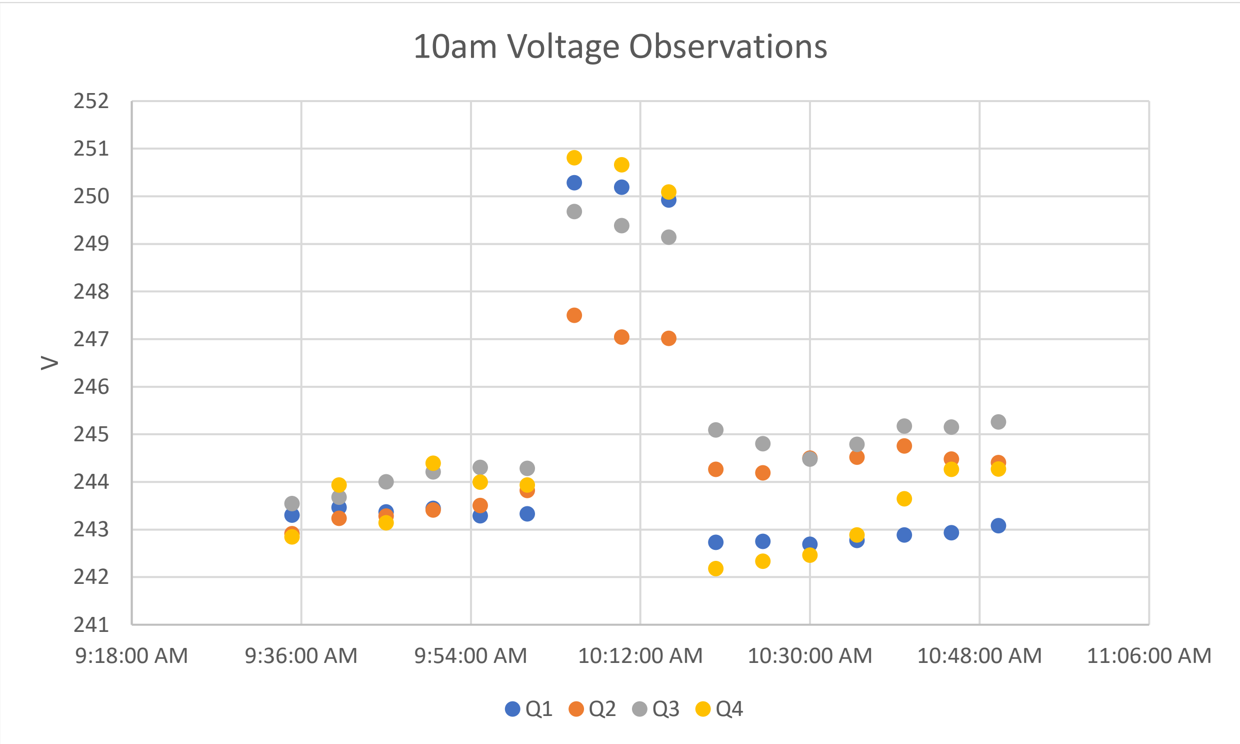

Figure 14: 10am Voltage Observations

All 2pm dispatches throughout the year appeared to reach or exceed 250 volts during their dispatch. Q3 appears to have reached the highest at 253 volts however the Q3 starting point appears around 3 volts higher than other quarters.

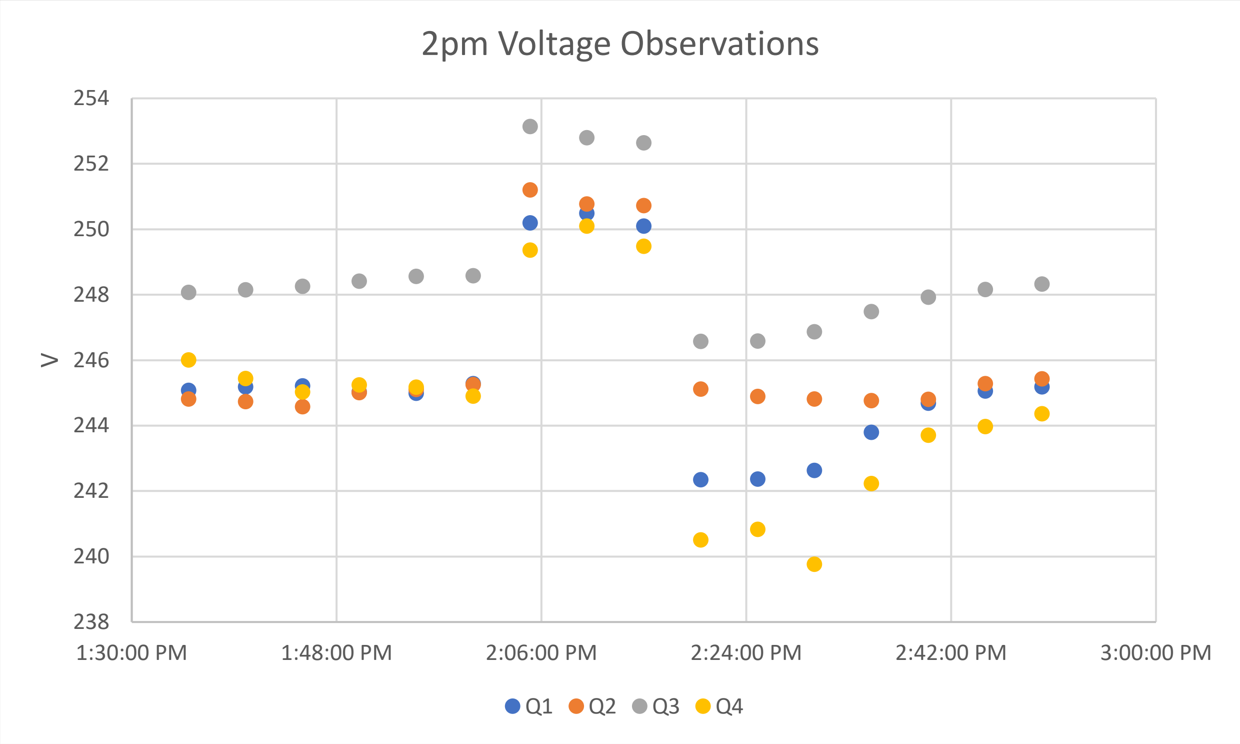

Figure 15: 2pm Voltage Observations

By 6pm, demand on the local network has increased, the level of solar generation has fallen, and voltages have dropped back to a starting point of 240 to 242 volts. On discharging the ESS, the voltage climbs by around 4 volts. During the tests, the 6pm discharge proved to be the most efficient of all the dispatch periods.

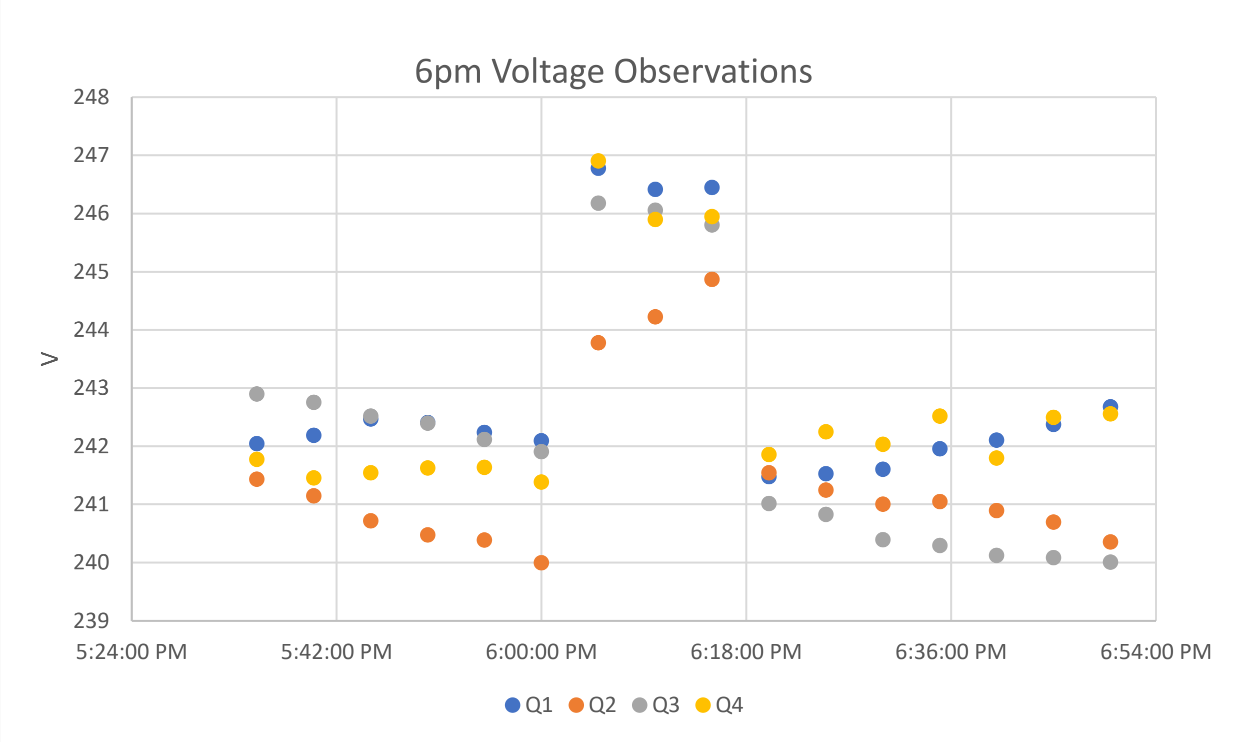

Figure 16: 6pm Voltage Observations

The conclusion of the above is that dispatching at or around times of peak solar production and low demand levels does indeed increase the voltage, particularly in Q2 and Q3. It should be highlighted that whilst voltage increases were observed, they were done so behind the meter and may not be representative of the impact on the network.

4.1.4 Potential Issues for Further Investigation

It is known that some of the voltage rise observed at the inverter when energy is being dispatched arises from impedance in the customer's service main and household wiring, and does not manifest at the network connection point, which is the point where the distribution network is required by regulation to maintain voltage within bounds. There would be merit in further investigation of the difference in voltage between the network connection point and the inverter during VPP dispatch events, to better inform how networks can optimise local voltage to allow for DER and VPP operation.

Between Q4 2020 and Q1 2021 SA Power Networks rolled out upgrades to voltage regulation equipment at 140 major zone substations ('line drop compensation'), which has the effect of dynamically reducing voltage at the substation at times of low demand, which helps to mitigate downstream voltage rise issues due to solar PV. As this program has only recently completed, there would be merit in repeating some of the voltage tests to investigate the extent to which this network upgrade has had a practical impact at VPP sites.

4.2 Platform ("deX") Development and Performance

4.2.1 Summary of Previous deX Development Stages

Stage 1

The focus of the deX team was to develop the end-to-end system integration capability that included:

- Registration of the Tesla Powerwalls within the deX platform through integration with Pow (Tesla Powerwall software) via development of an API;
- Developing the requirements for a network interface to give SAPN visibility of energy storage systems; and
- Demonstrating capability through basic wholesale dispatch of the fleet and development for advanced dispatch in anticipation of FCAS capabilities.

At the end of Stage 1 of VPPx, 4 stages of deX development were completed that included:

- Basic Dispatch – Dispatch of DER from various technology vendors in accordance with market behaviours;
- DER Registration – Enrolment of DER in to deX via the GreenSync VPP platform from various technology vendors;
- DSO Visibility – Live visibility of DER and associated telemetry from various technology vendors in the deX Vision platform; and
- Advanced Dispatch – Ability for DER to participate in additional markets (e.g. FCAS) and the ability to vary the strategy of a DER dispatch.

The architectural development, frameworks and use cases for the modules completed as part of Stage 1 were discussed as part of the Knowledge Sharing report released for Stage 1[2].

Stage 2

The GreenSync development team progressed the project against key functionality milestones having completed 7 of the 8 stages of deX development as shown in Figure 17. For all of the completed stages, use cases were successfully demonstrated against the required functionality. The completed stages include:

- DSO Mediation;
- DSO Forecasting; and
- DSO / ISO contracts.

The modules completed as part of Stage 2 were discussed in the Knowledge Sharing report released for Stage 2[3].

Note: No additional work on the deX platform was conducted by GreenSync during Stage 3 of the project.

[2] Knowledge Sharing Report – Stage 1 available at: https://arena.gov.au/assets/2019/06/simply-energy-vppx.pdf

[3] Knowledge Sharing Report – Stage 2 available at: https://arena.gov.au/assets/2020/08/simply-energy-vppx-stage-2.pdf

	Stage #1 Jan-Mar 2018 Basic Dispatch	Stage #2 Apr-Jun 2018 DER Registration	Stage #3 Jul-Sep 2018 DSO Visibility	Stage #4 Oct-Dec 2018 Adv Dispatch	Stage #5 Jan-Mar 2019 DSO Mediation	Stage #6 Apr-Jun 2019 DSO Forecasting	Stage #7 Jul-Sep 2019 DSO/ISO contracts	Stage #8 Oct-Dec 2019 Evaluation
deX markets	deX Demonstration > Wholesale Dispatch Integration > Technology API Integration (VPP)		deX Demonstration > FCAS Dispatch in Sandbox	deX Demonstration > FCAS Dispatch > Export Limit Dispatch			Demonstration > Publish service contracts for DSO/TSO/ISO	Evaluation > Simple and transparent contracting > Value for services
deX vision		Documentation > deX Connection Process	Demonstration > Network Interface > VPP dispatch visible to DSO		Demonstration > Publish constraint data > Mediate VPP dispatch within network limits	Demonstration > View historic performance and inform forecasting		Evaluation > System visibility and trust > Coordination for reliability
deX connect	deX Demonstration > Developer Centre Integration > Technology API Integration (Geli)	Demonstration > deX Ready Certification Process	Demonstration > DER Fleet Optimisation API in Sandbox	Demonstration > DER Fleet Optimisation API Integration > DER Fleet Optimisation API Integration (Geli)				Evaluation > Open access > Predictability > Fleet optimisation > Security
Simply		Use Case > Dispatch for wholesale market within VPP		Use Case > Dispatch for FCAS Optimisation of DER fleet within VPP portfolio			Use Case > Contract and dispatch for grid services	Evaluation
SAPN			Use Case > Use Case #1 Monitoring for quality of supply.	Use Case > Use #6 Export Limit (*) Functionality with or without new product/device	Use Case > Use Case #3 Mediation of VPP Dispatch	Use Case > Use Case #2,5,8 Data provision and bundling.	Use Case > Use Case #4,7 DER Contracting	Evaluation

Figure 17: Development of deX platform integration

4.2.2 Stage 3 Lessons Learned

The deX architecture and its functionality for VPPx has been successfully demonstrated as a proof of concept for all functionalities. This outcome reflected the collaborative effort between all stakeholders involved. The input and feedback provided by project partners were instrumental in addressing the challenges associated with deX development. Some of the key lessons learned are discussed below:

- **Market forecasting:** Whilst the VPP platform does collect significant amounts of telemetry from the fleet, market forecasting was not tested. Whilst there is certainly an option to evolve the platform so it undertakes this role, it may not be beneficial to include self-produced forecasts in a centralised forecasting system. As long as historic or live data is being provided to the market operator, the market operator may be best placed to provide a consistent method for forecasting.

- **Data processing challenges:** While the deX platform is designed to be scalable in nature and can accommodate significant increases in data associated with a much larger fleet of DERs, the VPP control software used by the aggregator was more limited in its ability to cater to larger amounts of data. This is due to the fact that the VPP control software is primarily designed to commercial and industrial fleets, with a smaller number of DERs. DER aggregation and orchestration via VPPs require the ability to process large amounts of data and, as the fleets grow larger, more and more steps in the management of VPPs need to be automated. One of the challenges to be addressed by industry is ensuring that DER vendor platforms are capable of scaling to ensure that individual devices are addressable (as per 2030.5).

- **DER integration challenges:** The ability for deX to integrate with multiple DER controllers adds significant value to the commercial attractiveness of the platform – both for the aggregator, who can offer more product variety to customers and increase sales, and the network who has less integration effort of its own to efficiently communicate operating envelopes. With the increase in onboarding of integration partners, the time to build and test the interfaces has reduced significantly. Direct access to the DER hardware was critical to enhance end-to-end testing timeframes.

- **The quest for a common API**: In collaboration with VPPx partners and a broader community of industry stakeholders, GreenSync has been working to develop a common API to support deX integration. In parallel to this (and also in collaboration with these efforts) the national DER API technical working group have been working towards a standardised API for networks to be able to communicate directly to DERs, or market platforms such as deX. In a future where networks seek to regularly communicate operating envelopes to DERs, the value of marketplaces like deX is that a wide range of DERs can be contacted through the one integration point. In addition, this communication channel could also be used to communicate opportunities for VPP fleets to provide network services, with the benefit that a marketplace can attract multiple VPP aggregators, improving the likelihood of achieving the critical DER density required. It is therefore critical that deX ensures its API is consistent with the emerging common standards and that it integrates with as broad a DER and aggregator community as possible.

- **The value for aggregators**: In order to appeal to aggregators, deX can provide access to additional value streams through the DSO/ISO Contracting functionality but it also needs to remove integration complexity. Enhancing the ability of aggregators to connect with more DER types and vendors is important to reducing the complexity, cost and timeframe associated with VPP integration.

- **The importance of dynamic connection agreements:** VPPx has shown that the primary constraint on VPP dispatch is the export constraints imposed by networks on customers. These export constraints are static and universal, despite different parts of the network being able to cater to larger exports at certain times. Through the deX Connect and deX Mediation functionality, deX could be leveraged to support dynamic connection agreements. This is where the network allows higher exports at times and in locations where the network can support it. In the same way that deX facilitates the communication of operating envelopes for VPP dispatch, it could communicate changes to export limits to DERs connected to the platform, enhancing value for DER owners and VPP aggregators while maintaining the integrity of the network.
- **deX development approach**: Due to the limited time to develop and test the proof of concept for each module, the project team identified a test use case and then developed a framework around it to demonstrate the concept and support future functionality when necessary. Through this process, it was identified that (if there had been more time) a better approach would be to first identify multiple use cases and then build a standardised framework to support development activities and future functionality.
- **The role of the DMO**: For the purpose of VPPx, the role of market operator was effectively played by the consortium group, developing the rules for DSO contracting and mediation, which were then applied through deX to test the proof of concept. Key learnings from the exercise are:
    - The role of DMO and DSO are distinct and separate with one (the DMO) having financial responsibility while the other is responsible for the integrity of the physical system;
    - With the DSO providing the operating envelopes to put a boundary around market activity and potentially contracting for services in the market, there could be a potential conflict of interest; this conflict could be managed by an independent DMO or other approaches (e.g. appropriate regulation), however, further work would be required to assess this potential conflict of interest and the various management approaches;
    - With the technology now available to run the market, based on the defined rules of engagement, the DMO could be less about operations and more about governance/oversight; and
    - It is quite possible that with the emergence of dynamic limits being rolled out across networks as incentivised by state-based limitations on exports and supporting network tariffs that the role of the DMO may simply not emerge in Australia. This has yet to play out.

4.2.3 Further work on operating envelopes

The learnings from implementing and testing the DSO mediation approach in this project have significantly progressed the thinking around enabling high levels of VPP dispatch within the limits of the distribution network. One of the key findings was that while dispatch mediation may ultimately enable the most optimal use of distribution network capacity in a future distribution market, the evolution from fixed per-customer export limits to dynamic operating envelopes at the site level has the potential to achieve much of the benefit in the near term. This is being explored from different perspectives through several related ARENA-funded trials including the *Advanced VPP Grid Integration* project in South Australia[4], Zeppelin Bend's project *evolve*[5], the *Flexible Exports for Solar PV trial*[6] being undertaken by SA Power Networks and AusNet Services, and the *Dynamic Operating Envelope Working Group*[7] convened under the ARENA DEIP program.

One of the relevant findings from SA Power Networks' *Advanced VPP Grid Integration* project has been that dynamic operating envelopes can often allow VPP batteries to be dispatched even when local solar is generating, i.e. enabling an individual customer to safely exceed the normal static 5kW limit. This has the potential to relieve some of the bottlenecks in dispatch efficiency identified in the VPPx project when the VPP has sought to dispatch during the solar day (see Section 4.1).

National technical standards in this area are being progressed by GreenSync and others in the cross-industry DER Integration API Working Group, which is working on an Australian implementation guide for the IEEE 2030.5 DER communications protocol (CSIP-AUS) to standardise the DSO-DER interface.

4 SAPN "Advanced VPP Grid Integration" project. Accessed online at: https://arena.gov.au/projects/advanced-vpp-grid-integration/

5 Zeppelin Bend "evolve DER Project" project. Accessed online at: https://arena.gov.au/projects/evolve-der-project/

6 SAPN "SA Power Networks Flexible Exports for Solar PV Trial" project. Accessed online at: https://arena.gov.au/projects/sa-power-networks-flexible-exports-for-solar-pv-trial/

7 ARENA. Accessed online at: https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/dynamic-operating-envelopes-workstream/

5 Suitability of Regulatory Frameworks

The VPPx has provided Simply Energy with first-hand insights into the suitability of existing regulatory frameworks when implementing such innovative projects in support of the energy transition.

It was expected there would be regulations that pose challenges given they were developed for an environment when VPPs were not part of the energy ecosystem. While those challenges have been called out, we have also considered it important to highlight some regulatory frameworks that indeed remain suitable.

5.1 Generation License Requirements

Simply Energy was requested to acquire a generation license in South Australia for the VPPx project. An exemption from this requirement was requested in October 2019 and granted until June 2021 and following consultation in early 2021, was extended through to June 2023.

Simply Energy believes that the current licensing is inappropriate for a Virtual Power Plant on the basis that generation plant is commonly defined as being the location of the physical equipment or connection point to the transmission line or distribution network. However, the key differences with a VPP are:

- VPPs consist of multiple geographically unrelated locations that do not have a shared connection point which can be dispatched individually or in aggregate.
- VPPs include properties with existing solar installed and individual connection agreements (therefore falling under the existing exemption definition).

Simply Energy believes that more clarity and preferably a consistent approach surrounding what does and doesn't constitute a generator is required across all regions of the NEM. For example, while the SA Government requests the VPP to have a generation licence, for the purposes of participating in FCAS markets with a DER, AEMO requires each of the connection points to be classified as 'loads' rather than as 'generation'. Additional licensing by individual states to encompass small customer connection points which already have connection agreements is likely to add further complexity and costs which will in turn reduce any benefits that can be passed on to customers.

Additionally, greater consideration needs to be given by authorities, when considering whether licensing requirements are indeed appropriate. In the case of a VPP, each individual connection point has its own connection agreement with a range of standards and safety requirements that differ from that of typical generating plant, nor are they negotiated with the VPP operator.

We consider a consistent set of standards and regulations across the NEM is one of the keys to the success of a VPP. Additionally, market access requirements and processes for DERs to take part in Ancillary Service markets need to be as lean as the security of the electricity system will allow rather than casting a wide net of requirements that ultimately increase costs for consumers or alternatively act as a complete barrier to market entry for many participants.

5.2 DER Export Limits and Connection Agreements

While Simply Energy acknowledges the voltage-related issues that DER can create on distribution networks and the need for DNSPs to operate their networks in a safe and efficient manner, the aggregated fleet was unable to provide its maximum available output due to technical constraints – the most significant of which was static export limitations (63% of overall constrained power[8]). This static pre-defined site export limit inhibits the optimal aggregation of available DER load on the network. For the VPPx project, a default limit of 5kVA was applied to all participating systems.

However, Simply Energy is encouraged by DSNPs' exploration of dynamic export limits, i.e. where a customer's DER export limit can be varied automatically via communication with the DSO based on the operating conditions of the local network at a point in time. By adding more location- and time-based flexibility, we believe dynamic export limits will create more efficient DER market operation, enhancing value for DER owners and VPP aggregators while maintaining the integrity of the network.

5.3 AEMO VPP Demonstration Program

Simply Energy appreciates the timely commencement of AEMO's VPP Demonstration program. It provided the industry with a pathway for VPPs with small customers to trial participating in FCAS. Lab testing of a battery inverter was also quite straight forward and easy to satisfy.

A challenge encountered was that fleet wide frequency injection test required a lengthy period of waiting for a sufficiently large frequency deviation to prove that the aggregation could deliver a proportional power response.

Another challenge was the requirement that only NMIs registered with AEMO as providing the frequency response creates an ever-declining fleet as customers churn away and cannot be replaced on a one-for-one / like-for-like basis without a full re-registration of the fleet within the market.

The Market Ancillary Service Specification (MASS) is a document published by AEMO detailing a description of each kind of market ancillary service, the performance parameters and requirements which must be satisfied by a market participant.

Simply Energy is of the view that the MASS v6.0 effective 1st July 2020 requires revision to accommodate the new types of service providers that can provide Contingency FCAS services as it would appear that it is heavily weighted towards thermal generators rather than aggregations of DER. In particular, the fast FCAS service requires 50ms metering to be installed at or near each connection point and is of a specification that is only available 'off the shelf' at a cost of greater than $14,000 each. Whilst some technology vendors have claimed to have solutions costing less than $20 each, these are only currently available when purchased with other products, the lowest cost solution that we have identified would result in around $750 needing to be outlaid per customer.

A solution going forward may be to allow residential scale DER to have the fast FCAS response verified at intervals at or less than 1 second granularity which would match the level of granularity that can be accessed by most if not all of the technologies that have participated in the VPP Demonstrations Program which would avoid the need to incur additional costs for retrofitting additional metering to participate in two of the contingency FCAS markets. Whilst there may be a

[8] Simply Energy VPPx Stage 2 Report: Peak solar dispatch test

potential for errors utilising one second metering data, University of Melbourne analysis has highlighted that improvements can be made in the verification process using the 1 second data alone.

5.4 Implications of SA Government's *Smarter Homes* Legislation

The South Australian Government introduced new legislation effective 28th September 2020 to address state energy security concerns, notably raised in AEMO's paper *Minimum operational demand thresholds in South Australia, May 2020*[9]. The legislation placed additional technical requirements on new inverters to ride-through system disturbances, as well as new obligations on customers to nominate a *Relevant Agent* when installing or upgrading solar generation. The *Relevant Agent* framework established a new entity with responsibilities of being capable of disconnecting and reconnecting distributed solar, when directed, to help prevent system-wide blackouts during extreme minimum demand events. Customers under this framework were responsible for ensuring their system was capable of being controlled by their nominated Relevant Agent.

The implications on this project were minor. Inverters installed as part of this project were deemed to comply, then later tested, to satisfy voltage-disturbance-ride-through (VDRT) technical capabilities. A Relevant Agent was also nominated for all installations post 28th September 2020. To date the Relevant Agent scheme has only been enacted once, on Sunday 14th March 2021, for a short duration when one of the SA-VIC interconnectors was down for maintenance.

These requirements were introduced to address the immediate risks associated with large, uncontrollable distributed solar. VPPs also present an opportunity to help mitigate these risks by constructively stabilising energy systems at times of low demand. VPPs can provide synthetic inertia and frequency support and hence reduce the size, scale, and likelihood that backstops such as remotely disconnecting solar PV are required. The capabilities of VPPs to constructively assist with grid stability by responding to instantaneous changes in frequency are being trialled in AEMO's VPP demonstrations, with funding support from ARENA[10].

Ultimately however, until enough DER are natively contributing to grid-stabilisation through an innate response, or participation in stabilisation markets, additional backstop measures such as those introduced in Smarter Homes will be required to manage system security during certain high-risk events. Such measures should be designed and operated with regard to the role of DER and VPPs in supporting the system. For example, the dynamic and flexible nature of VPPs presents the opportunity to respond to curtailment requests by balancing behind-the-meter resources to prevent export instead of simply tripping off generation, which delivers a better outcome for customers. Similarly, measures such as emergency voltage raise can be highly effective in curtailing large amounts of passive solar PV, but will also reduce the output capacity of battery inverters. These interactions need to be understood in order to achieve a predictable response from any emergency interventions.

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[9] AEMO. Accessed online at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2020/Minimum-Operational-Demand-Thresholds-in-South-Australia-Review

[10] AEMO Virtual Power Plant Demonstrations" project. Accessed online at: https://arena.gov.au/projects/aemo-virtual-power-plant-demonstrations/

5.5 AEMC *Access and Pricing* review

In July 2020 the AEMC received three rule change requests relating to future distribution network regulation[11]. These arose from the industry-wide *DER Access and Pricing Review* undertaken within ARENA's Distributed Energy Integration Program (DEIP)[12]. As at May 2021 the AEMC is consulting on its draft determination in response to these rule changes.

The draft determination proposes changes to the National Electricity Rules (NER) that will:

- Recognise in the rules that one of the functions of the distribution network is to enable DER customers to export energy
- Establish obligations and incentives on DNSPs to manage demand for export capacity, including efficient investment in the network to meet customers' future needs as DER penetration continues to grow
- Enable future network tariffs to apply to both export and supply, consistent with the established principle of cost-reflective network pricing

These reforms will, if successful, materially reduce the risk that future VPPs will be constrained in their ability to participate in markets by local network constraints, as distribution networks will have obligations, and a mandate under regulation, to invest efficiently to ensure that there is sufficient export capacity to meet customers' needs, whereas no such obligation exists today.

5.6 ESB *Post-2025 Market Review*

The Energy Security Board (ESB) is currently examining the long-term future of the NEM in its Post-2025 Market Review[13]. One of the core workstreams is examining issues of DER / market integration, including the future roles and responsibilities of aggregators and VPPs, the role of the DSO in managing distribution network capacity, and the future role of platforms like deX in facilitating DER access to markets. The findings of the VPPx project should help inform the outcomes of that review.

5.7 Network Tariff Reform

In accordance with the network pricing principles in the National Electricity Rules, distribution networks are moving progressively from flat tariffs to more cost-reflective network tariffs.

In South Australia, SA Power Networks introduced its new 'Solar Sponge' time-of-use tariff on an opt-in basis for all customers in July 2020.

The new network tariff enables residential customers to access lower rates for energy consumed from the grid overnight and in the middle of the day, with the lowest 'super off peak' rate occurring during the solar window of 10am to 3pm. This provides a new opportunity for VPPs to gain value from supporting the local network by shifting load out of peak times, in particular into the middle

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[11] AEMC. Accessed online at: https://www.aemc.gov.au/rule-changes/access-pricing-and-incentive-arrangements-distributed-energy-resources

[12] ARENA. Accessed online at: https://arena.gov.au/knowledge-bank/deip-access-and-pricing-reform-package-outcomes/

[13] ESB. Accessed online at: https://esb-post2025-market-design.aemc.gov.au

of the day. The new tariff also creates arbitrage opportunities even on days when the customer has no surplus solar energy, by charging batteries from the grid during off-peak times in order to avoid grid imports during the morning and evening peaks.

The transition to more cost-reflective network tariffs enables customers and VPP operators to access the value of using their DER in ways that support the network without having to establish a specific network support contract. There is more work to be done to explore the future interaction between tariffs, which reward behaviours that reduce long-run marginal cost to networks, and local network support contracts, which can provide additional value by engaging VPPs to target specific short-run, local network constraints.

If the Access and Pricing rule change is successful, it will enable networks to create more sophisticated tariffs that could unlock further value for VPPs in future, including tariffs that include credits as well as charges – e.g. the network charge could be negative for energy exported at a time of peak demand, reflective of the fact that this tends to reduce, not increase, long-run cost to the network.

6 Economic Assessment

This section considers the value the VPPx generates across a number of stakeholders:

- Value Generated for Customers (Section 6.1)
- Value Generated for Simply Energy (Section 6.2)
- Value Generated for Distribution Network Service Providers (DNSPs) (Section 6.3)
- Value Generated for the National Electricity Market (NEM) (Section 6.4)
- Value Generated for Project Partners - Tesla (Section 6.5)

6.1 Value Generated for Customers

6.1.1 Approach to Measurement

Analysis was undertaken to quantify the change in energy consumption after installation of the ESS. The analysis included:

- Changes in amount of **energy exported to the grid**; and
- Changes in amount of **energy imported from the grid**.

A sample of 47 customers were taken from the project. These customers were all Simply Energy customers before the VPPx project, which enabled the 'before versus after' comparison of energy usage for the 12 months before and the 12 months after installation of the ESS.

Changes in amount of energy exported to the grid (point 2) and changes in amount of energy imported from the grid (point 3) were used to calculate the value generated for customers and the ESS payback period.

6.1.2 Changes in Amount of Energy Exported to the Grid

The change in the average amount of energy that customers export to the grid before versus after installation of the ESS was measured for the sample. This is important as it shows how much local customer generation is actually being consumed by the household due to the battery being able to store energy for later use rather than being exported directly to the grid. Reduced export to the grid also means however that customers are generating less revenue from the Feed-in-Tariff (FiT). This is reflected in the payment period calculations in Section 6.1.4.

The results in the table below and the chart following show that customers are on average exporting 117.1 kWh (19.4%) less energy to the grid per month after installation of the ESS than before.

Ave. reduction in energy export after ESS installation (kWh)	**117.1 kWh per month**
Ave. reduction in energy export after ESS installation (%)	**19.4%**
Median reduction in export consumption after ESS installation (%)	**34.2%**
Maximum reduction in export consumption after ESS installation (%)	**86.8%**
Proportion of customers who reduced export consumption (%)	**81.4%**

Table 4: Changes in customer energy export to grid after versus before ESS installation.

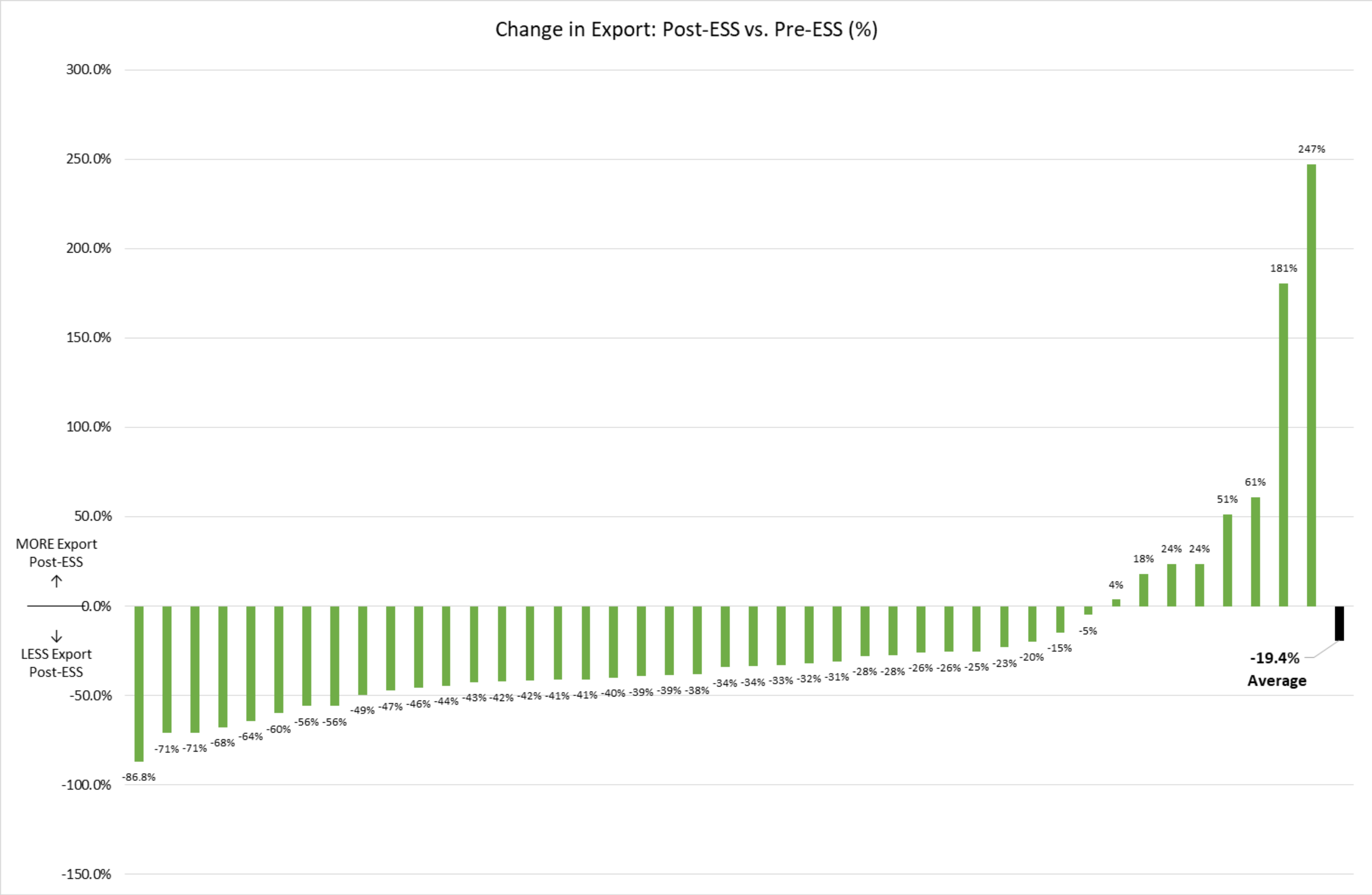


Figure 19: Changes in amount of energy exported to the grid

6.1.3 Changes in Amount of Energy Imported from the Grid

The change in the average amount of energy that customers import from the grid before versus after installation of the ESS was measured for the sample. This is important as it shows how much less reliant customers are becoming on the grid and is an important factor in the payback period calculation (see Section 6.1.4) via reduced energy purchase costs.

The results in the table below and the chart following show that customers are on average importing 166.9 kWh (50.2%) less energy from the grid per month after installation of the ESS than before.

Ave. reduction in energy imported from the grid after ESS installation (kWh)	**166.9 kWh per month**
Ave. reduction in energy imported from the grid after ESS installation (%)	**50.2%**
Median reduction in energy imported from the grid after ESS installation (%)	**52.1%**
Max. reduction in energy imported from the grid after ESS installation (%)	**88.1%**
Proportion of customers who reduced import from the grid (%)	**95.5%**

Table 5: Changes in customer energy import from grid after versus before ESS installation.

Customer impact from VPP participation was low during 2020

Year 2020	Energy	Customer benefit from feed-In tariff	Customer charges from additional grid imports	Cost of VPP participation per customer
Ave. per customer requested discharge from the battery	68kWh	$10.20	$27.13	$16.93
Ave. per customer requested import to the battery	21kWh	$0.00	$8.38	$8.38
Energy cost of VPP participation during 2020	89kWh			$25.31

Table 6: Costs incurred by customers as a result of energy being requested from or to their battery.

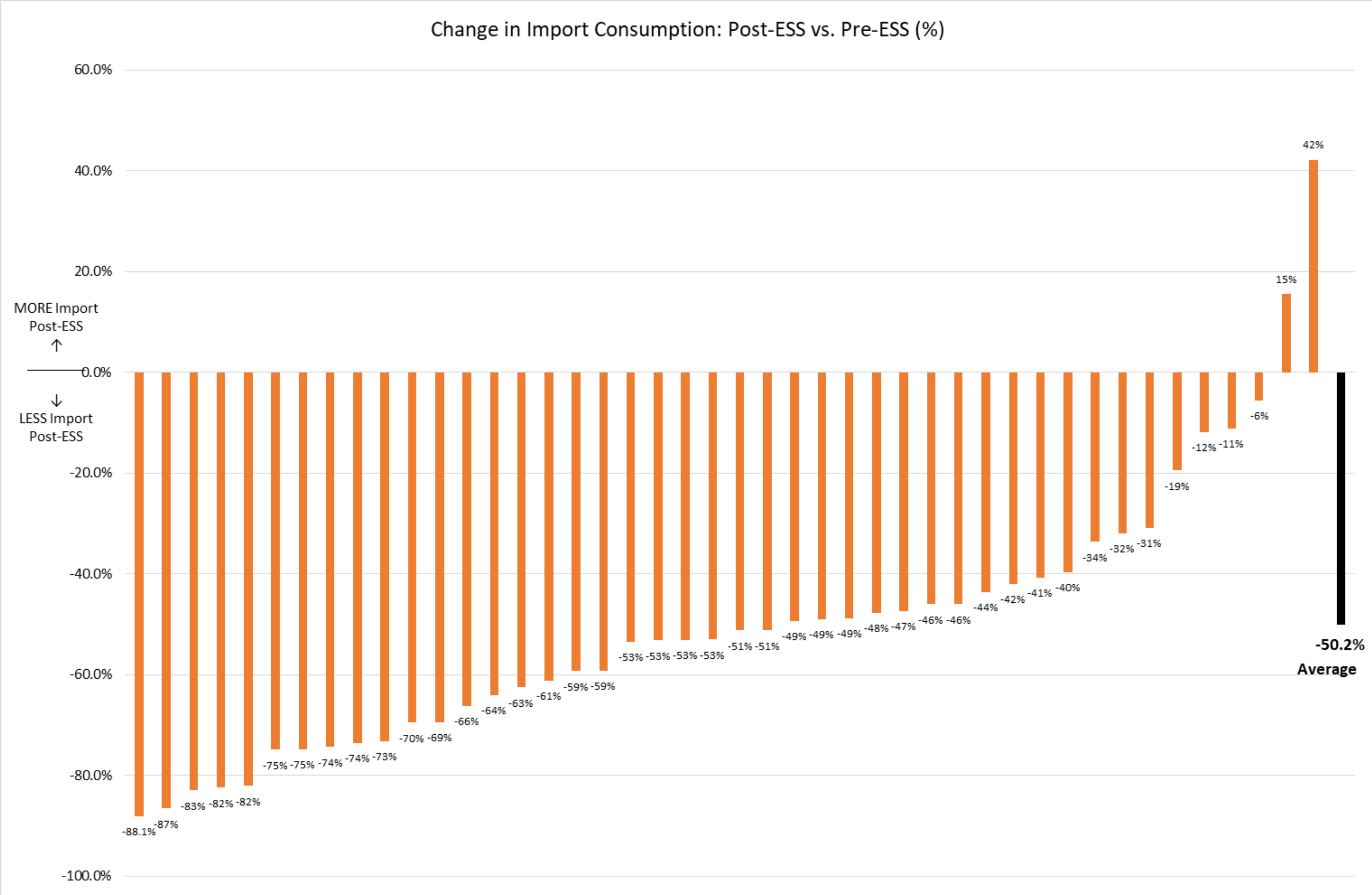


Figure 20: Changes in amount of energy imported from the grid

6.1.4 Customer ESS Payback Period

The average payback period for an ESS system for a customer participating in the VPPx was calculated based on the analysis in Section 6.1. The calculation considered three elements:

- Initial cost: Upfront out-of-pocket ESS investment cost
- Customer value stream 1: Change in Feed-in Tariff (FiT) revenue from decreased energy exported to grid
- Customer value stream 2: Change in grid energy purchase cost from increased energy imported from grid

The calculations for each of these elements is stepped out following.

Initial cost: Upfront out-of-pocket ESS investment cost

The total out-of-pocket cost to the customer for installing the ESS comprises:

(A) The cost of the battery and installation (before subsidy and rebates)

minus

(B) The subsidy that Simply Energy provides (paid via $7 per day)

minus

(C) The rebate that the SA Government provides

Participating customers incurred different total out-of-pocket costs depending on their choice of battery offered as part of the VPPx. This is not only due to different costs of the batteries themselves (A) but also different levels of SA Government rebates (C). The subsidy that Simply Energy provided (B) was consistent across battery types.

A summary of initial out-of-pocket costs to customers (before and after subsidy and rebates) is shown below by battery type:

Battery	No. sold [14]	% of fleet	ESS + install cost before subsidy and rebates (A)	SE subsidy (B)	SA Gov. rebate (C)	Total out-of-pocket cost to customer after subsidy and rebates
Tesla	809	70%	$ 13,508.43	$ 5,100.00	$ 6,000.00	$ 2,408.43
Sonnen	182	16%	$ 14,780.67	$ 5,100.00	$ 6,000.00	$ 3,680.67
Equana	28	2%	$ 17,236.00	$ 5,100.00	$ 6,000.00	$ 6,136.00
LG Chem	100	9%	$ 12,673.50	$ 5,100.00	$ 4,650.00	$ 2,923.50

[14] Not including 20 x sample batteries installed.

Varta	33	3%	$ 9,440.00	$ 5,100.00	$ 3,000.00	$ 1,340.00
		Minimum:	**$ 9,440.00**			**$ 1,340.00**
		Maximum:	**$ 17,236.00**			**$ 6,136.00**
		Sales volume weighted average:	**$ 13,611.01**			**$ 2,714.13**

Table 7: Customer upfront out-of-pocket ESS cost.

Customer value stream 1: Change in Feed-in Tariff (FiT) revenue from decreased energy exported to grid

This values the decrease in energy the customer exports to the grid. Customer earn a Feed-in Tariff (FiT) for every kWh they export, so a reduction in the amount of energy exported will result in less FiT credit on their bill – i.e. a net cost.

Average change in energy exported to grid (kWh)	117.1 kWh per month less energy exported
Feed-in Tariff (FiT)	$0.15 / kWh
Value of change in energy exported to grid	*117.1 kWh x $0.15 =* **$17.57 per month less FiT revenue (net cost)**

Table 8: Value of change in energy exported to grid.

Customer value stream 2: Change in grid energy purchase cost from increased energy imported from grid

This value stream captures the customer's cost savings from reducing the amount of energy they source from the grid.

Ave. change in energy imported from the grid after ESS installation (kWh)	166.9 kWh per month less energy imported
SMART Storage tariff ($/kWh is pre-discounts)	$0.43900 / kWh
Value of change in energy imported from grid	*166.9 kWh x $0.43900 =* **$73.27 per month cost savings (net benefit)**

Table 9: Value of change in energy imported from grid.

Net customer ESS payback period

Combining the initial out-of-pocket cost of the ESS (after subsidy and rebates) with the findings of the two value streams above, we calculate a payback period of between 2.0 and 9.2 years, with a sales weighted average of 4.03 years:

		Before Subsidy + Rebates	After Subsidy + Rebates
Upfront ESS investment cost		$9,440.00 to $17,236.00 Weighted ave. = $13,611.01	$1,340.00 to $6,136.00 **Weighted ave. = $2,714.13**
Value stream 1: Change in feed-in Tariff (FiT) revenue		$17.57 per month less FiT revenue (net cost)	
Value stream 2: Cost savings from reduced grid import		$73.27 per month cost savings (net benefit)	
Net customer value		-$17.57 + $73.27 = $55.70 per month = **$668.39 saved per year**	
Payback period	Minimum:	*$9,440.00 / $668.39 =* 14.1 years	*$1,340.00 / $668.39 =* 2.0 years
	Maximum:	*$17,236.00 / $668.39 =* 25.8 years	*$6,136.00 / $668.39 =* 9.2 years
	Weighted average:	*$13,611.01 / $668.39 =* 20.4 years	*$2,714.13 / $668.39 =* **4.03 years**

Table 10: Customer ESS payback period.

6.2 Value Generated for Simply Energy

6.2.1 New Revenue Streams - FCAS

FCAS market access granted by AEMO on 16th October 2020 for 3MW of contingency FCAS capacity across all six markets (Fast Raise, Slow Raise, Delayed Raise, Fast Lower, Slow Lower, Delayed Lower).

Since then to the end of June 2021, nearly $483,000 of FCAS revenue has been generated:

18 Oct - 14 Nov	$ 24,033
15 Nov - 12 Dec	$ 25,050
13 Dec - 9 Jan	$ 21,407
10 Jan - 6 Feb	$ 16,479
7 Feb - 6 Mar	$ 16,830
7 Mar - 3 Apr	$ 144,674
4 Apr - 1 May	$ 49,822
2 May - 29 May	$ 73,206
30 May - 26 Jun	$ 110,913
TOTAL	**$ 482,416**

Table 11: Contingency FCAS Settlement Payments (October 2020 to end of June 2021).

FCAS revenue is typically $16k to $25k for every four weeks period. Exceptions to this were experienced in March (~$145k) and April (~$50k) when higher FCAS revenues were primarily driven by network outages (increased lower FCAS revenues) and higher wholesale energy price outcomes (increased raised FCAS revenues).

FCAS has become more critical as it became evident that opportunities to extract benefits from wholesale energy markets are limited.

6.2.2 New Revenue Streams – Wholesale Energy Market

Since early 2019, VPPx has been able to access benefits derived from wholesale market access. Whilst this doesn't provide a direct revenue stream, the benefits are accessed as a result of Simply Energy having a retail portfolio of customers that contract with Simply Energy to manage the risk of being exposed to high (or low) wholesale market prices.

Whilst a lot of this price exposure can be hedged against through financial contracts, the VPP was still able to demonstrate its value as if it was directly exposed to the market prices. These benefits were the primary focus of trading activities prior to contingency FCAS market registration being achieved in late 2020. The annualised value for this activity was $115 per customer per year.

6.2.3 New Customers Acquired

The VPPx served as a strong customer acquisition program for the broader Simply Energy retail business, with 80% of VPP customers being new to Simply Energy (representing over 1,000 new customers).

The majority of these new customers have to date also not churned away from Simply Energy. This 'stickiness' is likely due to the strong degree of customer satisfaction experienced by VPPx participants (see Section 7). Of the small number of customers (115) that have exited the project prematurely, the table below details the stages at which this occurred.

Reason	No. customers
Customer churned to another retailer, all Simply Energy agreements cancelled.	50
Customer cancelled VPP registration but remains with Simply Energy.	45
Customer failed a credit check, registration did not proceed.	9
Customer joined VPP but later left. Remains with Simply Energy.	7
Customer moved out of the property, all Simply Energy agreements cancelled.	4

Table 12: Reasons for VPPx customer project exits.

6.3 Value Generated for Distribution Network Service Providers (DNSPs)

6.3.1 Capability to reduce daytime solar excess

VPPs provide an opportunity to deploy DER at times that support a reduction in the long-run cost to operate the distribution network. This is particularly of value in South Australia in the middle of the day during the 'solar window' (10am to 3pm), during which time the amount of excess solar generation exporting to the grid can be significant and cause constraints on local networks. Shifting solar export out of this time reduces these constraints and hence reduces the need for SAPN to invest in network upgrades.

This load shifting can be further supported by new tariffs such as SA Power Networks' 'Solar Sponge' time-of-use tariff that provides residential customers to access lower network charges for energy consumed during the solar window. More cost-reflective network tariffs create greater value for VPPs by rewarding behaviours that support the local network.

VPPs and cost-reflective network tariffs therefore enable customers and VPP operators to access the value of using their DER in ways that support the network without having to establish a specific network support contract.

6.3.2 Capability to respond to emergency generation curtailment signals

The dynamic and flexible nature of VPPs presents an opportunity to constructively stabilise energy systems at times of low demand by balancing behind-the-meter resources to prevent export instead of simply tripping off generation – a better outcome for customers.

VPPs can also provide synthetic inertia and frequency support and hence reduce the size, scale, and likelihood that backstops such as remotely disconnecting solar PV are required. Emergency voltage raise can be highly effective in curtailing large amounts of passive solar PV, although it is noted that this will also reduce the output capacity of battery inverters. These interactions need to be understood in order to achieve a predictable response from any emergency interventions.

The capabilities of VPPs to constructively assist with grid stability by responding to instantaneous changes in frequency are being trialled in AEMO's VPP demonstrations, with funding support from ARENA[15].

6.3.3 Insights into local network voltage levels

By measuring the voltage rise at the inverter, VPPs can provide DNSPs with more detail of voltages on the local network when energy is being dispatched than is otherwise possible with typical LV network monitoring. As presented in Section 4.1, discharge tests are able to provide a highly granular view of voltage variations during battery discharge at different times of day (10am, 2pm and 6pm) and at different times of year.

These types of insights into local network voltage levels are important to DNSPs because the distribution network is required by regulation to maintain voltage within bounds as measured at the network connection point. It should be noted however that due to impedance in the customer's service main and household wiring, adjustments need to be made to account for voltage differences between the inverter and the network connection point.

6.4 Value Generated for the National Electricity Market (NEM)

The Simply Energy VPP fleet has generated value for the NEM by demonstrating the benefit of aggregated behind the meter capacity to respond to frequency disturbances, increasing self-consumption of solar PV generation that would have otherwise spilled into the local distribution system, responded by exporting energy in times of high demand and high price events in the NEM.

Simply Energy has contributed 3MW of FCAS into each of the six contingency FCAS markets from late October 2020 and as of late June 2020 will be contributing 4MW of contingency FCAS. Whilst FCAS has been the primary market that the VPP has operated in since October 2020, the VPP has traded 8.6MWh of energy into the market since late 2018. In addition to this the market has benefitted from an average of 166kWh reduction in grid demand per month per VPP customer.

[15] AEMO Virtual Power Plant Demonstrations" project. Accessed online at: https://arena.gov.au/projects/aemo-virtual-power-plant-demonstrations/

6.5 Value Generated for Project Partners

6.5.1 Tesla

Tesla has seen a steady increase in the enrolment of Powerwall systems into the Simply Energy VPPx, with a total of 809 Powerwalls sold representing 70% of the total VPPx battery fleet.

The strong uptake of Powerwalls in the VPPx and other SA VPP programs is being driven largely by the ability for VPP customers to extract additional value from the battery beyond solar self-consumption or time-of-use tariff optimisation – and thereby lowering the cost of ownership of Powerwall and improving customers' return on investment.

Over this same period, Tesla has tripled the number of Powerwall Certified Installers in South Australia. This has ensured sufficient geographical coverage and installation capacity to meet customer demand across the state, while also driving greater customer awareness, knowledge and ultimately uptake of VPP offers.

Beyond sales volumes, the opportunity to have Tesla technology operating in the Simply Energy VPPx and other South Australian VPP programs is providing Tesla with valuable real-world learnings. These are then feeding directly into product development to enhance the capabilities, reliability and scalability of the Powerwall product. Currently 67% of all Powerwalls in South Australia are enrolled in a VPP program, making the State a key market for Tesla and the advancement of its VPP technology.

6.5.2 GreenSync

The Simply Energy VPPx project was instrumental in the transition of the deX platform from the concept incubation phase to commercial deployment.

The Decentralised Energy Exchange (deX) initiative led by GreenSync was initiated under the ARENA A-Lab program which facilitated the concept development for DER interoperability within competitive electricity markets. The VPPx project allowed for co-design of functionality with key partners and stakeholders, application to real-world use cases and establishment of a production platform.

Through the VPPx trial GreenSync was able to develop

- deX Connect API interfaces and supporting documentation to allow cloud to cloud integration with DER platforms including Tesla, SwitchDin and SolarEdge.
- deX Vision UI and API to enable network visibility and control of DER. The project laid the foundations for consideration of dynamic connection agreements and was a catalyst for broader industry discussion and trialling of dynamic operating envelopes to allow VPP functions within dynamic network constraints.
- deX Command UI and API to support Simply Energy dispatch DER and provide reporting on status and performance. deX was also utilised to participate into AEMO's VPP trial, allowing the VPPx fleet to provide FCAS services.

7 Customer Satisfaction and Feedback

The project captured feedback from customers via two sources:

- A customer survey led by Simply Energy (Section 7.1), and
- A "Virtual Power Plan Users Survey" conducted by AEMO (Section 7.2).

The aggregate key findings include:

- The Net Promoter Score (NPS) of Simply Energy VPPx customers is 64.8. This is very strong when compared against typical utility NPS scores (which are typically negative) and exceeds most industries.
- The strong NPS score also correlates with overall user satisfaction which sits at an average of 8.8 out of 10.
- The main factor in influencing consumer uptake of residential home battery systems and participation in VPP programs is price. Or more specifically, the level of subsidy available to reduce the price of a battery storage system over its lifetime. Changes to the level of subsidy available for residential home battery systems, both from the SA HBS and the VPPx Project, had a material impact on consumer uptake. The most pronounced spike in demand immediately preceded a $2000 reduction in the level of the SA HBS and the announcement that Simply Energy's $5,100 VPP subsidies had limited offers remaining. The imminent withdrawal of a benefit proved to be a far greater incentive than the initial announcement of a benefit, as the SA HBS and Simply Energy VPP subsidies had been in market for well over a year prior to this spike in demand. Applying different levels of VPP benefit payments based on the size of the energy storage system inverter and reflecting the benefit of the battery type to the VPP is therefore an effective way to drive uptake in preferred technology and tailor the composition of the VPP fleet.
- COVID-19 did not have a material impact on the level of demand for home battery storage systems and VPP participation.

The results of the individual surveys are discussed following.

7.1 Survey 1: Simply Energy Survey

Please note:

This Section 7.1 provides a summary of key findings from the Simply Energy survey conducted during 2020. More detail is available in the Lessons Learned Report published October 2020 and available at: https://arena.gov.au/assets/2020/11/simply-energy-lessons-learnt-report.pdf

7.1.1 Survey Sample

The project conducted a survey which was issued on 20th June 2020. The survey was issued to over 800 people including:

- Simply Energy customers who had signed up to the VPP offer between February 2020 and April 2020
- Customers who had signed up to a waiting list, and
- Customers who had decided not to proceed.

The survey included a mix of questions regarding customers' response to the SA HBS subsidy reduction, impacts COVID-19 had on purchasing decisions as well as a range of questions regarding other potential drivers. In excess of 100 customers responded to the survey. Of those who responded, overwhelmingly survey participation came from customers who had signed up to the Simply Energy offer.

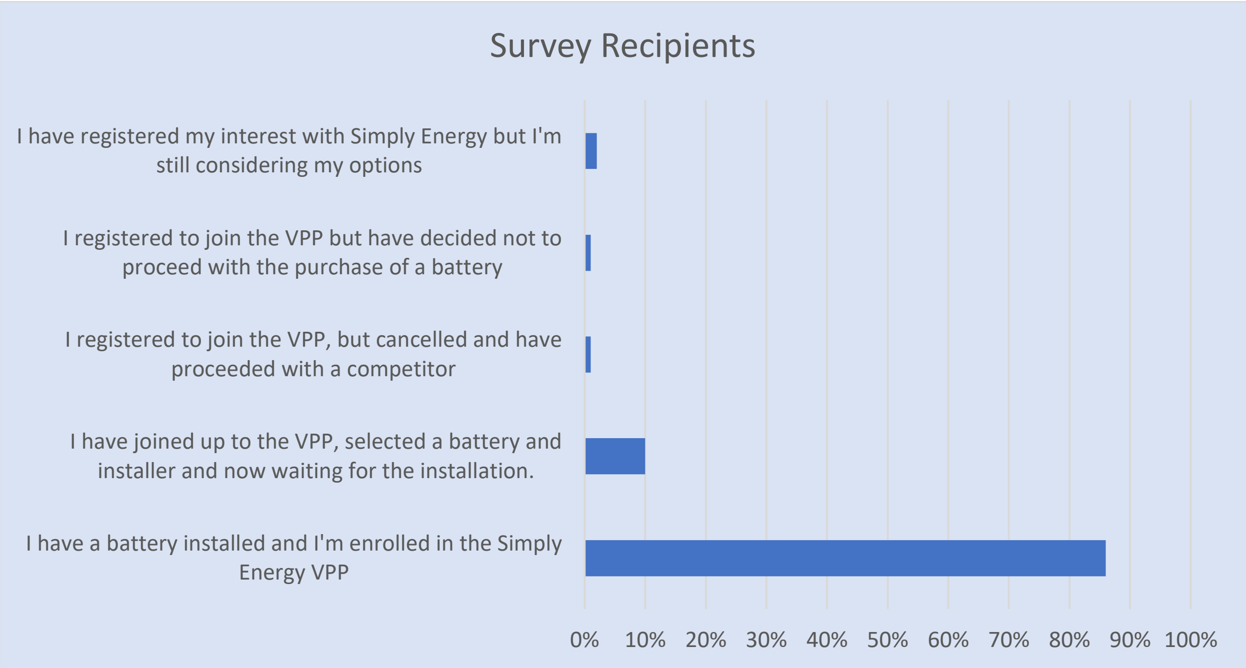


Figure 21: Question: Please select a statement which describes your current situation with Simply Energy in regard to the Virtual Power Plant (VPP).

7.1.2 COVID-19 – Impacts on purchasing decisions

Overall, the survey identified that COVID-19 did not impact on customers purchasing decisions. 85% of customers indicated that COVID-19 did not impact their decision to move forward with purchasing an energy storage system and joining the VPP. Customers did indicate that they felt positive about their purchasing decision in that they would be saving money at a time when the economy may be unstable. Other factors such as level of subsidy, return on investment, battery brand and capability were stronger influences in their purchasing decision. In considering these results the fact that most respondents had proceeded with the purchase would obviously influence the results however given the significant increase in total sales and registered interest over the 3 month period (including several weeks when COVID-19 restrictions were in place in South Australia) would indicate that a high number of customers who had been considering purchasing a battery did not change their mind over this period.

Customers were asked if COVID-19 influenced aspects of their purchasing decision and overwhelmingly customers indicated that COVID-19 did not impact their decision.

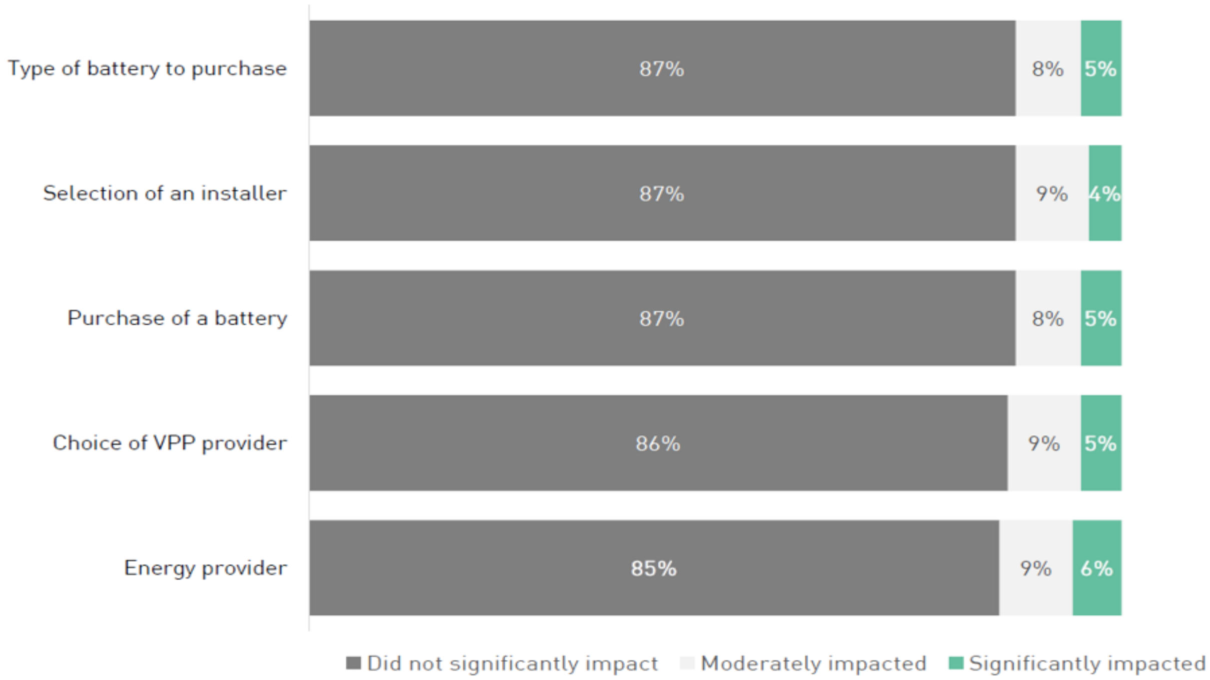
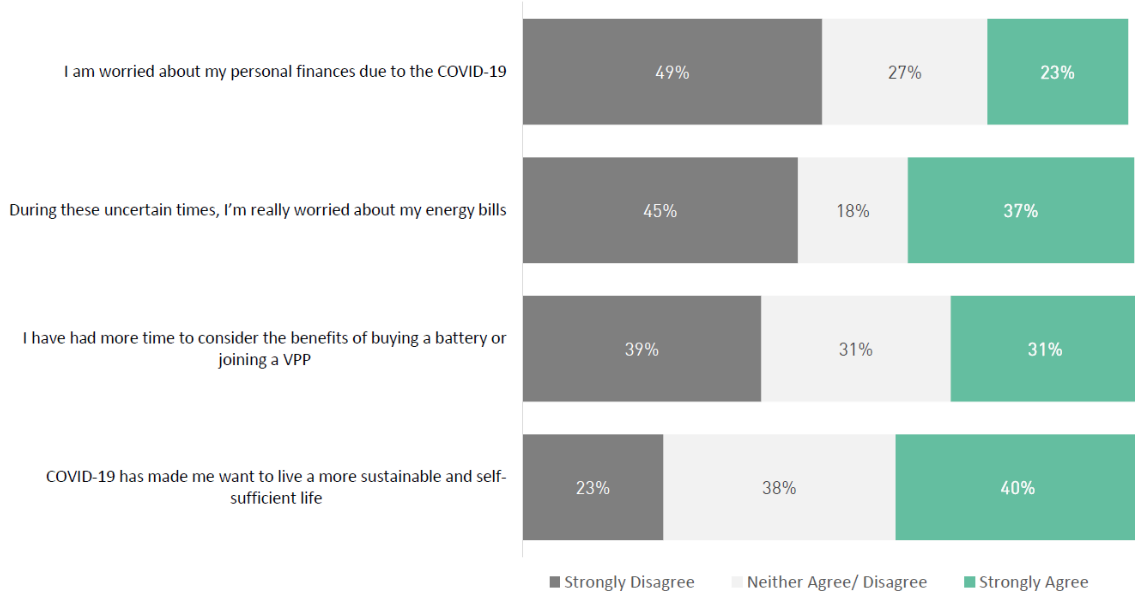
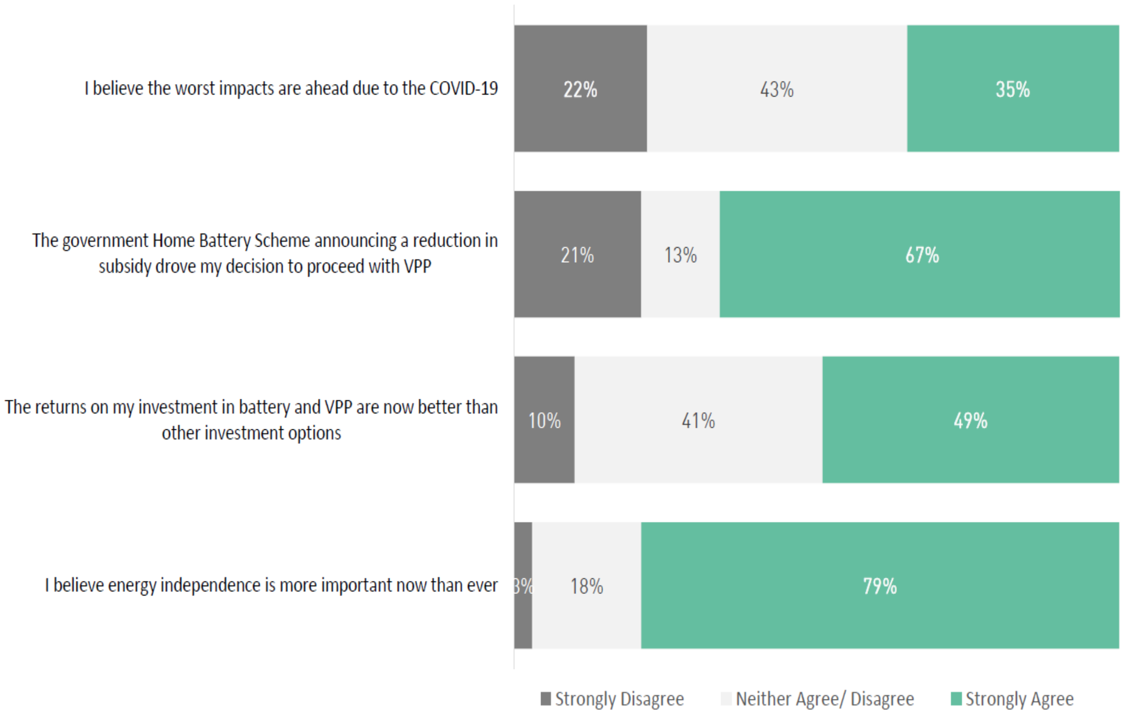


Figure 22: Question: Has COVID-19 impacted your purchasing decision on the following?

7.1.3 COVID-19 – Customers Attitudes

Customers were also asked to rate a series of questions in terms of how they felt about COVID-19 to better understand customers attitude and mindset to COVID-19. Overall, the results indicated that customers were generally not overly concerned with the impacts of COVID-19 in terms of the areas specified.


I am worried about my personal finances due to the COVID-19
49%
27%
23%
During these uncertain times, I'm really worried about my energy bills
45%
18%
37%
I have had more time to consider the benefits of buying a battery or joining a VPP
39%
31%
31%
COVID-19 has made me want to live a more sustainable and self-sufficient life
23%
38%
40%
Strongly Disagree
Neither Agree/ Disagree
Strongly Agree


I believe the worst impacts are ahead due to the COVID-19
22%
43%
35%
The government Home Battery Scheme announcing a reduction in subsidy drove my decision to proceed with VPP
21%
13%
67%
The returns on my investment in battery and VPP are now better than other investment options
10%
41%
49%
I believe energy independence is more important now than ever
3%
18%
79%
Strongly Disagree
Neither Agree/ Disagree
Strongly Agree

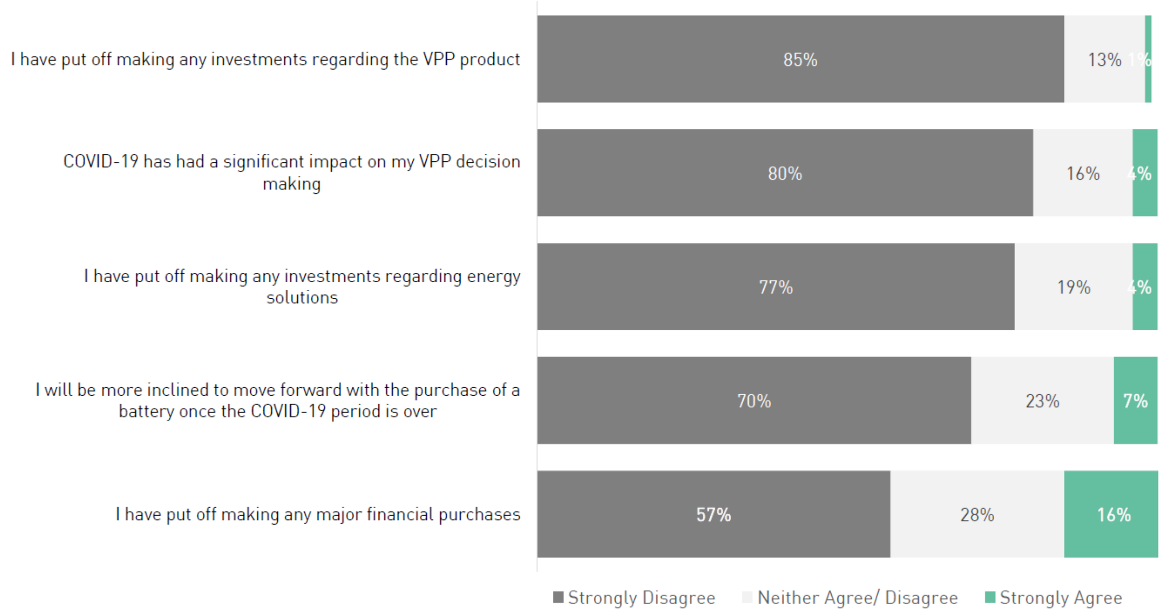


Figure 23: Question: We would like to read you a list of questions that might describe how you might think and feel about COVID-19.

7.1.4 COVID-19 – Impact on Future Spending

Customer were asked how they expected their spending would change over the following three months (July-Sept). Overall customers indicated that they intended to maintain spending with the exception of a major purchase such as property and travel which may also be due to COVID-19 travel restrictions.

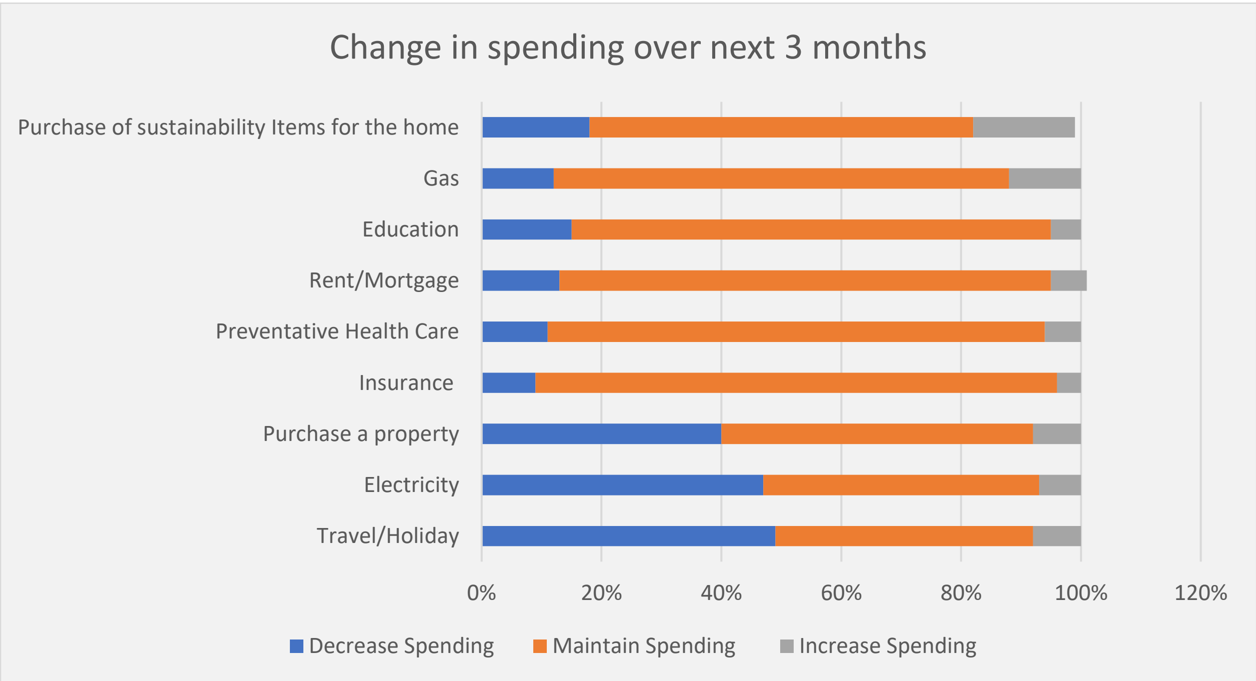


Figure 24: Question: How do you expect your spending to change over the next three months in the following areas?

7.1.5 COVID-19 – Summary

Customer responses overall to the survey indicated that COVID-19 did not impact customers purchasing decision in terms of an energy storage system and customers were generally not concerned about the financial impacts of COVID-19.

Responses maybe due to a number of factors these include:

- The purchase of an energy storage system is a major purchase and customer plan and research in advanced and so are already invested in the purchase.
- The majority of the sample of customers had already or were about to purchase the system so naturally COVID-19 had not prohibited the decision.
- The demographic of customers who are purchasing tend to be an older demographic who may be more financially secure with less family expenses or reliance on employment income. The majority of participants were over 55 yrs.
- The purchase of an energy storage system may seem a timely investment to reduce overall energy costs any greater energy independence.

7.1.6 SA HBS Subsidy Reduction – Impacts

Recipients were asked whether the SA HBS announcement of the reduction in subsidy impacted their decision to purchase an energy storage system. 49% of customers responded that the reduction in the SA HBS subsidy had been a significant influence in their decision. Younger families indicated that it motivated them to reprioritise household expenses to allow them to move more quickly to take up the offer. The older 'empty nester' demographic indicted they had made the commitment however made the decision to move quicker to take up the offer.

7.1.7 Purchasing Triggers and Considerations

Customers were asked to rate what triggered their decision to purchase an energy storage solution. Financial benefit was the key driver with environmental factors being a secondary benefit.

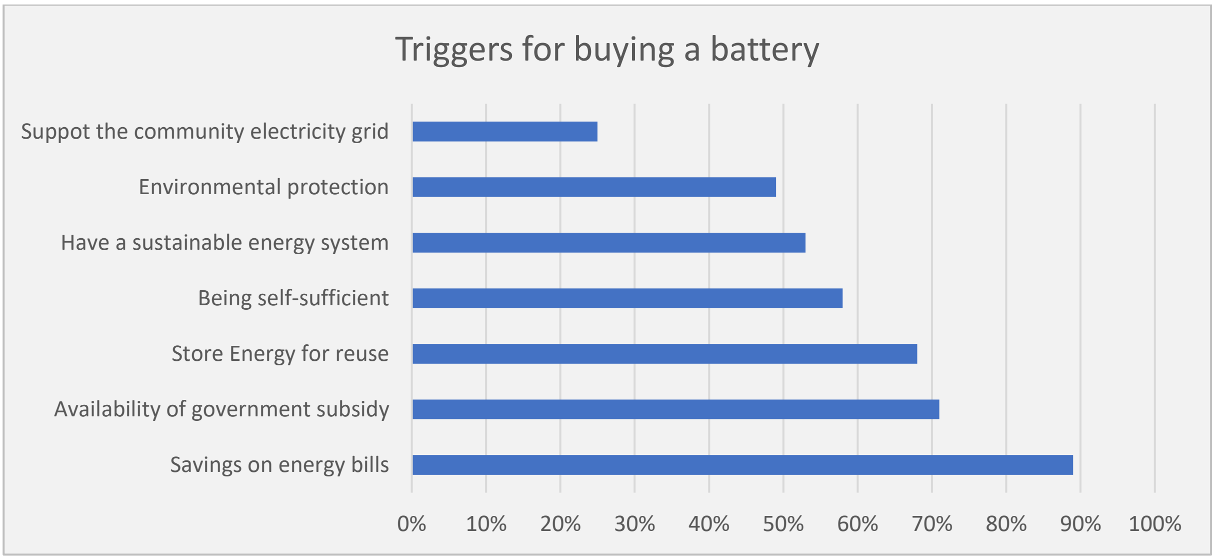


Figure 25: Question: What initially triggered you to look for an energy solution for your home?

7.1.8 Sources of Purchasing Research

Customers were asked to identify their primary sources of information when researching for the purchase of home storage solution. Overwhelmingly, most customers undertook their own research using a range of sources.

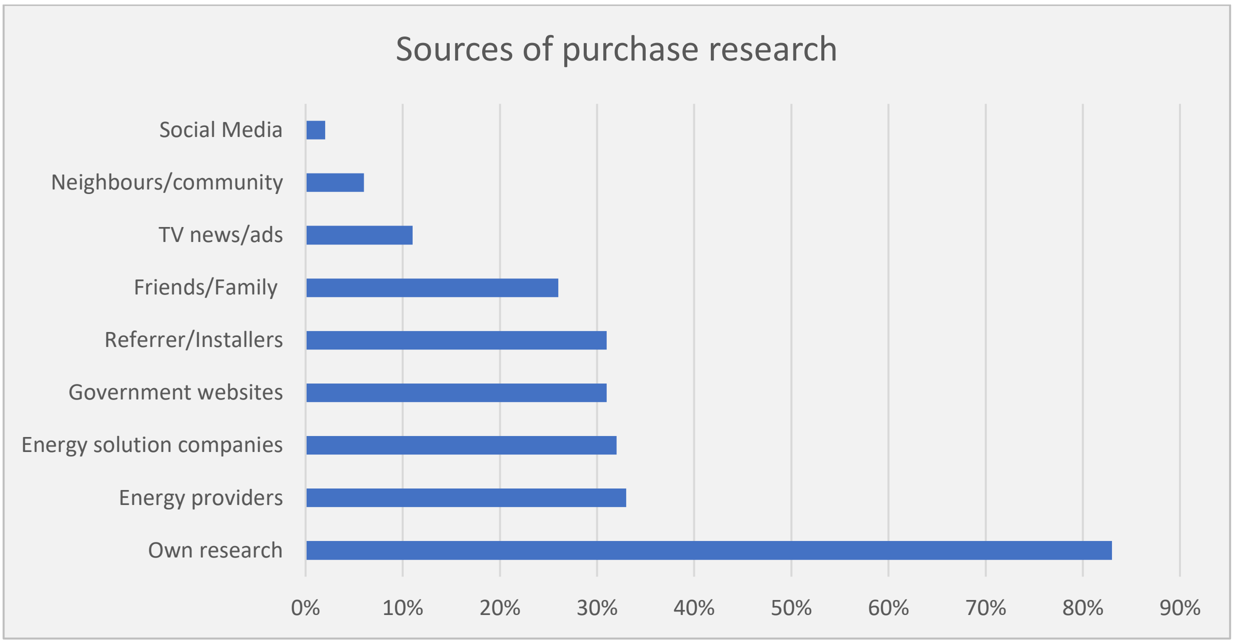


Figure 26: Question: What are were your primary sources of information when considering an energy solution?

7.1.9 Considerations when Researching

Interestingly when customers were asked about the information they sought when considering the purchase of a home energy storage solution, return on investment (ROI) rated relatively low however aspects such as cost of a home energy storage solution and installation and availability of subsides rated high.

Cost factors were among the primary considerations when researching for an energy solution system. Customers rated 4 cost factors within the top 5 considerations. Interestingly, battery brand rated 6th in terms of importance for research (although still a factor for over 70% of respondents) however rated number one in a later question specific to battery purchase.

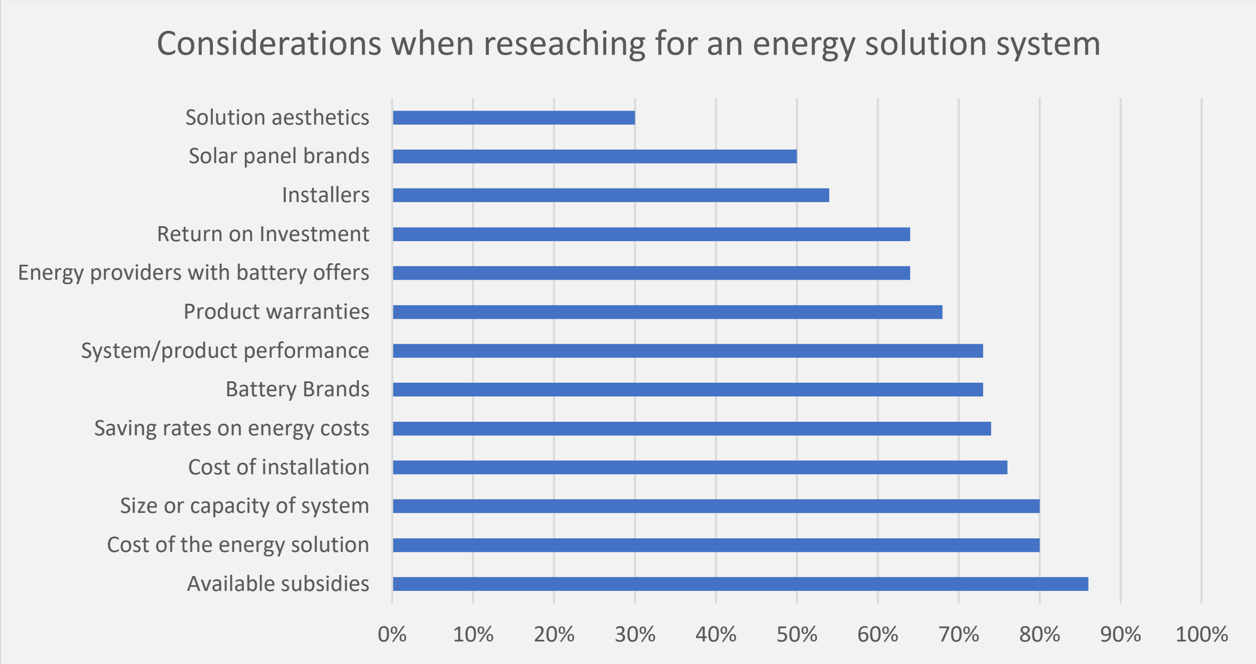


Figure 27: Question: What information would/did you want to find out when you are/were searching for an energy solution?

7.1.10 Key Barriers

Participants were asked to rate the barriers to purchasing an energy storage system. Consistent with earlier findings, cost factors remain the overwhelming barrier. Participants cited 5 cost factors in the top 6 barriers, including the cost of battery, loss of Premium feed-in-tariff, ROI, cost of solar and available subsidies.

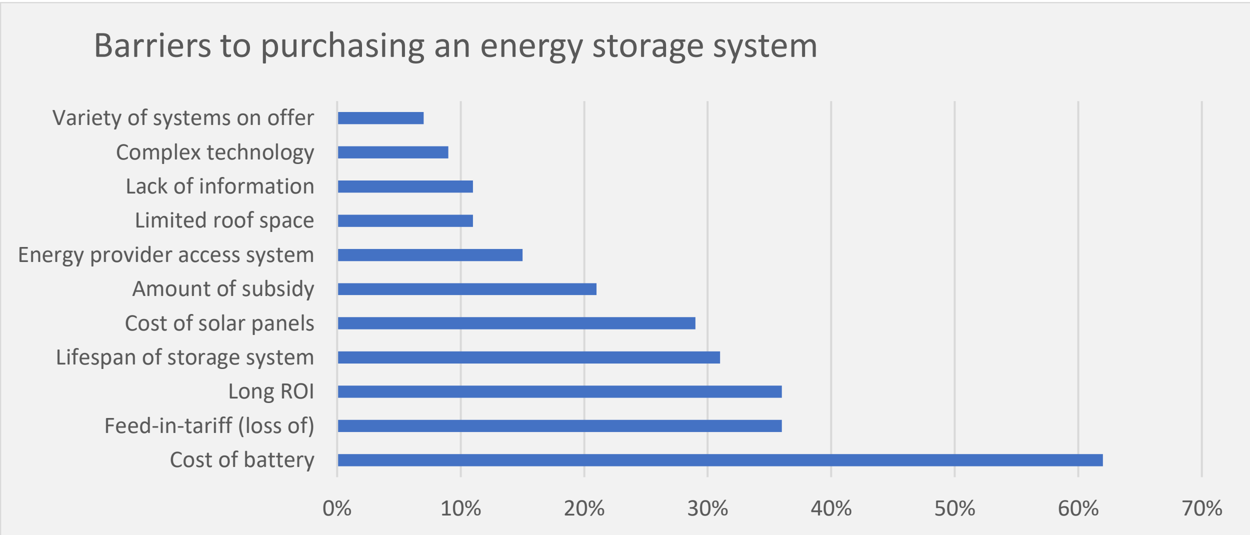


Figure 28: Question: Overall what did you consider to be the key barriers to having an Energy Solution Product?

7.1.11 Purchasing Considerations

Participants were asked to rate various factors they considered when purchasing a battery. It is interesting to note the importance of brand reputation that customers place on purchasing decisions. Not surprisingly, features such as storage capacity rated highly along with product life. Customers also rated financial factors such as savings on energy bills, VPP incentives and subsidies as common considerations in the battery purchasing decision.

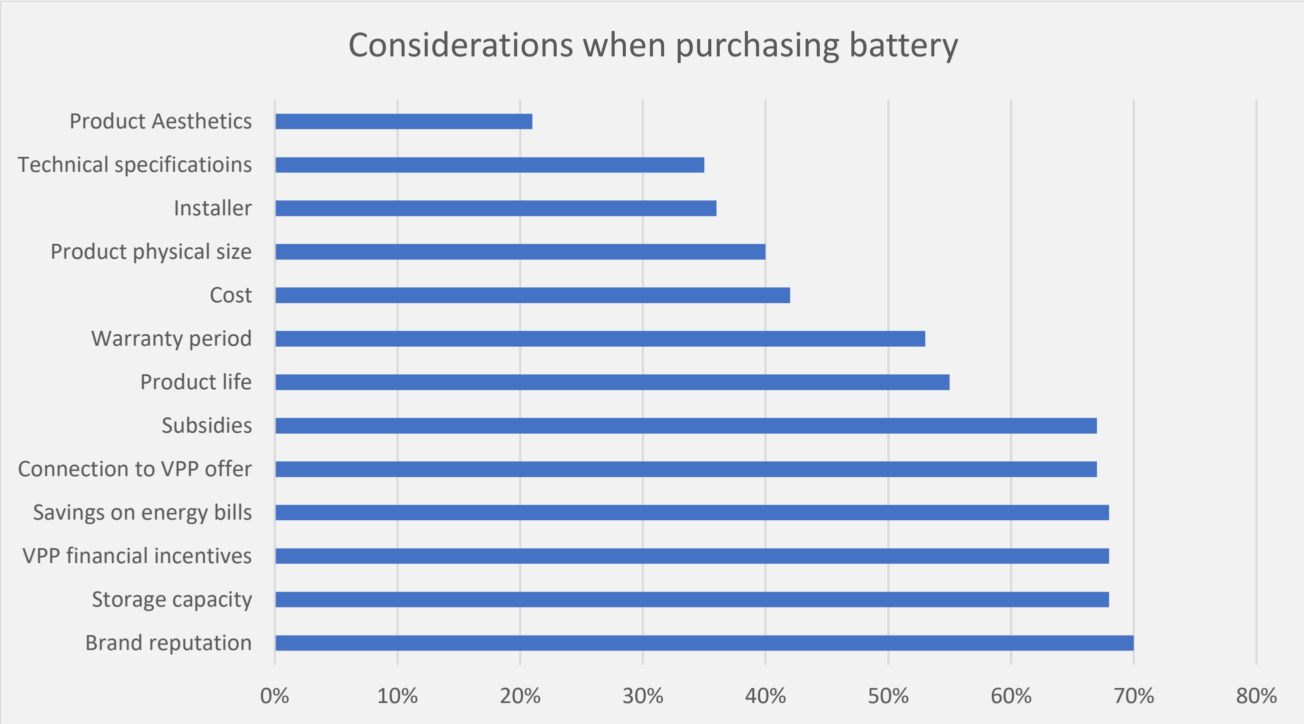


Figure 29: Question: What are/were your primary sources of information when considering an energy solution?

7.2 Survey 2: AEMO survey

A "Virtual Power Plan Users Survey" was conducted by AEMO with the results for Simply Energy's VPPx provided in November 2020.

7.2.1 Key Insights from the AEMO Survey

- The Net Promoter Score (NPS) of Simply Energy VPPx customers is 64.8. This is very strong when compared against typical utility NPS scores (which are typically negative) and exceeds most industries.
- The strong NPS score also correlates with overall user satisfaction which sits at an average of 8.8 out of 10.
- Results will need to be tracked over a longer timeframe. Users are still early in their VPP experience. Four in five Simply Energy respondents (80%) have been using VPP for less than 12 months. Only 20% have been using it for more than a year.

Overall Net Promoter Score (NPS): How likely is it that you would recommend the VPP to a friend or colleague?	**64.8**
How would you rate your overall satisfaction with the VPP (out of 10)?	**8.8**

Table 13: Key customer satisfaction metrics.

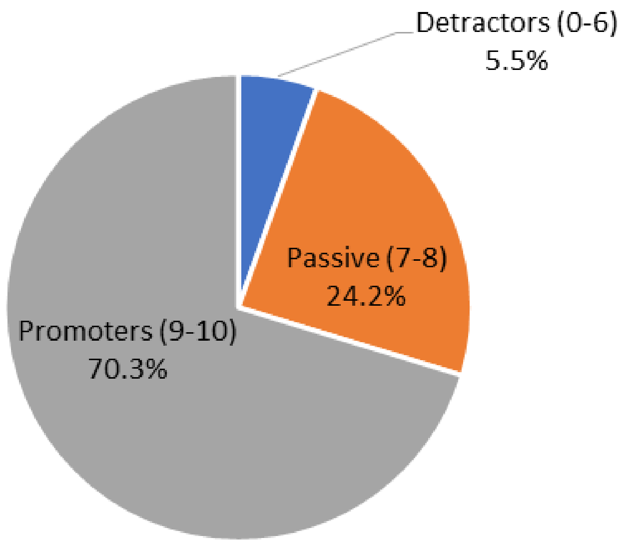
7.2.2 Net Promoter Score (NPS) Deep Dive

VPPx results

The NPS has become a standard benchmark used to measure customer loyalty across industries. Using the question "How likely is it that you would recommend [company] to a friend or colleague" it is calculated by subtracting the percentage of "detractors" who provide a score between 0 and 6 from the "promoters" who provide a score of 9 or 10.

The results for the VPPx are shown to the right, resulting in a **NPS of 64.8**.

Further breakdowns of the VPPx NPS are included following. These show relatively consistent results across different age groups, income brackets, metro vs. regional and time on the VPP.



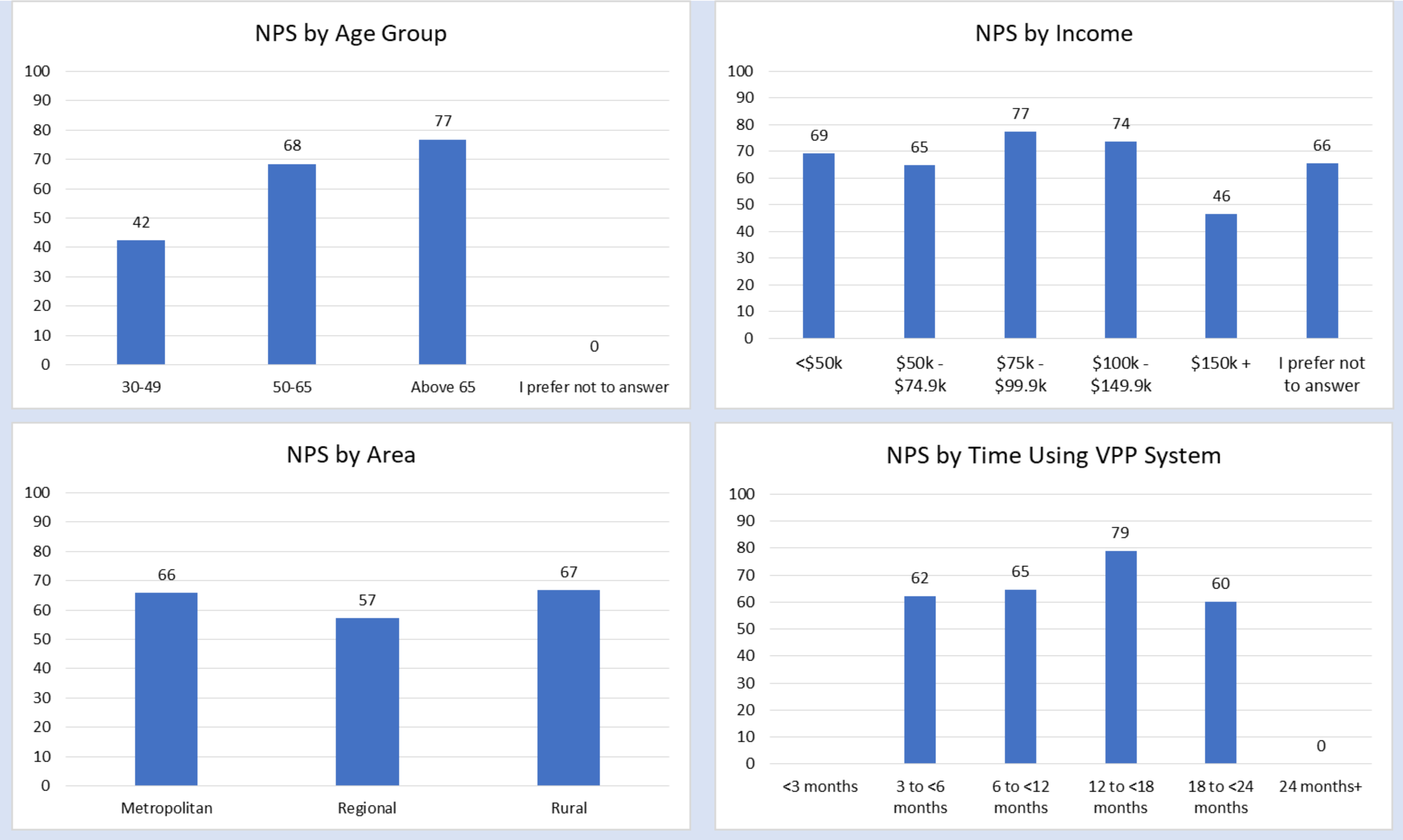


Figure 30: Net Promoter Score (NPS): Breakdowns by age group, income, area and time using VPP.

How do these NPS results compare to other utilities (and other industries)?

Being a standard benchmark, the NPS allows for comparison of customer loyalty both within and across industries.

The image following shows standard NPS scores across five industries including utilities (circled in blue) and sub-industries for Australia. The score for the VPPx is also shown in green, highlighting that customer satisfaction and loyalty is strong not just against typical utility NPS scores but across all industries.

This is a positive outcome for not just the VPPx, but for customer participation in VPP programs more broadly.

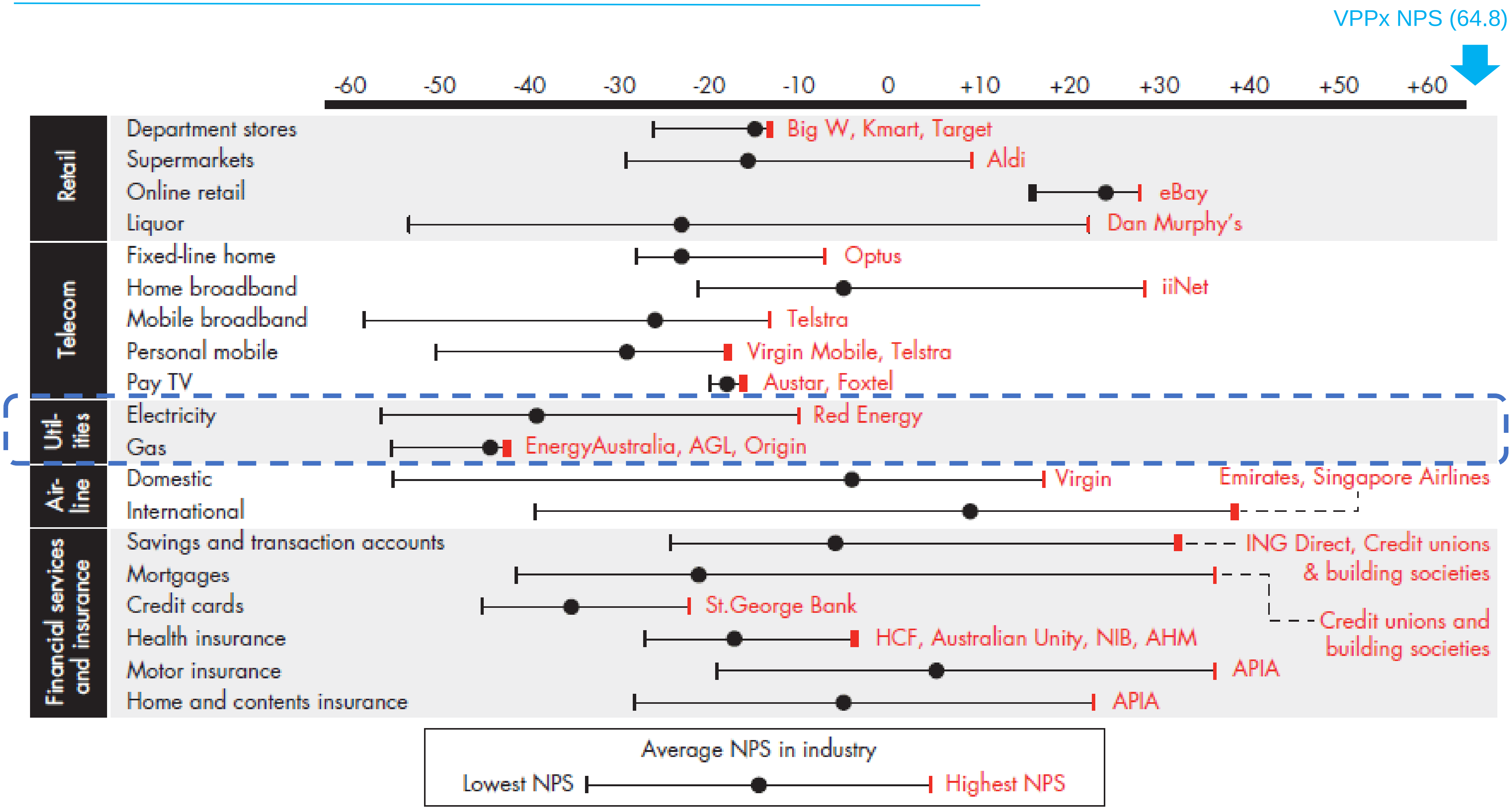


Figure 31: NPS scores across five industries (utilities circled) for Australia[16]. Simply Energy VPPx NPS score (64.8) shown with arrow.

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[16] Bain, "The powerful economics of customer loyalty in Australia". K. Bradley and R. Hatherall (2013) https://www.bain.com/insights/the-powerful-economics-of-customer-loyalty-in-australia/

7.2.3 Customer Drivers for Participation in the Program

The survey also explored reasons why customers initially became involved in the VPPx. The key results were:

- Over half responded that financial considerations were the key driver – either by taking advantage of the subsidy offered (34%) or to save money on electricity bills (24%).
- Nearly a quarter responded with an altruistic reason – either to lower their carbon/environmental impact (14%) or because "it seemed like the right thing to do" (8%).
- Security of energy supply was the main driver for 15% participants.

The breakdown of all responses is shown in the following chart.

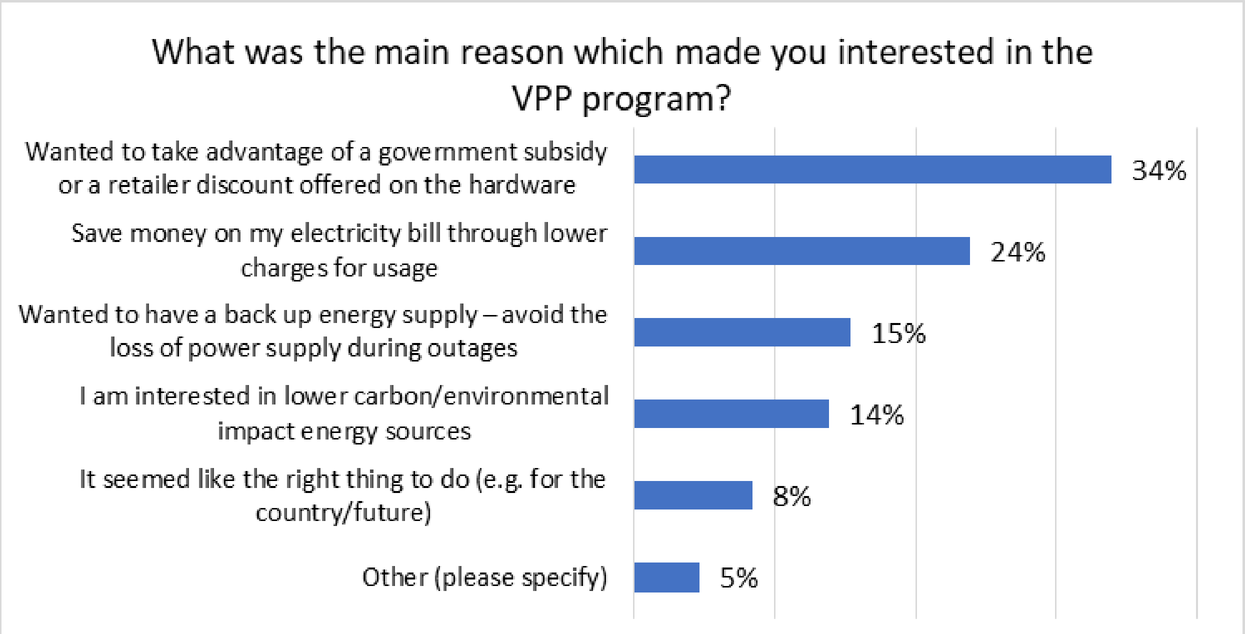
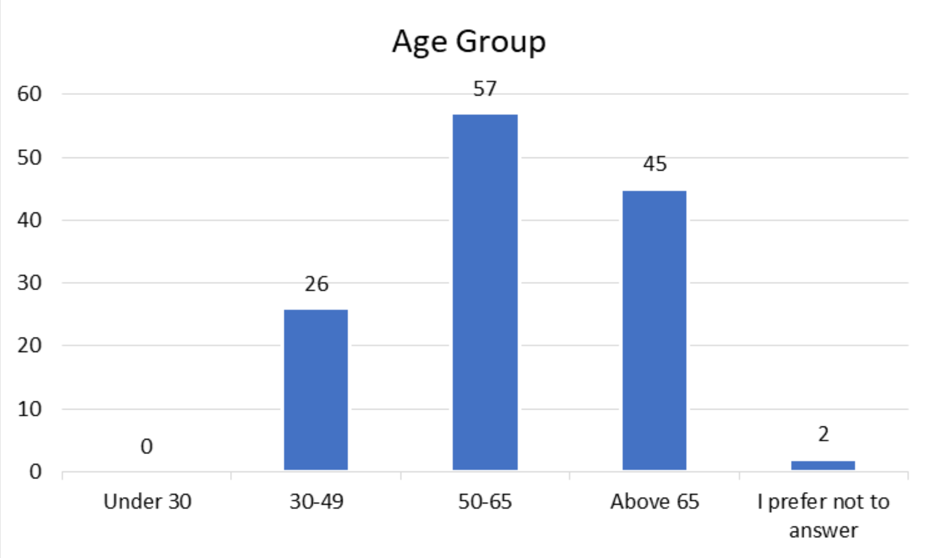
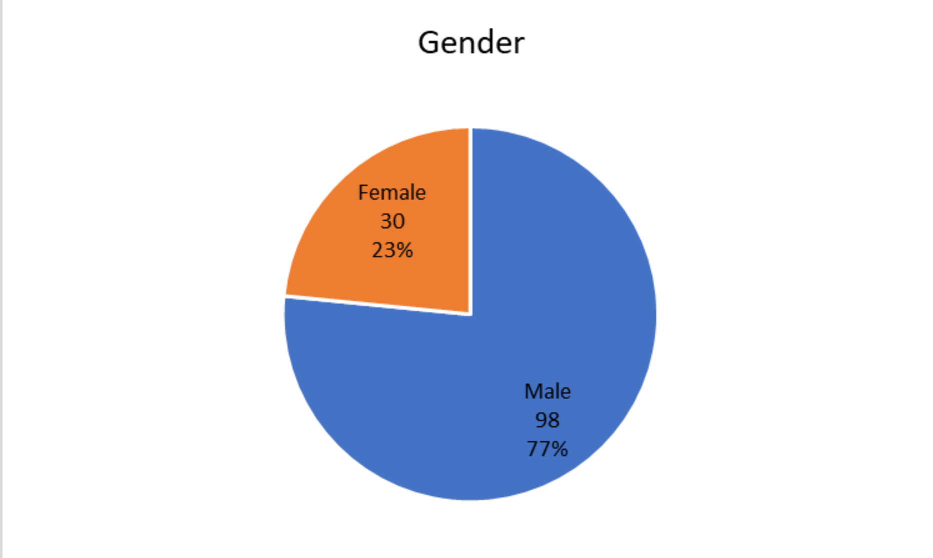


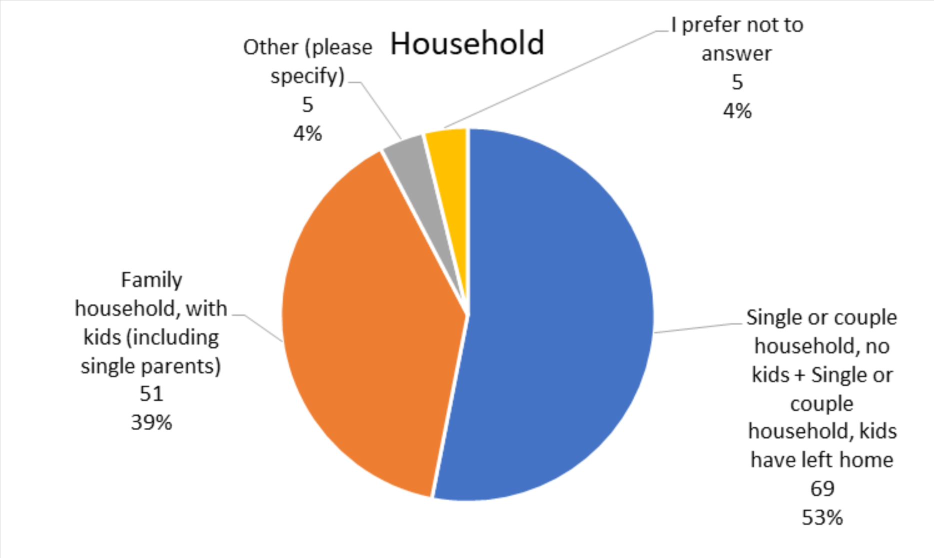
Figure 32: Customer drivers for participation in the VPPx.

7.2.4 VPPx Customer Demographics

An overview of the demographics of the VPPx customer base is provided on the following page.


Age Group
60
50
40
30
20
10
0
0
26
57
45
2
Under 30
30-49
50-65
Above 65
I prefer not to answer


Gender
Female
30
23%
Male
98
77%


Household
Other (please specify)
5
4%
I prefer not to answer
5
4%
Family household, with kids (including single parents)
51
39%
Single or couple household, no kids + Single or couple household, kids have left home
69
53%

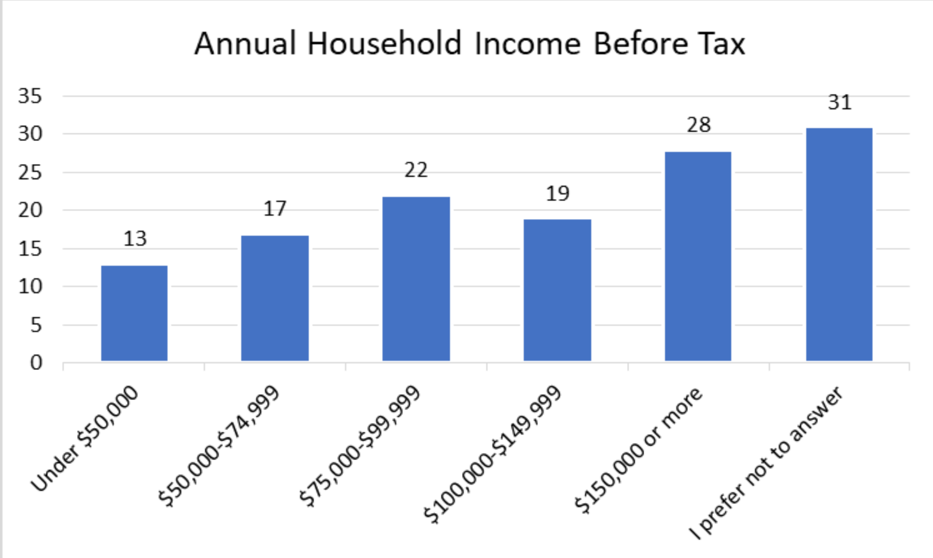

Annual Household Income Before Tax
35
30
25
20
15
10
5
0
13
17
22
19
28
31
Under $50,000
$50,000-$74,999
$75,000-$99,999
$100,000-$149,999
$150,000 or more
I prefer not to answer

Figure 33: VPPx customer demographics by age, gender, household type, income, property type, are and time using VPP.

8 Conclusion

The VPPx concept has been successfully proven

Through a considerable amount of work by all project stakeholders across a number of years, the key elements of the VPPx have been successfully proven:

- There was strong take-up of systems by households (as tested across varying price points) which ultimately exceeded the original rollout target, and of which 99.9% were successfully integrated into the VPP.
- The project completed FCAS trials and successfully registered for FCAS markets, with revenue generated for the business.
- The project created a new VPP registration and dispatch management platform in the deX platform which serves as proof of concept for DER management options for the future grid.
- Dispatch testing demonstrated that VPP enabled batteries can contribute to strengthening the resilience of the grid – although local grid limitations can result in constraining the ability of the batteries to respond to market demand.
- A variety of different technology types were supported, including batteries from five different manufacturers.

Customers were overwhelmingly satisfied with the outcomes

Of key importance to Simply Energy was that the feedback from our customers was positive:

- The Net Promoter Score (NPS) of Simply Energy VPPx customers is +64.8
- Overall user satisfaction is 8.8 out of 10.
- COVID-19 did not have a material impact on the level of demand for home battery storage systems and VPP participation.
- Sensitivity to system pricing was evident when we tested lower value subsidies in mid-2020.
- The announcement in early 2020 of the reduction of the SA HBS subsidy created an avalanche of enquires and commitment from customers to purchase a battery system, This activity provides evidence that customers are sensitive to the out-of-pocket costs when purchasing energy storage systems.

There are economic benefits for all stakeholders

All stakeholders in the VPPx value chain gain from participation:

- Customers: Battery payback period of ~4 years (including subsidy and rebates).
- Simply Energy: Generated ~$500k in FCAS revenue to date and acquired new customers.
- DNSPs: The VPPx has shown the ability to reduce daytime solar exports (thereby support a reduction in the long-run cost to operate the distribution network), respond to emergency generation curtailment signals and generated insights into local network voltage levels.

The deX platform also demonstrated the ability to support a DNSP's operating envelope and manage VPP dispatch within a defined operating range.

- NEM: The VPPx has shown the ability to respond to frequency disturbances, increase self-consumption of solar PV generation (that would have otherwise spilled into the local distribution system) and respond by exporting energy in times of high demand and high price events in the NEM.
- Battery providers: The VPPx has driven an increase in the enrolment of energy storage systems, increased the number of certified installers and generated real-world VPP learnings.

The success of the project has been externally recognised

The VPPx project has recently won two awards:

- Winner of the South Australia 2020 Premier's Awards in Energy and Mining (Energy Sector, Innovation & Collaboration). [17]
- Winner of the IoT Energy Award 2020. [18]

Overall, the success of the Project is reflected in the fact that Simply Energy has leveraged all of the lessons learned from VPPx trial to develop a new VPP offer which it launched in May 2021. This new offer does not rely on ARENA subsidies and is available across SA, Victoria, NSW and Queensland. Simply Energy recognises the strategic importance of VPPs in support the transition to a decarbonised, decentralised and digitised grid and expects that's VPP fleet will not only grow in terms of scale and geographic coverage, but also in the diversity of DERs it includes.

[17] Department of Energy and Mining (SA), https://energymining.sa.gov.au/petroleum/data_and_publications/mesa_journal/news/exceptional_performance

[18] 2020 IoT Festival, https://www.iothub.com.au/iotfestival-iot-conference/?ref=%2fiotfestival-iot-conference%2fiot-awards#register-form