Stage 2 Knowledge Sharing Report

Simply Energy VPPx

June 2020 – 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

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Executive Summary

VPPx is an ARENA funded project which commenced in March 2018 and has been working to build the first virtual power plant (VPP) that will integrate with a distributed energy market platform. The project is led by Simply Energy and involves a consortium of project partners including technology vendor GreenSync and distribution network service provider SA Power Networks (SAPN). At completion, the VPP will host 1,200 energy storage systems (ESS) which will deliver 6.5 MW of flexible capacity to the South Australian (SA) electricity grid. GreenSync's Decentralised Energy Exchange (deX) platform is being developed as part of the project and is being utilised to support the transaction of value from this flexible capacity in the provision of 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 (DER) using VPP's based on real-world experiences, including customer willingness and preferences to participate. This includes the operation, architecture and responsibilities of the parties interacting with a distributed energy marketplace and trading platforms such as deX. These learnings are intrinsic towards the integration of DER into electricity systems around the world as they become more decentralised.

In March 2019, Simply Energy published its first Knowledge Sharing report covering Stage 1 of the three-stage project. This second Knowledge Sharing report covers outcomes from Stage 2, covering the period from February 2019 to February 2020[1] and highlighting the key achievements, challenges and lessons learned.

Stage 2 of the VPPx project has overseen several key achievements, including.

1. New product offerings and accelerated customer acquisition

Simply Energy has tested multiple product offerings and sales channels to attract customers to their VPP offering and have successfully achieved customer sales in excess of 600 VPP memberships to date. In a significant shift in approach, Simply Energy have moved from direct sales of home batteries to a 'BYO model', where customers who have purchased an approved home battery from a select group of installers are eligible to join the VPP and receive VPP access credits.

2. New technology offerings

Four new battery types and two new DER controllers have been added to the eligible home battery product range in Stage 2.

These four new Battery types are:

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

The two new DER Controllers are SwitchDin – StormCloud and SolarEdge Grid Services platform.

[1] From a contractual perspective this period includes activities from both Stage 1 and Stage 2, but for simplicity it is referred to in this report as "Stage 2".

3. Demonstrating individual ESS performance

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. It demonstrates that VPP enabled batteries can contribute to strengthening the resilience of the grid, the testing also demonstrates local grid limitations result in constraining the ability of the batteries to respond to market demand.

4. Testing the aggregated VPP functionality and performance

The VPP was dispatched with a greater fleet size in comparison to Stage 1 which allowed 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. An average dispatch effectiveness for the VPP was 53% (i.e. on average 53% 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. These constraints are further elaborated in section 2.4 of this report.

5. Accessing market benefits

The fleet was dispatched to generate wholesale market value over four months of 2019. To date, due to the limited size of the installed fleet, the VPP has not been able to access FCAS market value, and due to the dispersed nature of the home batteries across the network, the VPP has not been able to access network services value streams.

6. Further development of the deX platform

GreenSync has finalised the development of the required deX functionalities for the VPPx project. It was delivered on-time and within budget with the final evaluation review complete. In Stage 2, the team successfully showcased use cases for Distributed System Operator (DSO) mediation, forecasting and DSO/ISO (referring to Independent System Operator) contracting.

Next steps

Moving forward with the lessons learned in Stage 1 and Stage 2, the next steps of the VPPx project will focus on:

VPP Recruitment

The next stage of the project will take advantage of the current positive uptake rates of the Simply Energy VPPx offering in the South Australian market. Simply Energy will continue to work with existing partners to improve customer experience whilst also onboarding new partners to expand the reach of the project. Additionally, the pool of eligible systems may be adjusted to better suit the technical requirements and challenges met with operating a VPP.

VPP Testing and Knowledge Sharing

Given the positive uptake of the VPPx offering, the next stage of the project will be able to continue VPP testing efforts, in alignment with a greater scale and distribution of battery storage assets. These tests will provide invaluable insights to operating a VPP at scale and its ability to be replicated in other parts of the Australian power system. The next stage will result in the following knowledge sharing activities:

- Test the recruitment of a DER cluster in an area of the network that would benefit from energy storage installations to expand learnings on VPP benefits to the network;

- Understand customer drivers for being recruited into a VPP (i.e. addressing major blockers from previous research and undertake further research to validate the extent of the issue);
- Test deX functionality across markets; wholesale, FCAS and simulated distribution network support services (network services);
- Test the VPP platform functionality with a larger fleet of systems;
- Test storage systems for ‘VPP readiness’;
- Test VPP preference settings and optimisation;
- Assess value generated for customers;
- Assess the impact of any regulatory changes required to support VPP customer benefits and their system performance;
- Assess the VPP platform’s ability to support market forecasting; and
- Assess the role of the DSO and DMO in a VPP market environment with input from the Reference Group Committee.

1 Introduction

1.1 Project Overview

Australia is leading the world in DER uptake and currently has highest per-capita uptake of behind the meter rooftop solar. 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[2]. This creates both risks and opportunities for the management of the electricity system in Australia and, specifically, South Australia.

One of the obvious opportunities 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 sustainability objectives.

Recognising the opportunities in this changing energy landscape and the alignment with its sustainability objectives, Simply Energy has initiated collaborative efforts to evaluate the technical and commercial feasibility of a sizeable DER fleet, aggregated on the innovative 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 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.

The first Knowledge Sharing report was published in March 2019 covering the establishment and initial sales, marketing, integration and operation activities. This second report is focussed on capturing the progress and lessons learned from Stage 2 of the project, incorporating progress up to February 2020.

1.2 Review of Stage Objectives

The key objectives of Stage 2 for VPPx were to:

1. Attain targeted VPP participation numbers
2. Successful enrolment of different battery types onto the VPP;
3. Test VPP functionality across multiple value streams; and
4. Finalise development of the deX platform

1. Enrol a targeted number of batteries into the VPP

In Stage 1, the challenge of marketing a technologically complex and innovative product in an emerging market with low take-up numbers and with multiple VPP and home battery offers, generated challenges for Simply Energy to achieve originally set milestone targeted enrolment numbers. However, as part of Stage 2, Simply Energy, (and after making come contract variations) have exceeded their sales target of 350 batteries. This achievement is an outcome of:

- Testing multiple product offerings with the South Australian market; and
- Enabling Simply Energy customers to access the VPPx offer through the South Australian Government Home Battery Scheme (HBS).

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

Although overall sales of VPPx have met targets, there is still a substantial time delay between selling the product and enrolling the battery as part of the VPPx fleet. Due to this time delay, the enrolled VPPx fleet size remains relatively small. A summary of sales and VPP integration across Stage 1 and 2 is shown in Table 1.

Table 1- Customer Acquisition numbers

Customer Acquisition	Knowledge Sharing Report 1	As of 19/12/19 (Milestone 6)	As of 10/2/2020
VPP Participation Target	163	350	N/A
VPP Participation Achieved	42	478	606
VPP Integration	71	151	198

The details of sales and customers are discussed in Section 2.2 of the report.

2. Test VPP functionality across multiple value streams

As an outcome of multiple VPP functionality and performance tests performed during Stage 2, the technical viability of aggregated DER was validated for:

- Aggregated dispatch via co-ordinated fleet testing for wholesale market value;
- Frequency Response; and
- Voltage Response.

The details of VPP functionality and performance are discussed in Section 2.3 of the report.

3. Finalising the development of the deX platform

GreenSync have worked with project partners to demonstrate the use cases for DSO Mediation, Forecasting and DSO/ISO contracting. deX development to date has involved 3 showcase events to the VPPx projects consortium and industry members. The details of deX platform development are further discussed in Section 2.4 of the report.

2 Current Stage Review

2.1 ESS and Installations

2.1.1 Product Offerings

The market leading, technologically complex and innovative nature of the VPPx project concept has made it a challenging product to market. Simply Energy's product offering has gone through an iterative process to increase consumer uptake. This process of market testing, followed by changes in product offerings, has significantly improved customer acquisition during Stage 2 and Simply Energy is on track to achieve their upcoming milestone targets.

In Stage 1, Simply Energy launched the **S.M.A.R.T Storage offer** in May 2018. This offer consisted of a subsidised bundled ESS and "all you can use" electricity to South Australian households with an existing solar PV system. The subsidised ESS was a 13.5 kWh Tesla battery which required a $7,299 upfront cost. Customers were then offered a fixed electricity offer at $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. As reported in the first Knowledge Sharing report, these options proved to be challenging because:

- 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;
- Installation was complex and problematic, with delays between sales and installations; and
- Multiple VPP programs and home battery subsidies in South Australia made the market confusing for customers, who were trying to find the best offer.
- During Stage 2, a key focus was gaining access to the home battery subsidies available under South Australia's HBS and re-structuring the product offer in order to be competitive in the market. Specific re-structuring activities included:
- The introduction of the "BYO Model". Under this arrangement, Simply Energy initially partnered with three installers accredited for the HBS. Customers who purchased an eligible battery, which needed to be one of the four batteries specified above, from the select group of installers would receive the HBS subsidy and could also "BYO" their home battery to the VPPx trial to receive an additional $5,100 subsidy which is paid through a bill credit of initially $3.5/per day on the customers commodity account for up to five years referred to as a VPP access credit. This resulted in significant positive uptake in customer interest and forthcoming sales. Access credits were later increased to $7.00 per day to a total of $5100.00
- **Expanding the eligible battery brands**. In addition to the Tesla Powerwall 2.0, in Stage 2 Simply Energy also offered VPP membership to owners of other battery types including products from LG, Sonnen, Varta and Eguana.
    - A range of factors need to be considered when including various battery types on a VPP. These factors include, the expected value that can be derived from the battery, the cost to deploy a new battery type – i.e. integration costs and the likely take up of the battery type by customers. With these factors taken into consideration, a staged approach was taken to rolling out additional battery types.
    - The range of battery types was expanded in an effort to increase participation numbers, offering customers more options, as well as lower cost options.
    - Although some of the battery types have low uptake rates it did increase participation, as well as enabling the project the ability to test other battery types performance on the VPP.

Conducting additional market research on the VPP offerings and customer's experience interacting with the Simply Energy VPP website enabled Simply to better understand it's customer perspectives and better service their needs. This provides greater long-term learning on how best to communicate to customers, the value of, what can be a seen as a complex concept and provides greater insights on customers perspective towards home storage and VPPs which can be considered in future offers.

- This research found that:
  - Only **16%** of respondents were comfortable with Simply Energy controlling the battery;
  - **40%** of respondents thought the information about the VPP offer was clear;
  - **36%** of respondents considered the website language complicated or lengthy;
  - **50%** of the respondents considered the website overwhelming and indicated they would prefer a face to face meeting;
  - **80%** of the respondents were not aware how much the energy storage actually cost;
  - Only **28%** found the VPP product appealing and only **28%** indicated the website provided enough information to make a decision;
  - Respondents expected price points for an initial outlay on home battery storage was
    - Min $2,070 – ***28% of respondents***
    - Optimum $4,900 – ***40% of respondents***
    - Max $7,880 – ***32% of respondents***

As a result of the research there was an immediate and significant overhaul of the Simply Energy VPPx webpage and further refinement to the VPPx product offer. These subsequent refinements included:

- **Sole focus on BYO model**, with VPP enquiries handled exclusively by Simply Energy. Simply Energy no longer offered a direct home battery sales and installation option as it could not access the HBS directly due to not being a CEC accredited Solar Retailer. Instead, Simply Energy worked with an expanding group of referring installers (now up to 8) who would promote the benefits of joining the Simply Energy VPPx trial at the point of sale and refer all interested customers through to the Simply Energy call centre to enrol their battery. Simply Energy does not provide a financial incentive to installers to refer customers, rather in addition to the HBS subsidy the ability for customers to access a further VPP subsidy provides installers with a very compelling battery offer.
- **Condensed timeframe for VPP benefits.** In addition, Simply Energy reduced the timeframe over which the VPP access credits are paid from 5 years to 3 years. This increased VPP membership credits to $7/day up to a total value of $5,100. The offer also included no exit fees.

These changes resulted in a steep change in sales with Simply Energy now capturing a significant share of the South Australian home battery scheme market as shown in Figure 1. Simply Energy is continuing to expand its referrer network (and one more being onboarded) and pursue other sales channels.

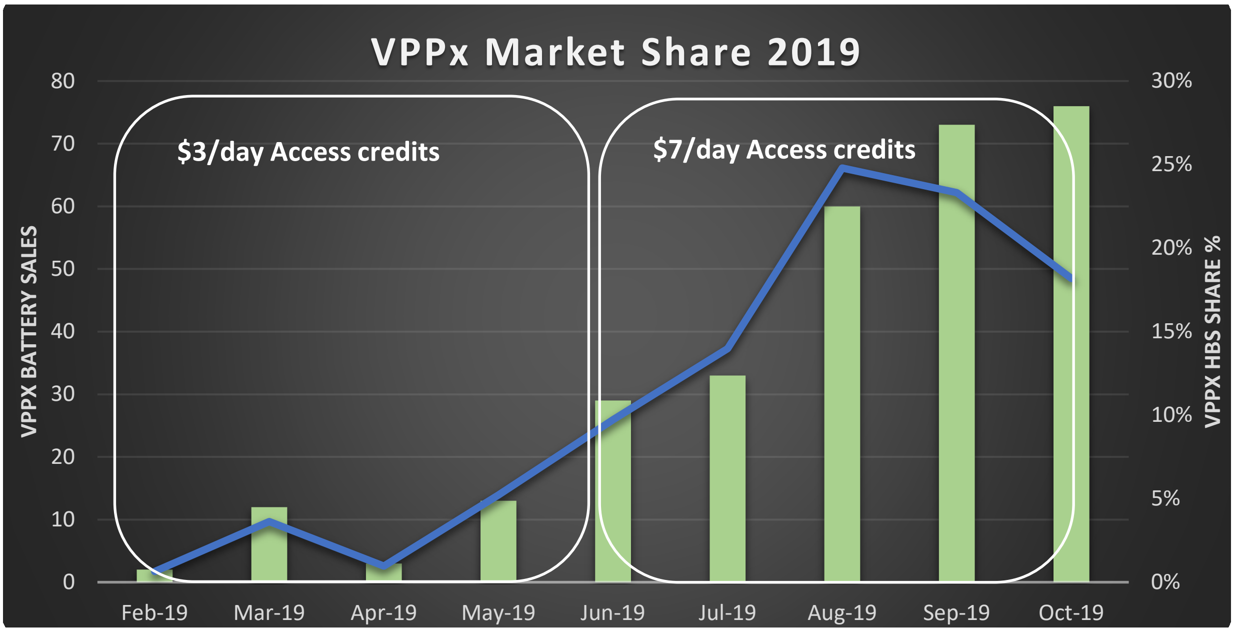

Figure 1- Battery Sales growth

Eligibility Criteria

As part of this iterative product journey, Simply Energy identified that some of the stringent eligibility requirements for the VPP inhibited interested customer's participation in the program. As part of the process, the following changes were made to project eligibility requirements to drive uptake and interest in the product:

- The requirement to be within a 100 km radius around Adelaide was removed. The requirement to be 100km of Adelaide CBD was originally applied for ease of installation (Installers are Adelaide based) and reduce the likelihood of unreliable internet connections. This was later removed with no notable issues on internet reliability from customers outside the 100km CBD zone and no significant change in participation as a result of the change in this criteria; and
- The requirement for stringent (cable connected) internet connectivity was relaxed for Tesla Powerwall's only to "reliable and continuous" connection (e.g. via Wi-Fi).

Eligibility criteria to participate in the VPPx trail also includes,

- The customer must be a South Australian residential customer and meets Simply Energy credit worthiness;
- The property has a fully functioning and performing solar PV system (with a minimum 3kW inverter size) or the customer is willing to purchase a system;
- The property already has, or the customer agrees to install, an eligible ESS on their premises by an installer from Simply Energy's specified list of approved installers. The system must have been purchased after 15 January 2019;
- The property has a remotely read interval meter installed at their premises or the customer agrees to obtain one before the commencement of the fixed benefit period;
- The property has an available, continuous and reliable internet connection at their premises (not 3G/4G or a dongle); and
- The customer owns the residential premises.

2.1.2 Technology Offering

Inclusion of new ESS Technology and DER control systems

In Stage 1, the VPPx trial only included a single type of battery ESS (i.e. Tesla Powerwall 2) using a combination of Tesla's Gridlogic control system and Greensync's deX Platform. Following a thorough selection process, Simply Energy has since added four more battery brands and two new DER control systems as part of the VPP offering. The battery ESS were selected based on:

- Inverter capacity – the portfolio of battery types needed to offer a range of inverter sizes to suit a range of customer requirements;
- FCAS response – the ability to provide an automated response that could support FCAS trading;
- Wholesale market response – the ability to provide a response to support wholesale market trading;
- Backup capability – the ability to provide backup power in the event of a local loss of grid supply; and
- Control and monitoring – the ability to be remotely controlled via the Simply Energy VPP and deX control platforms and to provide sufficient data for the trial analysis.

The current product offering now includes the following battery storage systems:

- Tesla Powerwall 2 13.5 kWh;
- Eguana Evolve 0513 13 kWh - 39 kWh modules;
- LG Chem Resu 9.8 kWh integrated with one of the following inverters;
    - Solar Edge HD-Wave SE5000h
    - Solar Edge StoreEdge SE5000

- sonnenBatterie eco 8.0/10,12,14;
- sonnenBatterie eco 8.2/10,12,14;
- sonnenBatterie eco 9.43/7.5,10,12.5,15;
- sonnenBatterie eco 9.53/10,12.5,15; and
- Varta Pulse 6.5 kWh

In order to successfully integrate these batteries into Simply Energy's VPP via the deX platform, the sonnenBatterie, Eguana and Varta ESS are required to utilise a SwitchDin droplet DER controller. deX integrates directly with Tesla, Solar Edge and SwitchDin products.

2.2 Sales and Installation

2.2.1 Project Media

The following project media was generated throughout the period of this report:

- Revised Simply Energy product offering webpage.
- Simply Energy VPPx overview video on YouTube.

2.2.2 Marketing Campaign and Channels to the Market

In Stage 1 of the project, Simply Energy's marketing activities for the VPPx trial involved:

- Direct Mail Campaigns
  - Electronic Direct Mail (EDM) sent out to existing eligible Simply Energy customers;
  - Direct mailout of an information pamphlet;
- Media
  - Promotions at the Adelaide MBA Building & Home improvement show;
  - Newspaper advertisements;
- Online
  - Promotions on third party websites, e.g. solar choice[3] and ARENA.[4]and;
- Townhall Events (8 events with various referrers)

EDM proved to be the most effective channel for Stage 1, generating 42% of the total leads. This was supported by Simple Energy's website (13%) and traffic via third parties, as detailed in Figure 2.

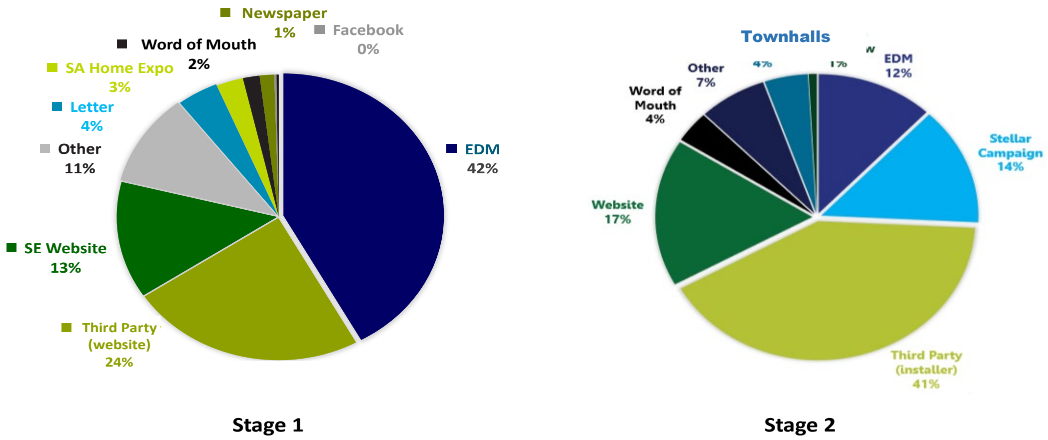

Figure 2 – Leads generated by marketing channels in stage 1 and stage 2 of the VPPx trial

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[3] https://www.solarchoice.net.au/blog/simply-energys-vpp-offers-customers-up-to-216-p-m/

[4] https://arena.gov.au/projects/simply-energy-virtual-power-plant-vpp/

This marketing campaign was reassessed during Stage 2 to accelerate customer acquisition with added activities including:

- Third party installers – where the selected partner installers generate leads for the VPPx trial at the point of sale;
- Online Marketing campaign – Simply Energy engaged an online marketing service provider, to develop and deliver a coherent digital marketing strategy, including Google ads targeting searches for batteries and the SA HBS;
- Town hall events – participation in town hall briefings for interested customers, in conjunction with other technology providers, to explain and promote the VPP product suite Townhall events tend to be useful in targeting installer customers base/customers who are in the market for solar and or batteries, These events included battery manufacturer, installer and Simply Energy providing customers access to experts at the same time .

The most significant impact in the change of approach was the prominence of leads generated by the installer network – this new channel was developed to take advantage of installers front-line engagement with customers. This is currently the largest source of lead generation (43%) followed by the Simply Energy website (17%) and Stellar campaign (14%).

The installer network model simplifies the sales process for the customer, enabling customers to engage with the appropriate expert for each component of the overall energy solution, solar/battery and installation, commodity offer and VPP participation. This enables Simply Energy to focus customer interaction on the commodity and VPP participation and the Installer the solar/battery purchase and installation. Customers generally contact solar/battery retailers when consideration a battery purchase, rather than an energy retailer, with VPP participation offering a secondary value add service.

2.2.3 Sales and Installation Metrics in Stage 2

Of the 1137 leads generated in Stage 1, only 3.7% were converted to final sales. Stage 2 achieved a conversion figure of leads to final sales of 56.2% - increasing significantly from the conversion figure from Stage 1 (3.7%). Installer referrals were the largest source of leads and the most effective channel for converting marketing leads to sales. As of December 2019, 97% of sales originated from a third-party installer lead, with the next highest being eDM (3%).

The complex nature of the sales model used in Stage 1 was simplified via the third-party referral approach and “BYO model”, where the proposition for the battery ESS and the VPP are now separated. There are typically two customer journeys

- Customers either come initially to Simply Energy, where the VPP product proposition and technical guidance is provided by the dedicated sales team and then the customers are directed to the install partner to purchase the home battery through the HBS (if they do not already have a battery installed).
- Alternatively, customers could approach a third-party installer first, to discuss the installation of a battery storage system and are then referred to Simply Energy at the point of sale to discuss the benefits of including their new battery in the VPP.

As of December 2019, customer sales for the Simply Energy VPP product offer totalled 478, 151 of which have been enrolled in the VPP fleet. Of these, 46 have been installed as part of S.M.A.R.T product and 432 with the BYO model. This is detailed in Table 2.

Simply Energy moved from selling the SMART Storage Offer in Q1(Feb) 2019 to the BYO Model. The below table demonstrates that it took several months to gain momentum for the sales numbers to pick this was due to the following factors, adding more referrers and more batteries, developing our working relationship with the referrers marketing activities i.e. townhalls are all contributors to the gradual increase in sales numbers. The original table does not tell that story.

Dec-19	Nov-19	Oct-19	Sep-19	Aug-19	Jul-19	Jun-19	May-19	Apr-19	Mar-19	Feb-19	Jan-19
58	88	82	73	59	37	23	4	4	-2	1	6

Table 2– Sales and installation metrics

Customer Acquisition	Stage 1	Stage 2 - Milestone 6 (as of 31/12/2019)
S.M.A.R.T storage offer	42	46
BYO model	0	432
Total	42	478
VPP enrolled	14	151

2.2.4 Customer Insights

During the course of the campaign, Simply Energy carried out survey and in depth marketing discussions with customers to understand how they were disposed towards the VPP product, particularly what drove their buying decision. The discussions with customers interested in the VPP product, shown in Figure 3, indicates that by far the most important consideration is the customers' ability to reduce electricity bills, followed by an interest in a self-powered home.

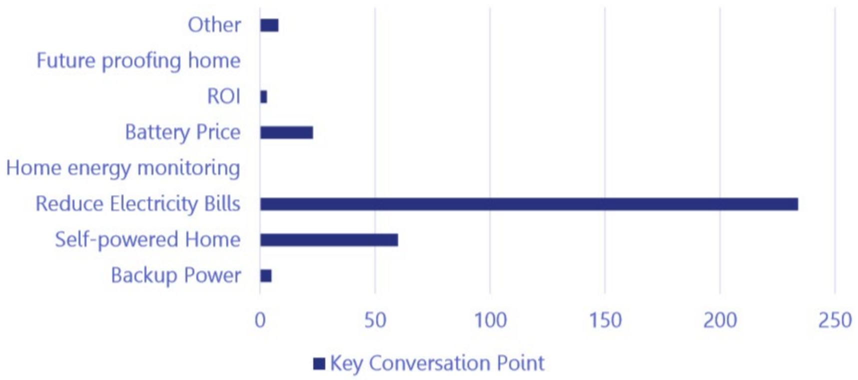

Figure 3 – Key conversation points in customer calls to Simply Energy regarding the VPP product

Data collected from the call centre found the leading reason that customers who expressed interest in VPP participation, but did not take up the offer, was due to the inability to comply with the eligibility checklist, followed by customers concluding that the product (battery purchase) was too expensive. Further details are shown in Figure 4.

Simply intends to use this data to refine its value proposition particularly around product attributes and price, and how it engages customers going forward.

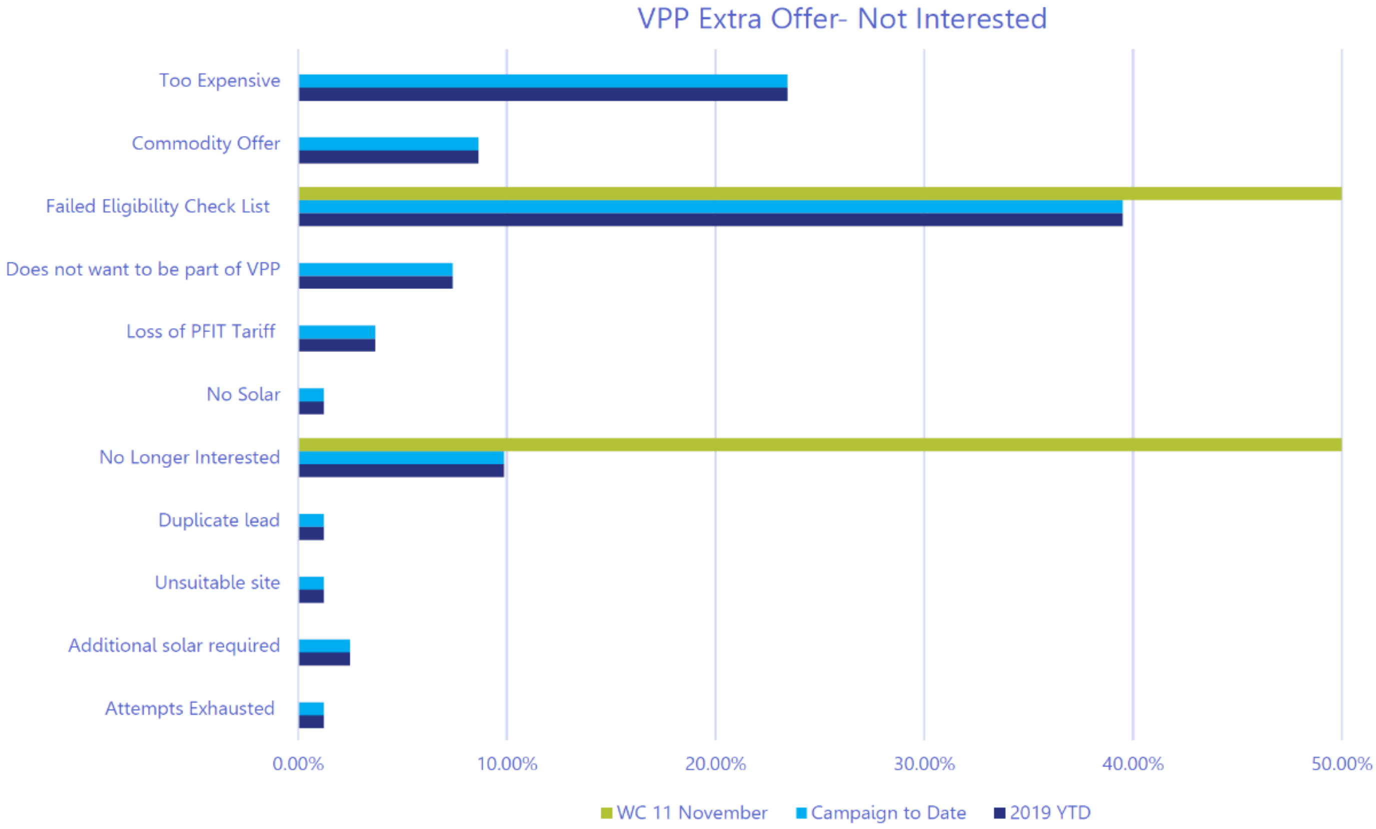

Figure 4 – reasons for customers not progressing their interest in VPP through to a sale

2.2.5 Sales Lessons Learned

Simply Energy achieved a significant acceleration in sales through Stage 2 of the project and has benefited from pivoting the sales and marketing approach based on lessons learned throughout the project to date. Key lessons learned in relation to sales and marketing include:

- A BYO approach to VPP products, which effectively separates the sale of the battery from the sale of the VPP offer, helps avoid the complexity of communicating and managing the end-to-end sales and installation process.
- A select referral network, with a limited number of high-quality installers, is a highly effective sales channel. The withdrawal of Simply Energy from direct battery sales also helped this process, as installers no longer saw themselves as a competitor.
- Retaining control of the VPP sales conversation is important to closing the deal. Simply Energy ensured all referrals were funnelled through the Simply Energy call centre so there was no reliance on the installers to communicate VPP product details and close the sale.
- Accessing the HBS subsidy has been critical to securing a competitive advantage in the South Australian market. Simply Energy's ability to combine both the HBS subsidy and the VPP trial offer resulted in a competitive VPP offer, which is reflected by the significant increase in VPP participation rates and installer feedback.
- The upfront cost of home battery storage solutions is still a major barrier for VPP uptake. Even with available subsidies in the South Australian market, the upfront cost of battery systems is a significant barrier for uptake, with 23% of customers who are interested in the product not proceeding for this reason.
- Having clear, simple communications promoting the product helped convert leads into sales. Updating the VPP webpage and simplifying the product offer helped to communicate the value to interested customers and contributed to the increased sales.
- New, targeted marketing channels, such as the online campaigns and town hall events, helped generate new leads when old channels, such as EDMs, to existing Simply Energy customers exhausted interest.

2.2.6 Installation Process and Typical Installation Configuration

With Simply Energy no longer offering direct sales and installations of home battery storage solutions, participation in the VPP now relies on the installations undertaken by the approved installer network. As at the end of December 2019, Simply Energy reached 432 VPP offer sales, 262 had confirmed installations and 151 has been integrated into the VPP. This is reflective of the recent increase in sales and the time delay between closing a VPP product sale, installing the battery storage system and integrating the system into the VPP. Typical timeframes are between twelve to sixteen weeks with the approximate stages explained below:

- On average ten weeks between the customer signing up to the VPP commodity and installing the battery (for customers without an existing battery storage system). The timeframes can be impacted by the backlog of work for the installer and availability of battery storage systems in the state.
- One to two weeks between battery installation and VPP integration. This is dependent on the battery technology installed. Some batteries can be directly integrated remotely, therefore timeframes may be shorter, whereas others require additional hardware (i.e. the SwitchDin droplet) to support integration and this requires additional installation and testing time.

It is expected that the next stage of the project will provide further insights into the effectiveness of the current process.

2.2.7 Installation Lessons Learned

In Stage 1 of the project, Simply Energy encountered several challenges associated with managing installations of battery storage systems. This included the availability of installers, installation issues associated with previous solar installations, the importance of site inspections prior to installations and the overall impact on customer costs associated with installation issues. To better manage these challenges, Simply Energy's BYO model has effectively transferred all responsibility for installations to third party installers, with Simply Energy only offering the VPP product, not the physical battery asset.

Nevertheless, customers still associate their installation experience with Simply Energy, particularly if they have provided a referral to an approved installer. Simply Energy is closely monitoring the performance of third-party installers to ensure a high standard of customer experience.

Simply Energy, where required, have provided support and advice to customers with regards to:

- the transfer process from another energy retailer;
- when VPP access credits will commence; and
- if a new meter is required.

In general, the BYO model provides customers with a process that allows them to interact with the most appropriate party for a given step in the customer experience. If issues arise, customers are therefore dealing directly with the correct responsible party ensuring effective resolution to their concerns.

2.3 Functionality and Performance

2.3.1 Individual Performance

As part of Stage 1, it was demonstrated that home ESS are configured primarily to maximise customer savings and serve as a backup supply. Under normal operations, they store the customer's excess solar energy in the middle of the day, discharging at night to reduce grid-based consumption.

Demonstrations and testing efforts in Stage 2 were focused on evaluating different response behaviours of different types of storage systems to the instructions they receive from DER controllers. Although there are five home battery brands currently eligible for Simply Energy's VPP, only 2 brands – Tesla and LG Chem - were installed and integrated at the time of testing. The tests undertaken in Stage 2 included:

- Tesla Powerwall 2:

  - Real power test
  - Frequency response test
  - Reactive power test
- LG Chem Resu:
  - Real power test
- Seasonal variation tests:
  - Voltage variation
  - ESS performance

Tesla Powerwall – Real Power Test

This demonstration was designed to test the storage system for real power dispatch and charging at different setpoints. A setpoint is the target outcome defined by the VPP controller, in this case Simply Energy, and communicated to the individual ESS via their VPP control software.

The ESS at the test site had a nominal power capacity of +/- 5kW. The system was instructed to subsequently charge and discharge to its peak power capacity.

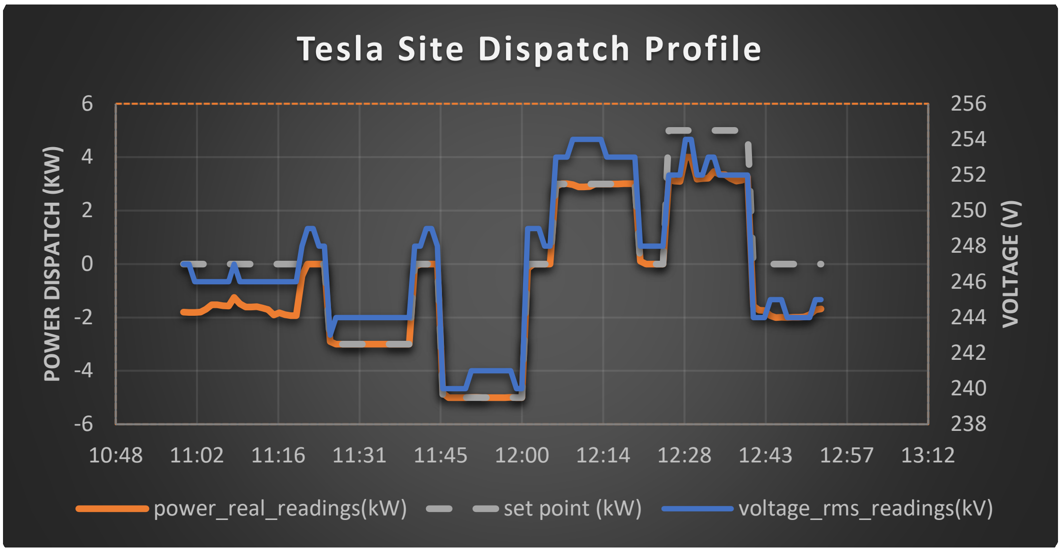

Figure 5- Real Power Dispatch profile of Powerwall

As an outcome of the demonstration, both the charging and dispatch requests from the VPP platform were accommodated as expected but the peak power discharge was limited to 3-4kW, most likely because of either network imposed export limitations [5]or the grid voltage being greater than 253V[6].

Tesla Powerwall - Frequency Response Test

With increasing variable DER penetration and a reduction in the inertia provided by large synchronous generators, battery ESS are expected to play a significant role in regulating the frequency of future electric power systems. This test was conducted to ascertain whether the storage system responded to frequency deviation of magnitude sufficiently.

A power quality analyser was installed on a site with three phase grid connection to analyse the total power response of the ESS to frequency deviation of significant magnitude.

Figure 6 shows the Powerwall reacting in less than 5 seconds to the first deviation and 2 seconds to the second deviation. While the response of the ESS has the effect of rectifying the frequency drop and the expected response to both frequency drops follows the general shape of the required response, it did not reach the peaks in each case. Additional telemetry is required from the site in order to ascertain whether

[5] Exports from residential solar systems are limited to 5kW in South Australia and there may have been existing solar exports which “crowded out” the battery exports

[6] 235 v is the upper limit of acceptable grid voltage and the point at which inverters will automatically constrain export - SAPN Doc TS129 section 4.9

the solar PV system or household load is impacting these measurements. Advice from the manufacturer is that the device responds to the frequency deviation by means of a 'Delta-P' – the power flow in addition to what was expected during the energy systems normal operation.

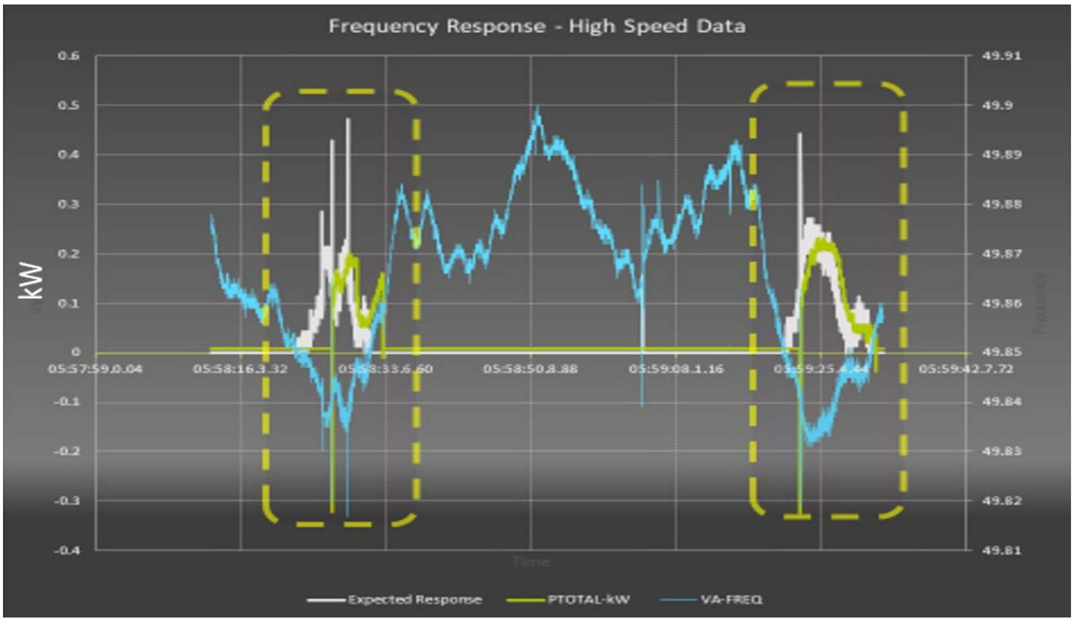

Figure 6 – Frequency Response profile - Tesla Powerwall

Tesla Powerwall - Reactive Power Test

To test the ability of the ESS to improve the power quality and manage voltage on specific areas of the grid, the ESS's ability to dispatch reactive power was tested. The intent was to evaluate the role of reactive power from a single ESS in reducing the average recorded voltage.

A single Tesla Powerwall was employed to provide a reactive power of 5 kVAr. For this test, multiple requests for kVAr were submitted at various setpoints in anticipation of dropping overall average voltage.

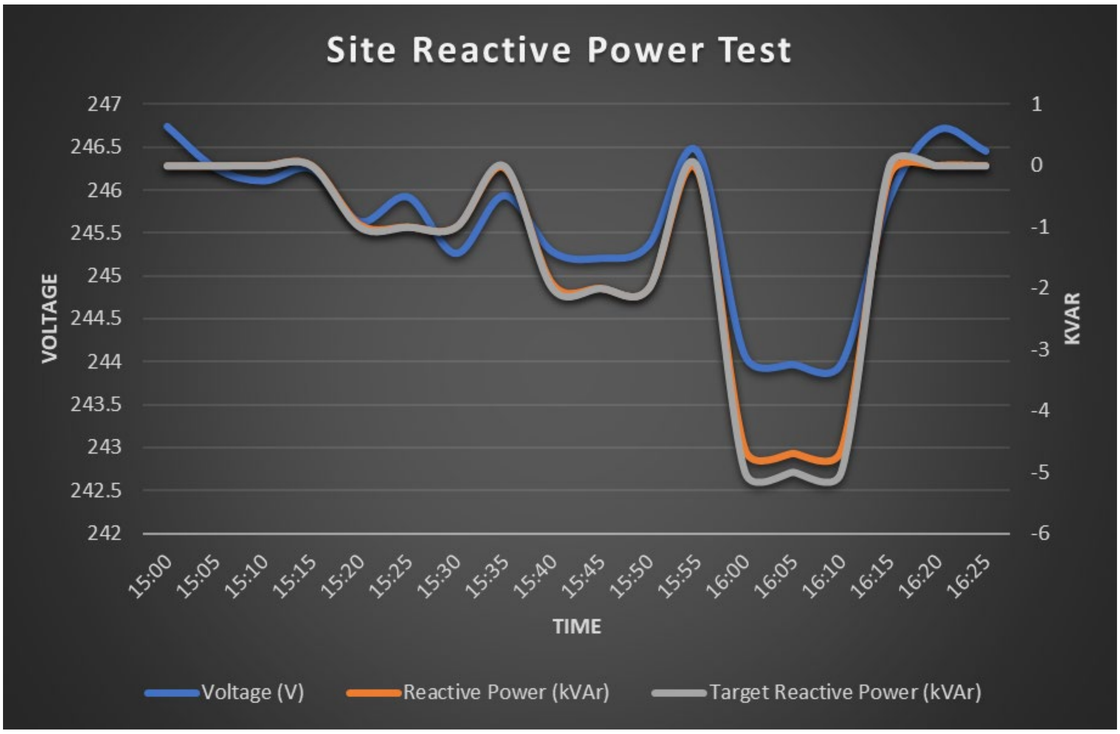

Figure 7 - Reactive Power dispatch of Powerwall

The ESS performed the dispatch request with a high degree of accuracy in two of three tests, the final test for -5kVAr was dispatched to within 10% of the target setpoint (Figure 7). The smaller of the reactive power setpoints (-1 and -2kVAr) appears to have had the least impact on the voltage levels recorded at the site. Alternatively, the voltage reduction observed at -5kVAr exceeded expectations, having observed a significant reduction of 3V. This demonstration substantiates the ability of home battery storage systems to improve power quality by influencing voltage on the network through reactive power dispatch.

LG Chem – Real power test

The performance of an AC coupled LG Chem RESU 10H (+/- 5kW capacity) and SolarEdge HD-Wave 5000H system was tested as it undertook real power dispatches and charges at different setpoints. The battery systems are expected to charge from the grid unimpeded (unless the storage is at or near capacity) and dispatch the stored energy in line with the dispatch request, subject to their export limitations.

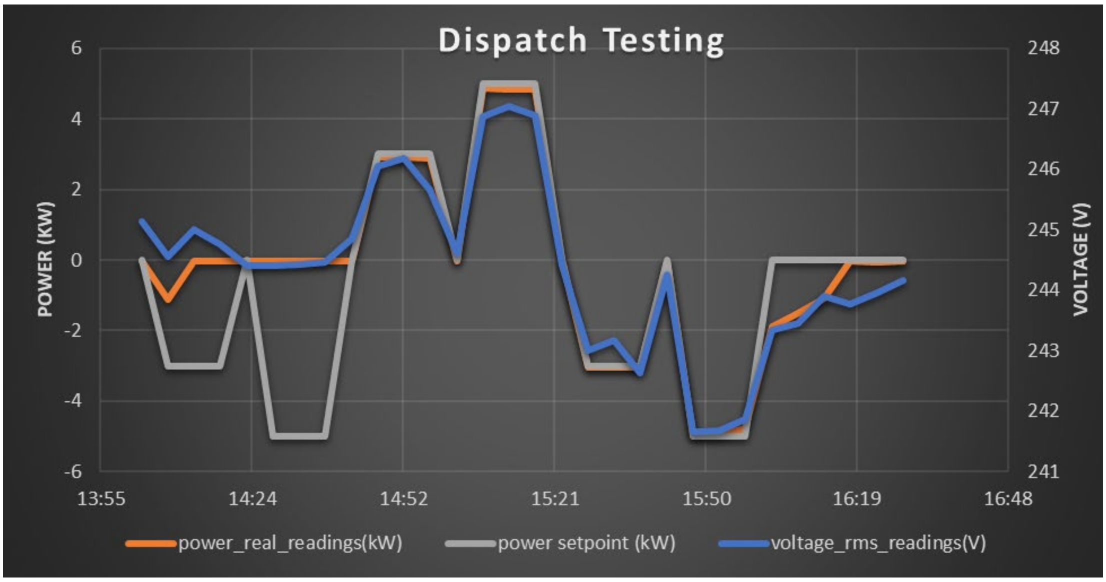

Figure 8 – ESS dispatch test for LG Chem

The ESS could not meet the dispatch request for two initial setpoints to charge the system because the battery reached its maximum storage capacity, shortly after the test began (Figure 8). With this noted, supplementary charging setpoints were added to the end of the test which were followed by several periods of discharging. No site voltage or site export constraints were observed during the testing. Except for the two initial setpoints, the system was able to dispatch with 98% accuracy. Voltages remained below 248V for the duration of the testing and voltage rise was observed to be 1.1V when dispatching 2.9kW and 2.3V when dispatching 4.8kW.

Seasonal variation - Voltage variation test

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. Seasonal variation impacts on ESS were assessed over the period of 12 months as highlighted in Figure 10. As part of that exercise, the data on the site average voltage and ESS performance in dispatch events over four different occasions are evaluated below.

Figure 9 shows the average hourly voltage profile for a site with a Tesla Powerwall installed across a 12 month period. Some of the key insights are:

- The average voltage was within the required operating range 216-253V for the full 12 month period;
- The daily voltage fluctuations follow a similar profile across the different months, with variance of between 6-12 V between peak and non-peak seasons;
- The voltage peaks with maximum solar generation and drops at peak demand in the evenings; and
- The average voltage increases during the day between 4-6V and drops in the evening by between 10-12V.

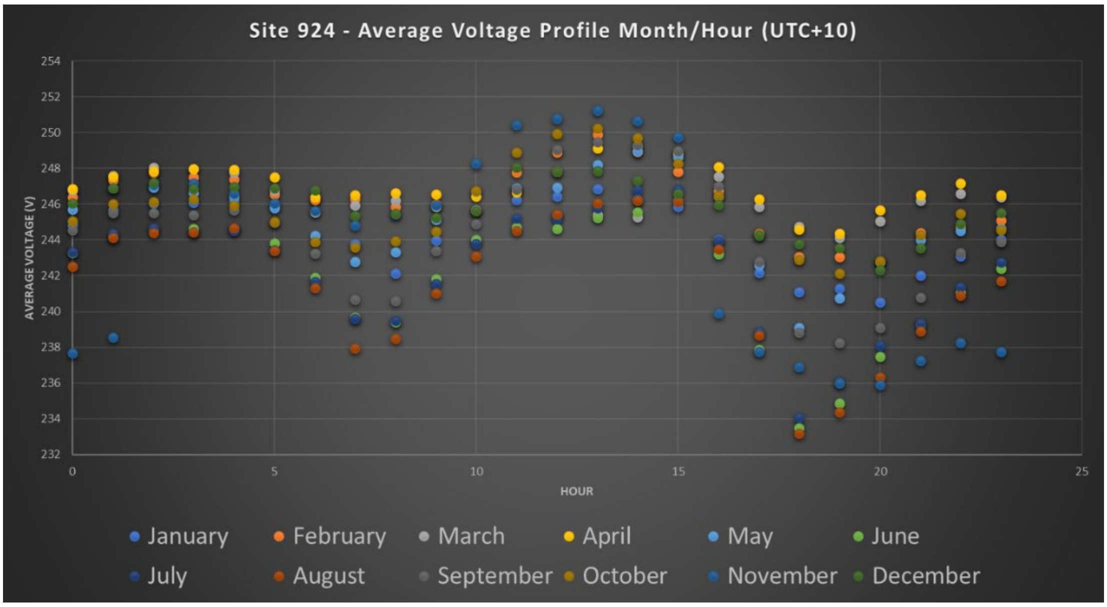

Figure 9-Seasonal annual voltage variation of a Tesla Powerwall

An increasing penetration of DER in the network, the fluctuation in voltages between different parts of the day are expected to increase which will pose serious power quality and reliability issues across the network. Visibility and access to dispatchable DER resources will have a major role to play in the provision of reliable access to energy.

Seasonal variation – ESS performance test

Four dispatch events were captured across four different seasons between 2018 – 2019 (Dec 2018, Mar 2019, Aug 2019, Nov 2019) for a test site. The main objective was to evaluate the performance of the battery to execute the dispatch instructions across different seasons. It was also interesting to observe the overall solar generation and voltage profiles as part of the dispatch process. The key insights for distinct events, chosen to highlight seasonal variation, are as follows:

(a) The dispatch event for December 2018 shows the battery attempting to dispatch 3kW with voltage rising along with it – the site export limit kicks in when the net load hits -5kW, indicating that there was also coincident solar exports, and the battery inverter is limited to 1.2kW to 2.2kW.

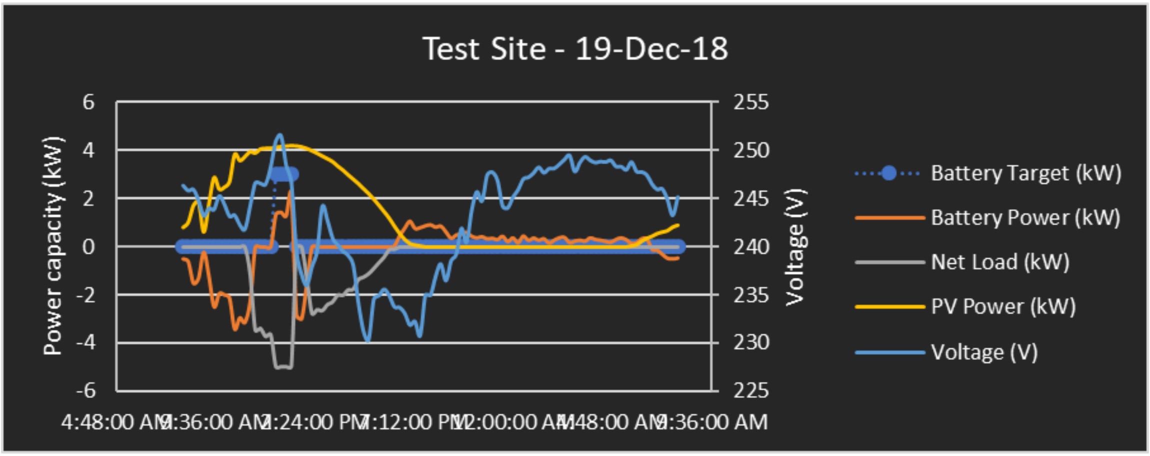

Figure 10- Seasonal battery performance of Tesla Powerwall at Test Site December' 2018

(b) The dispatch event for March 2019 (see Figure 12) shows the battery attempting to dispatch 5 kW at two different occasions, with the battery able to dispatch 4 kW in the first instance before the site export limit came into effect. The battery was able to meet the dispatch target on the second set point and dispatched 5 kW. No peaks in the voltage were noticed on either of the dispatch events.

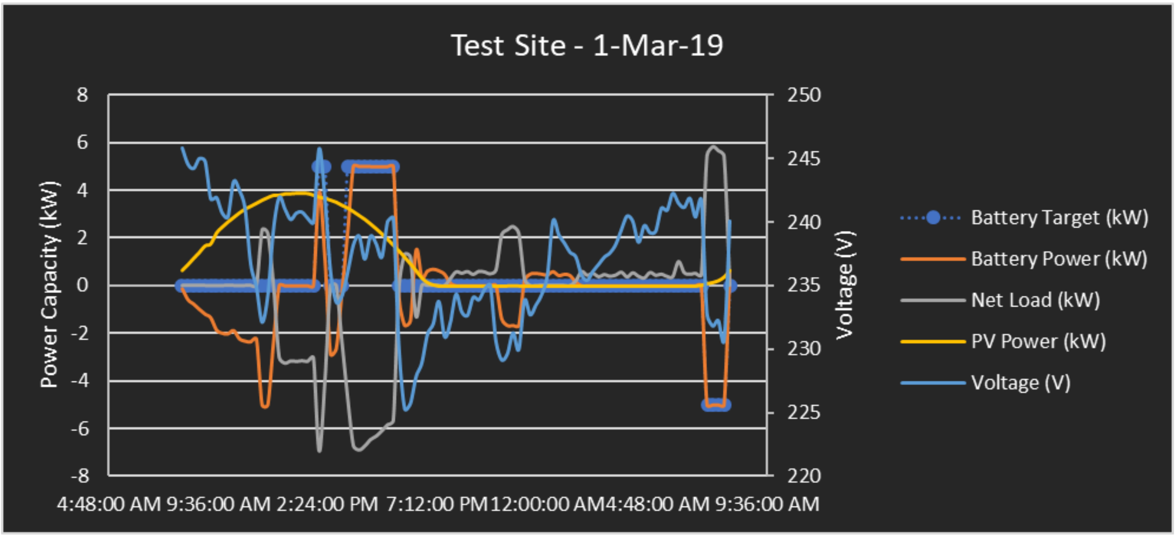

Figure 11- Seasonal battery performance of Powerwall at Test Site March' 2019

(c) The dispatch event for August 2019 (see Figure 13) shows the battery attempting to dispatch 5kW. The site export limit came into effect at 5kW net load and the battery power is limited to approximately 1.8kW. Voltage rise is more prevalent through the afternoon with average readings of over 253 V once the solar PV system began exporting to the grid.

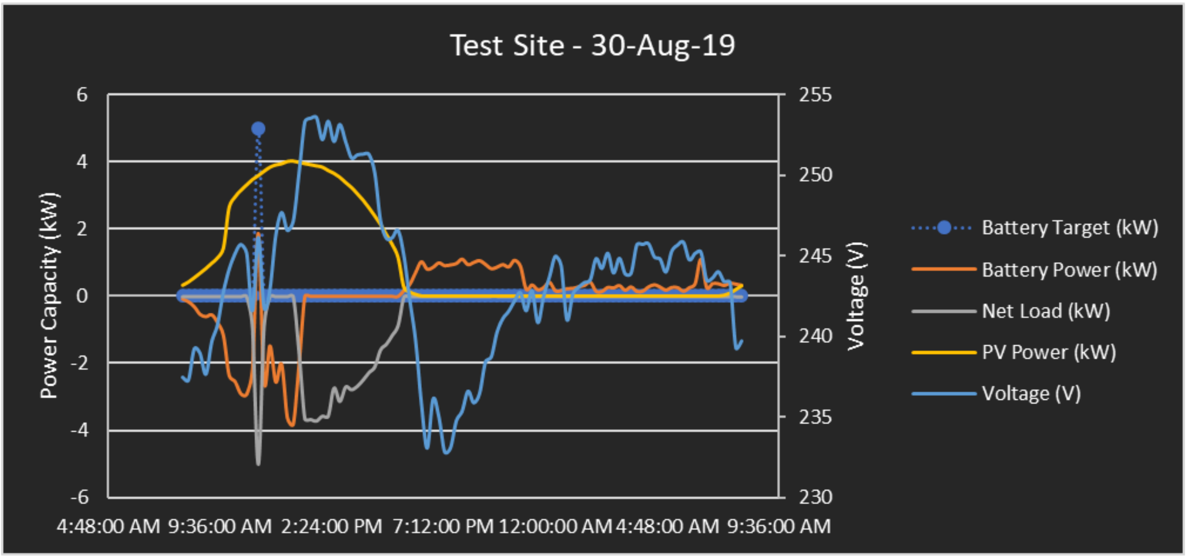

Figure 12- Seasonal battery performance of Powerwall at Test Site August 2019

(d) The event observed in November 2019 shows the battery attempting to meet two subsequent dispatch requirements of 3kW and 5kW each. The site net load approached 5 kW which limited the battery export to 3kW at peak. The battery switches on the charging mode to regain the specified state of charge, after which the solar export to the grid can be observed in Figure 14. Interestingly, the solar export to the grid results in significant rise in voltage and some solar PV curtailment.

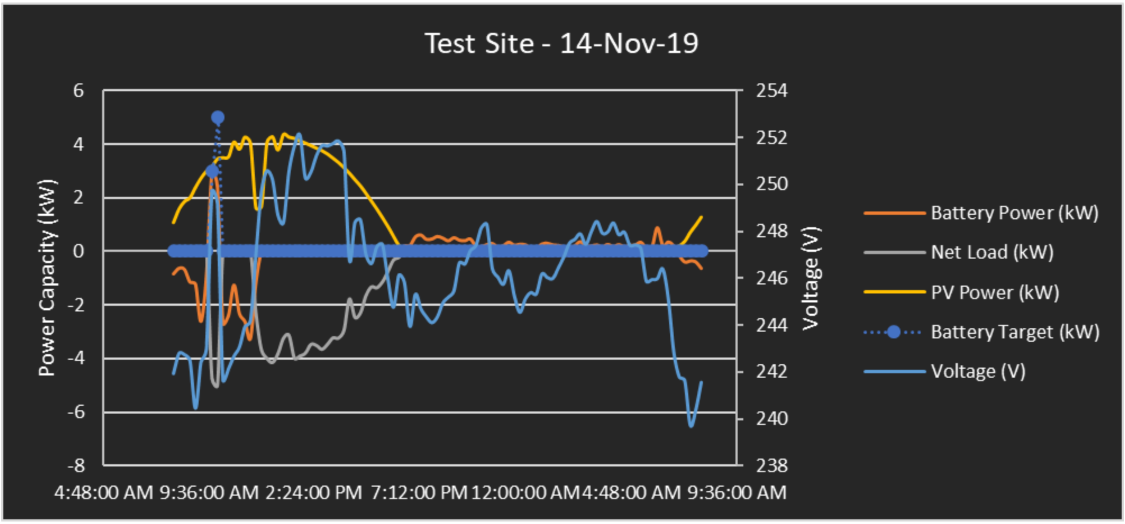

Figure 13- Seasonal battery performance of Tesla Powerwall at Test Site November 2019

2.3.2 Aggregated Fleet Control and Performance

As part of Stage 1, the aggregated dispatch response of only 3 batteries demonstrated the storage systems' ability to dispatch to the instructed set points. In Stage 2, with a significantly larger fleet of batteries, Simply Energy evaluated the dispatch capability and its impact on different functions of the VPP for bigger fleet sizes. There were three key tests:

- A fleet real power test to understand the overall responsiveness of the fleet to dispatch signals;
- A peak solar dispatch test to assess the constraints impacting the effectiveness of the fleet to dispatch as requested; and
- A fleet reactive power test to understand the overall effectiveness of the fleet to manage local voltage.

VPPx fleet power test

Figure 14 plots an aggregated VPP orchestration event that took place on 14 November 2019. In total, 88 storage systems with total individual inverter capacity of 440kW (5 kW each) participated in the event.

The dispatch instruction was set at two 15-minute intervals where each individual ESS was instructed to dispatch 3kW for the first 15-minute interval and 5 kW each for the next 15 minutes. The total dispatch load was capped at 264 kW for the first interval and 440 kW for the next interval.

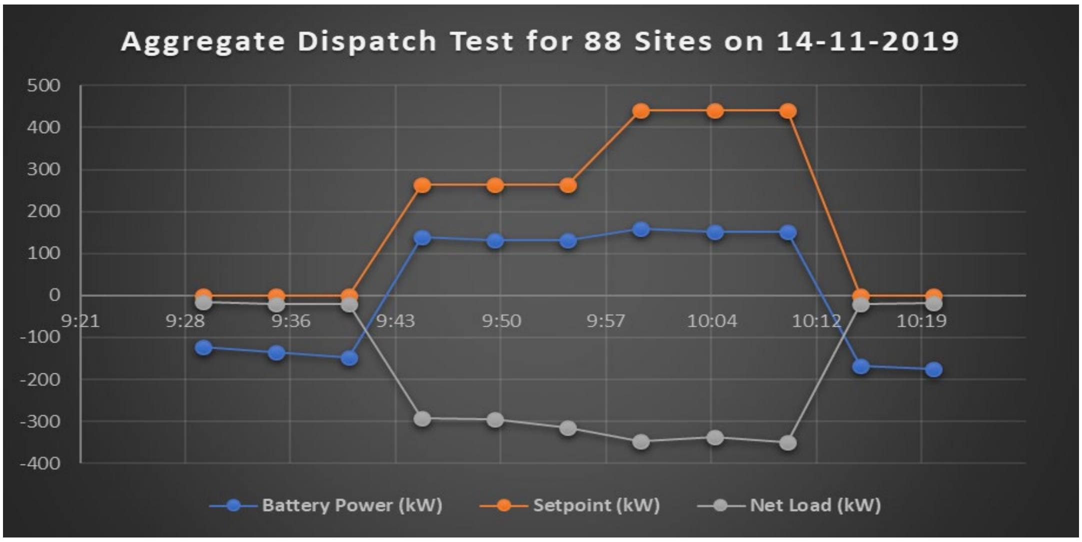

Figure 14 – Aggregate orchestration event VPPx

The outcome of the orchestration event resulted in the storage fleet dispatching approximately half of its inverter capacity for the initial setpoint interval. In the second interval, there was a slight increase in the power dispatch from the fleet, but significantly less than the set point.

Some of the key potential reasons for the fleet inability to dispatch the required capacity are as follows:

- Export limitation – the site's overall export limit (solar and battery) came into effect to limit storage systems' ability to meet maximum dispatch capacity;
- Voltage imbalance – peaking voltages restricts the storage systems ability to dispatch; and
- Limited inverter capacity (serving both on-site and dispatch load) – site net load reserves the maximum power capacity of the inverter, which restricts the storage system's dispatch capability. Bigger inverter sizes could help meet both.

A sample of 10 random sites were selected to observe the change of voltage due to power dispatch at each individual site during the orchestration event (Figure 15).

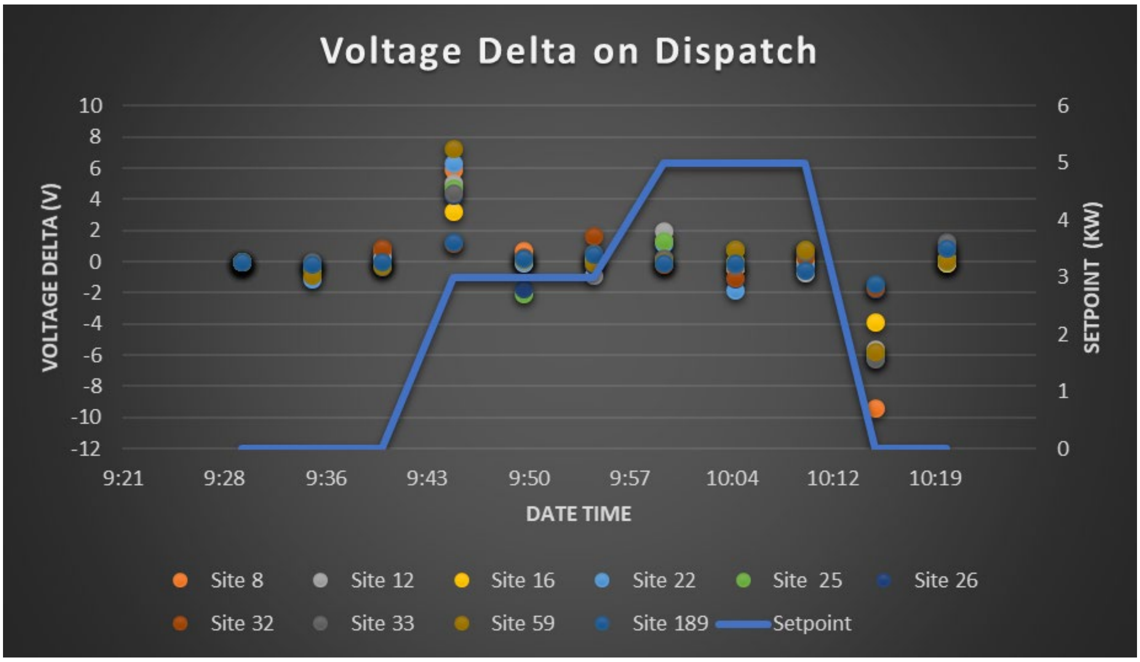

Figure 15 – Change in voltage over 10 random sites during dispatch

The change in the voltage at approximately 9:43AM when the sites dispatched from 0kW to 3kW was between 1.2V and 7.3V. With the setpoint change of 3kW to 5kW, we see a voltage rise between 0V and 2V. As the systems returned to their normal solar PV self-consumption mode at about 10:15 AM, the voltage dropped between 1V and 9V.

VPPx peak solar dispatch test

To better comprehend the constraints on power dispatch, a peak solar dispatch test (see figure 17) was conducted to understand the consequences of attempting to dispatch at times of low network demand and high solar PV export.

The test was conducted on 47 Tesla Powerwall battery storage systems that were instructed to dispatch their access power to the grid at 11:10 AM.

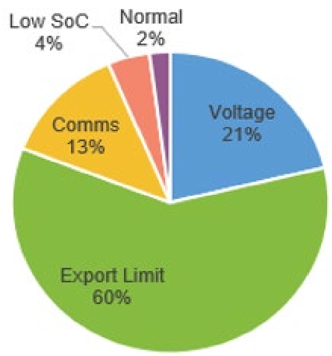

Figure 16- The causes of VPP dispatch constraints

The network assessment indicates that although the voltages were observed to be high at 40 out of 47 sites, only 21% of the ESS were appearing to be constrained by voltages in the excess of 248V and more than 60% were constrained by the export limits for the individual sites. Out of the other constraints on the ESS sites, communication links appeared to be a significant impediment to follow through on dispatch instructions.

Figure 17 shows that 63% of the overall constrained power was attributed to the export limit, with communications issues (either telemetary or on-site reception and acceptance of instructions) being the second leading issue.

Export limitations pose several issues for a VPP. They are static and are not typically adjusted when an energy storage device is added to a site with an existing solar PV system. Additionally, there doesn't appear to be a system in place for VPP operators to validate the currency of a site export limit with the Distribution Network Service Providers (DNSP). For VPPx, where the site export limit is unknown, a default value of 5kVA has been assumed with a view to adjusting if a different limit becomes known at a later date.

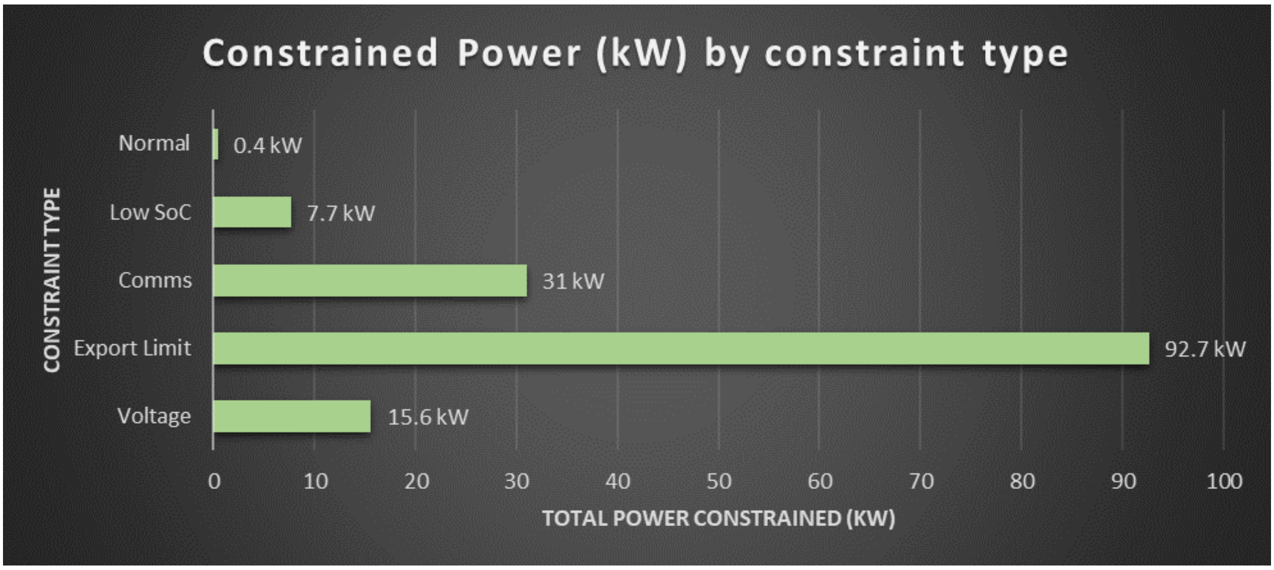

Figure 17 - Total power (kW) constrained by the constraint type

VPPx Reactive power test

The function of the storage systems to dispatch "reactive power" is a means to manage voltage on the distribution network. A fleet of 76 aggregated Powerwalls were instructed to dispatch reactive power (kVAr) at different intervals up to a max of -380 kVAr. With every dispatch of reactive power, the storage system works to reduce the overall voltage in the network (Figure 18).

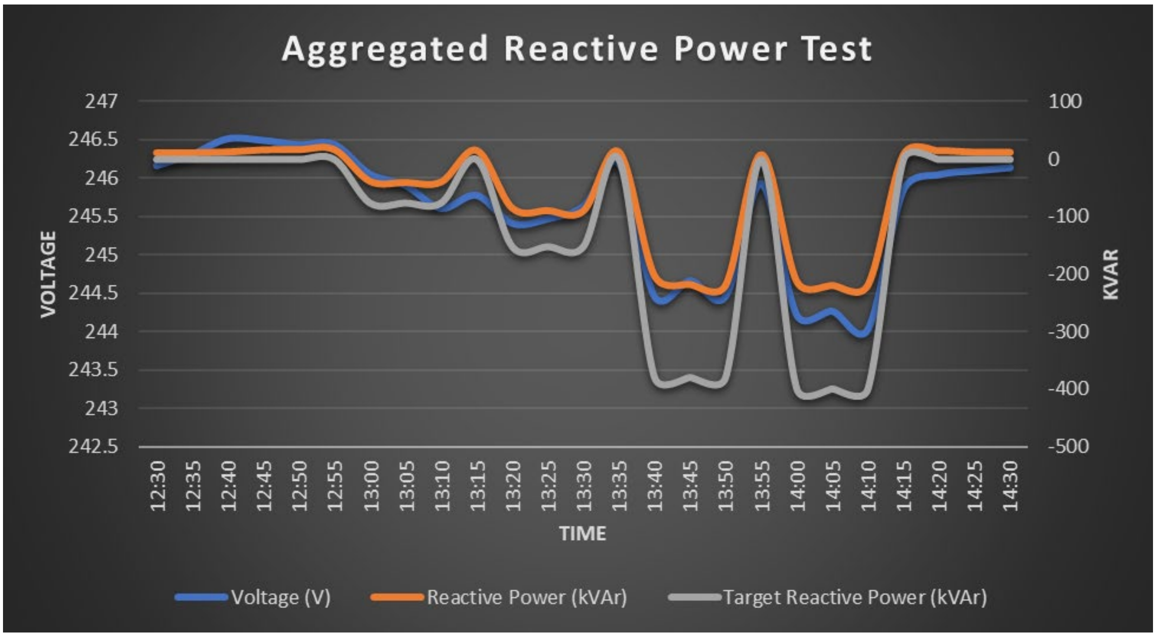

Figure 18 – Reactive power dispatch by the aggregated fleet

The test results showed that only about half of the total dispatch demand for the reactive power was met by the fleet. In terms of voltage drop, the dispatch in reactive power does appear to help drop the voltage across the fleet for this test in the range of -0.5V to -2.0V per dispatch instruction. Advice from the fleet manufacturer indicated that the Tesla Powerwall prioritises real power over any request for reactive power, so this would likely explain the difference between the reactive power response and the target reactive power.

With the increase in penetration of solar PV and resulting increases in network voltage, demand for reactive power is likely to increase and may eventually become a prominent and valuable feature on the battery storage operating platforms.

2.3.3 Summary of Market Benefits

The wholesale market value has been accessed by the VPP during four months of 2019 (January, March, July and November). No monetary value for FCAS or network service has been realised to date, mainly due to limited size of the existing fleet (below the threshold for FCAS bidding) and the dispersed nature of the fleet across the network limiting its effectiveness for network services. As the size of the fleet increases, the opportunities for FCAS value will increase.

Wholesale and Market Services

While average wholesale prices have increased, peak price events have become less frequent over the lifetime of the project. Figure 19 below shows that over the period of the last 11 months, while the available fleet size of VPPx grew from 12 systems to more than 102, Simply Energy was only able to capitalise on these resources in market events spread across four months, that amounted to approximately $2,500 in total as a cost offset.

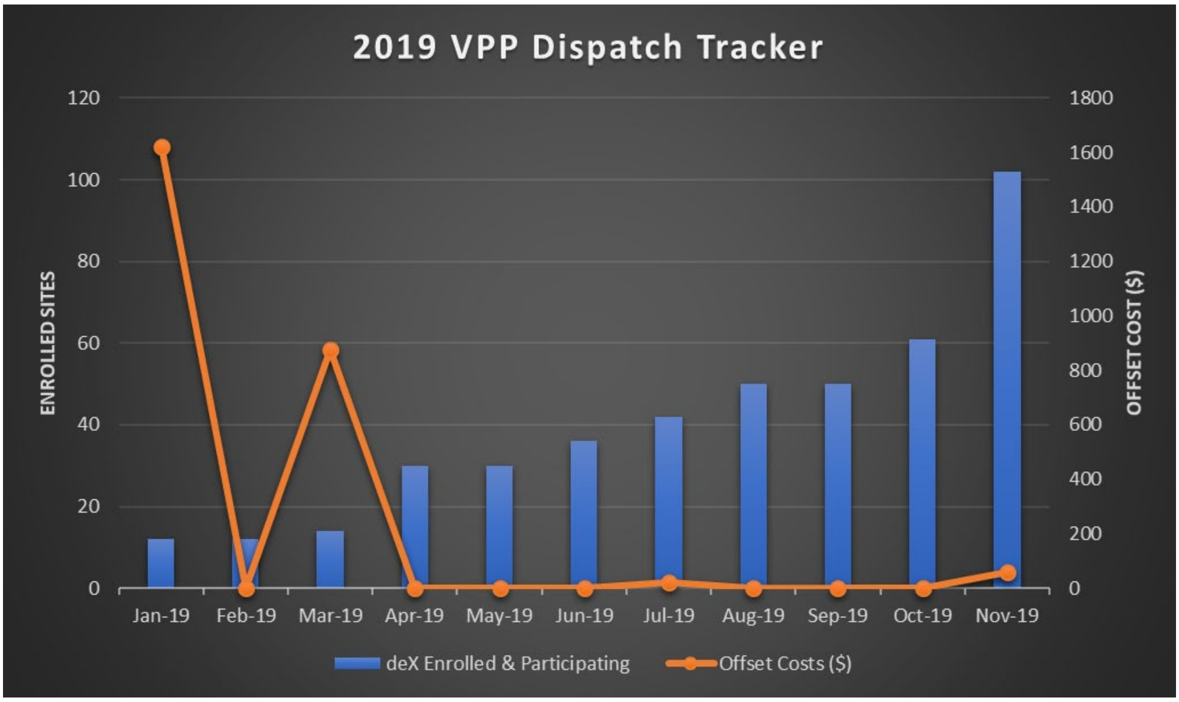

Figure 19 – Cost offset by wholesale market participation

FCAS Market Services

To date, the VPPx fleet size has not attained the minimum 1 MW of firm dispatchable capacity to be able to participate in the FCAS market. Simply Energy has now sold enough storage systems to obtain that capacity, and these systems will be used for FCAS trading as part of the Stage 3 of the project once installed and integrated.

Metering obligations under the Market Ancillary Service Specification (MASS) typically requires proponents to provide high speed data samples less than or equal to 50 milliseconds for fast FCAS response (in the 6 second FCAS market), whilst slow and delayed services require measurements of 4 seconds or less to verify services. These are uneconomical if applied to each ESS in the VPP.

However, Simply Energy has reached an agreement with the AEMO VPP Demonstrations Program, which requires them to have one high speed meter per region with an ability to provide one second data for the aggregation.

In addition, leveraging home batteries for FCAS can be challenging as the window for FCAS value extraction can often be small and unpredictable and home batteries need to be effectively in “FCAS mode” to respond in the required timeframes. Based on the current market mechanisms, a home battery is not immediately available for other normal VPP dispatch activities (and protocols) if it is offered into the market for a frequency control service. A VPP aggregator would need to determine the optimal revenue stream, whether it be a dispatch for the wholesale market, a service offered to a DNSP or FCAS based on forecasts and market intelligence, and adjust any offers to provide FCAS in advance if the fleet is likely to be used for another service.

Based on dispatch testing to date, it is expected that testing FCAS dispatch at installed sites in a live environment could also be significantly impacted by export limits. This means that a significantly larger fleet size - 3 times name plate capacity rating - will likely be needed to meet the minimum requirements. Separately, Simply Energy is still working with SAPN to resolve this issue by advocating for dynamic export limits.

Network Benefits

Due to the low level of ESS penetration at any constrained node in the network, Simply Energy is still working with project partners to quantify the realistic value of network benefits. Key developments to date are:

- SAPN have updated their standard connection agreements making it mandatory for the new inverters to have the ability to provide voltage services; and
- Simply Energy is working on a commercial model to incentivise the uptake of ESS at the constrained node of the network. This will likely aid in quantifying the commercial value of network services and will be reported in the Stage 3 report.

Case Study: Market Benefits – conflicting objectives of stakeholders

On the morning of 31 July 2019, the VPP was dispatched due to a high wholesale market price in South Australia. All of the VPP assets were requested to dispatch, and all sites but one accepted the request which was rejected due to a problem with site registration data. At 7:25am the SA price spiked to over $9,000/MW ($1,633/MWh for the settlement period). The fleet dispatched for just over 5 minutes and the pool revenue offset was minimal, however something interesting occurred just after the event. Some of the fleet appeared to have a backup setting which was different to the agreed setting and the dispatch created a variance between the two settings. Following the dispatch, the sub-aggregator recharged individual batteries back to the customer setting. This resulted in some grid draw immediately after the event (Figure 20).

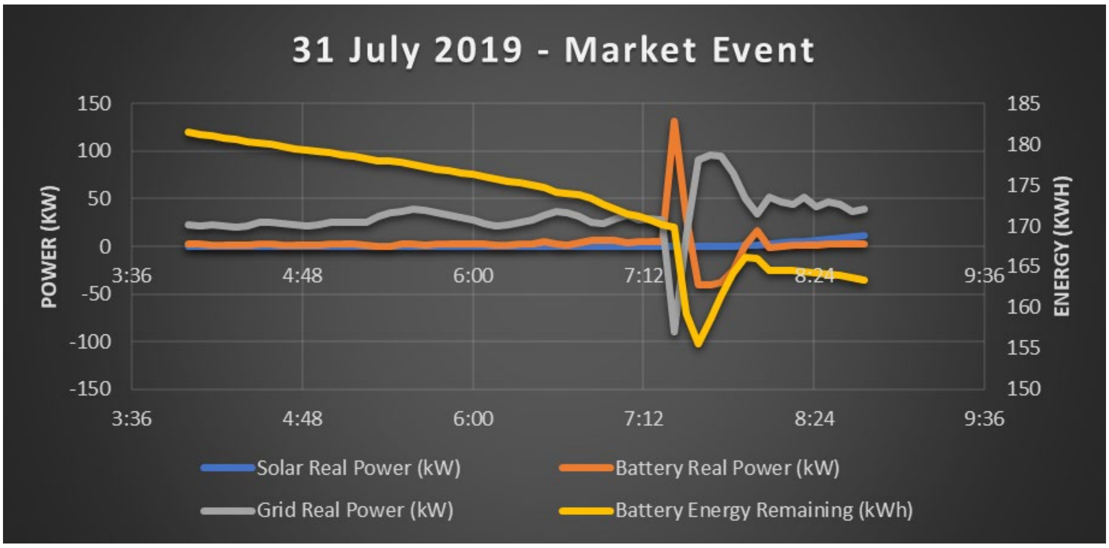

Figure 20 – Market Event – conflicting response

At a small scale, this shouldn't be considered much of an issue however if a large fleet was to operate in the same way, the spot electricity market could be prone to flip flop market outcomes with peaking assets stuck in a perpetual cycle.

Customers on one particular type of battery system have the ability to manually alter (via their system interface app) the percentage of backup energy that their system keeps in reserve, for use when the grid fails. The contract with the customer for participation in the VPP attempts to prohibit the customer from altering any settings that may interfere with the operation of the VPP, however in practice, this is difficult to police and Simply Energy regularly requests that the sub-aggregator resets the backup percentage to the agreed amount.

Operational Challenges

In addition to the technical performance challenges and limitations to accessing market benefits, some of the key operational challenges in accessing commercial value of VPP identified as part of the VPPx are:

1. **Getting information from customers** – For the enrolment of assets into the VPP, Simply Energy requires access to information from customers such as serial numbers and gateways. This has proven to be a challenging and time-consuming process.
2. **Contractual barriers** – Developing, negotiating and managing contracts with multiple DER controllers and battery vendors poses significant commercial challenges for aggregators. Some of the key challenges are:
   - Increased length of time to negotiate contracts;
   - Dealing with vendors in a start-up environment who often lack standard commercial models and terms; and

- Common language barriers for technical terms and standards;

3. **Additional costs** – Catering for different configurations of batteries, inverters and DER controllers has also created additional costs associated with integrating these devices and ensuring end-to-end VPP operation.
4. **Commercial constraints** – Because there are multiple players participating in a emerging market in pursuit of their own specific growth strategies, there are often significant commercial challenges for aggregators in executing commercial agreements with multiple parties.
5. **Physical constraints on the batteries' state of charge** – Standard settings on some batteries limit the aggregators ability take a full advantage of the asset when orchestrating the VPP. In the case of the Simply Energy VPPx, these constraints are triggered by both customers and manufacturers' setting configurations.

2.4 deX Development

2.4.1 Architecture and Functionality

The VPPx project involves significant effort to develop the deX platform and integrate it with the local DNSP and the VPP in order to transact value and provide system visibility and co-ordination functions. Three product layer explained in Table 4 underpin the deX platform.

Table 3 – deX Product Layers

deX Product Layers	Explanation
deX connect Open access	deX Connect allows DER assets to register and communicate with deX via open-access Application Programming Interfaces (API). This allows multiple technology vendors to integrate with deX.
deX vision Visibility & trust	deX Vision is composed of two primary systems: • **deX visibility** provides DNSPs and system operators with visibility of the location, performance and technical characteristics of DER (including historical, present and future operational behaviour) as well as contractual parameters. • **deX mediation** allows system operators to intervene in market dispatch and prevent DER operation from causing the power system to exceed its technical limits. These two functions assist system operators and DNSPs to operate, manage and plan the power system.
deX markets Simple & transparent	deX Markets allows contracts to be published and market participants to view these contracts.

Various participants interact with the deX platform. At this stage in its development, key roles in the deX platform with the relevant participants specific to the VPPx project are shown in
Table 4.

Table 4 – Key roles in the deX platform

Role	Explanation	VPPx Participant
Aggregator	This is an entity who has the contractual right to request DERs to dispatch. In this project, the aggregator will use GreenSync VPP software, integrated with the deX platform, to request dispatch.	Simply energy by ENGIE

Role	Explanation	VPPx Participant
DER Operator	This is the technology with direct control of the DERs and requires an interface with deX via the API. In the case of VPPx, the three DER Operators used in stage 2 are Tesla Powerhub (Tesla Powerwall batteries), SwitchDin droplets (Sonnen, Eguana and Varta batteries) and Solar Edge (LG Chem batteries)	TESLA solaredge switchDin
DER	This is the physical DER which can be controlled via the DER Operator. To date, the DER in the VPPx fleet consists of Tesla Powerwall 2, Eguana Evolve, LG Chem RESU, Sonnen Eco and Varta Plus.	
DMO	Manage the platform to ensure that participants meet registration requirements, information transparency, dispatch reconciliation and market settlement.	For platform testing capability, this role was played by the project consortium, who agreed the rules to apply (via deX) for dispatch constraint management.
DNSP	The DNSP owns and operates the low voltage distribution system, with responsibility for ensuring the distribution network meets the required technical standards. The DNSP can leverage the deX platform to procure network services from DERs.	SA Power Networks
DSO	The DSO is a new concept, introduced in response to the increased complexity of operating the distribution system in a high DER environment. While the full scope of DSO functions and the entity responsible is currently a matter of industry debate, for the purpose of the VPPx Project, the DSO is responsible for providing the operating envelopes within which the market will operate, acting as a mediator of DER dispatch. SAPN acts in the role of the DSO.	SA Power Networks
AEMO	The organisation responsible for operating the national electricity market (including FCAS markets) and responsible for power system security. AEMO interfaces with the project through both the VPP's energy and FCAS market value streams, and through its DER visibility and mediation requirements to manage system security.	AUSTRALIAN ENERGY MARKET OPERATOR

2.4.2 deX Development Status and Performance

To date, GreenSync's deX platform development has involved more than 20,000 development hours, complemented by multiple workshops, reference group meetings and showcase events. All project consortium members have been involved in this process, with significant input from Simply Energy and SAPN. As part of 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 system units; 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.

In Stage 2, the GreenSync development team remained on track with their project plan and made significant progress against key functionality milestones having completed 7 of the 8 stages of deX development as shown in Figure 21. 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.

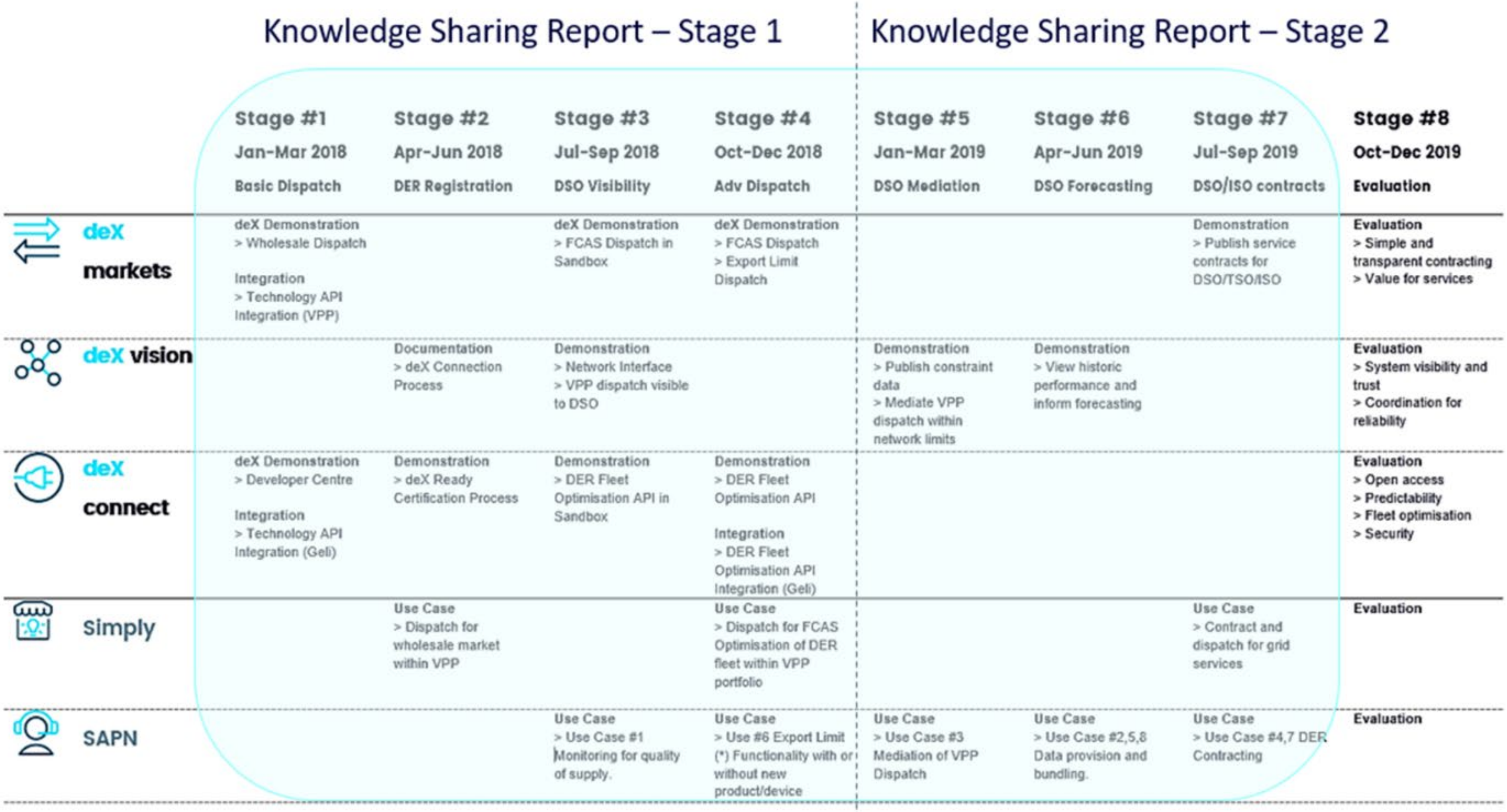

Figure 21 – Development of deX platform integration to date

A brief overview of the stages completed as part of Stage 2 follows.

Stage 5 – DSO Mediation

Stage 5 focused on adding a custom-developed DSO Mediation capability to the deX platform. DSO Mediation provides deX with the capability to act as a mediator between the physical dispatch of DERs and technical constraints of the network. Mediation provides the ability for the DSO to publish operating envelopes onto the deX platform and for those envelopes to constrain competing VPP dispatch arrangements (if necessary) to ensure the integrity of the operating conditions on the grid. Publishing operating envelopes can either be done automatically (if there is an interface with the DSO's systems) or manually uploading data provided by the DSO. The operating envelopes are provided at the network node level.

This stage included extensive workshop activities involving GreenSync, SAPN and Simply Energy to determine the scope of work, design specifications and future developments.

Showcase Event (12 March 2019): A showcase event was conducted to provide an overview of the deX platform. The demonstration showed the deX platform consuming the operating envelope data provided by SAPN and dispatching the available VPP dispatch capacity within those constraint limits.

Key features of the DSO Mediation process are as follows:

- Operating envelopes provided by SAPN are loaded into deX. These operating envelopes are provided by SAPN on an as-needed basis.
- Dispatches are determined in 5-minutes blocks and are stacked as they enter into the system. For this demonstration, the order of priority for dispatch was decided based on their registration in the deX system.
- Where competing VPP's bid within the same 5-minute block and it exceeds the operational envelope published by the network, the first VPP in the queue will have priority to dispatch first.
- If competing VPP's bid within the same 5-minute block at exactly the same time, and the total dispatch amount exceeds the operating envelope published by the network, then the dispatch that was entered first into the system will have priority to dispatch within the network constraint and the remaining dispatches that exceed the envelope constraints are rejected.
- The mediation module currently applies for aggregator VPP dispatch requests only. The FCAS dispatch process (which is typically an automatic response of the battery storage systems) is not currently mediated as part of VPPx.

These DSO Mediation rules were developed for the purpose of the trial in order to support deX development and testing. While the showcase event of this functionality was successful and the function of mediation has been validated at a proof of concept stage, more development work is required to enable better integration of VPP devices, sophisticated merit ordering of available dispatch and increased communication with market participants to develop and evolve this solution into an operational market place. The actual rules that determine how competing VPPs are dispatched in circumstances of constrained network areas will obviously need to be developed by the industry in due course.

Stage 6 – DSO Forecasting

The DSO Forecasting functionality enables deX to predict the DER's next course of action for improved network security and enhanced market efficiency. The DSO Forecasting module of deX for VPPx involves the following process:

1. The aggregator provides a forward dispatch schedule, based on their estimates of available dispatchable load from the DERs in their fleet.
2. deX creates a day ahead dispatch schedule and communicates this to the DSO, in this case SAPN.
3. The DSO provides technical constraints in the form of operating envelopes as part of DSO Mediation functions.
4. deX then provides information on any constraints to the planned dispatch activity to the aggregator.

DSO Forecasting involved extensive collaboration between GreenSync, SAPN and Simply Energy to determine the design specifications and demonstrate the use case. The DSO Forecasting capability was completed in time and within budget.

Showcase event (12 June 2019): A showcase event was conducted to demonstrate the deX platform forming a forecast day ahead dispatch schedule, communicating this to the DSO, and creating constraint limits for aggregated DER assets (at the node level) as an outcome of the operating envelopes provided by the network. Figure *22* shows the actual dispatch behaviour of the DER against the forecasted dispatch activity within the constraints of the network (note the test stopped at 3:00PM). Although the dispatch telemetry shows that the DER dispatch activity is different to the forecast activity in some instances, this signifies deX's ability to pass information between the two systems and provide visibility on aggregated DER activity against forecast in real time. In this instance, the constraint did not limit the forecast or actual dispatch of the VPP.

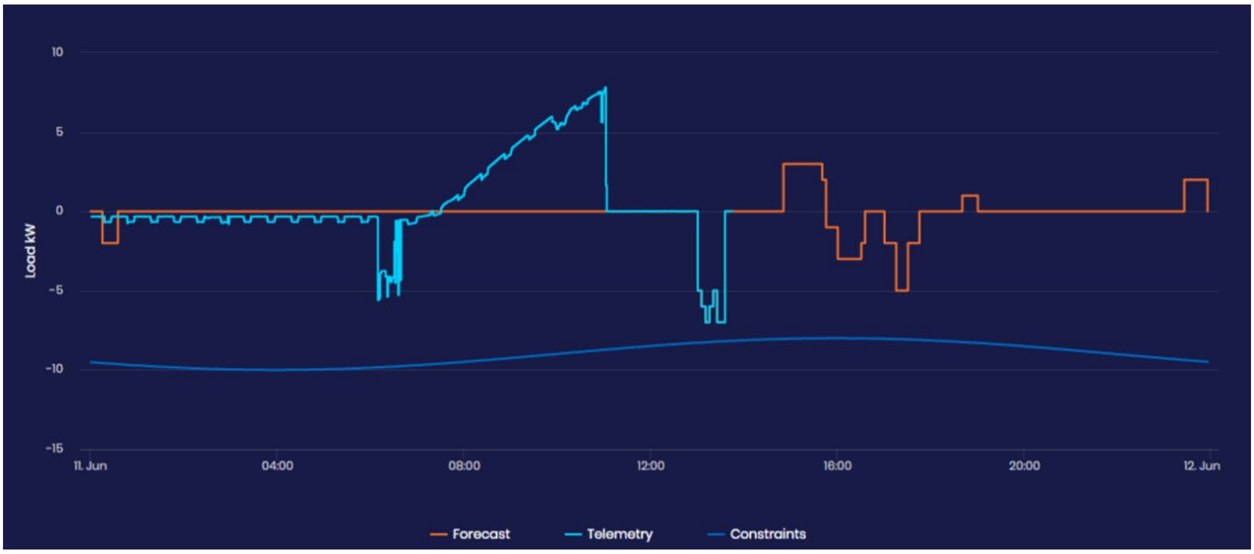

Figure 22 – deX platform demonstration of forecasting

Some of the key insights from the forecasting process are as follows:

- The forecasting module of deX was built on the assumption that the dispatch activity forecasts provided by aggregators will be a useful input for the DSO to help in its efforts to provide the limit within which the DER can dispatch. This is because if the DSO understands which DERs are seeking to dispatch, it can allocate available capacity more efficiently amongst market participants, avoiding allocating capacity to DERs with no intention to dispatch.
- While the DSO can develop these forecasts, and therefore result in efficient constraint conditions, for passive DER behaviour (e.g. passive solar output and battery solar shifting), the "active DER" behaviour is harder to predict. Active DER behaviour will vary greatly between aggregators depending on bidding strategies and the markets in which they participate. It would be extremely challenging for a DSO to compute these forecasts in a future scenario with multiple aggregators. If it has a view of the aggregators intentions, then it has a more effective approach to allocating available capacity.
- However, due to the commercial sensitivities and variability of DER bidding strategies of aggregators, there is a risk they may be unwilling or unable to provide these dispatch forecasts. Appropriate rules to ensure the independence of the DSO, or clarity of the DMO role in these circumstances may help.
- Ultimately, the forecasting functionality built by GreenSync in this stage of the project lays the foundation for the provision of future-looking information between the DSO and aggregator. This is going to be critical to optimally allocate network capacity and for the aggregator to optimally plan the future dispatch of its DER (e.g. they may choose to dispatch the batteries early, knowing a future network constraint will prevent later dispatch).

- Although this functionality has only been proven as a proof of concept, as the aggregation and dispatch control systems develop, deX has the capability to pass information that would enable this forecast-aware system optimisation.

The forecasting and mediation analysis within deX took place at the node level in the network. The constraint envelopes published by the network at the node level allows DER aggregators to pick and choose the required dispatch from various assets below the node as an aggregated load. This site-based mediation could be better handled by Dynamic Connection Agreements where a customer's export limits can be varied automatically by the DSO based on the operating conditions of the local network. This will add more flexibility to the aggregators for more efficient DER market operation. In the absence of Dynamic Connection Agreements, there is a pre-defined site export limit which inhibits the optimal aggregation of available DER load on the network.

Stage 7 – DSO / ISO Contracting

DSO/ISO contracting enables the DSO (in this case the local network, SAPN) or the ISO (an independent system operator, in this case AEMO) and an aggregator (which in the case of the VPPx is Simply Energy) to establish a service contract and then call upon it to resolve network constraints as an alternative to traditional network asset investment. While these functions could be used for both an ISO and DSO, the use case focussed on the DSO-Aggregator contracting. The DSO contracting capability of the deX platform enables the:

- Formation of a digital service contract between a DSO and an aggregator to provide a service;
- deX Command functions to aggregate DER dispatches against the service contract call;
- Provision of DER telemetry services to trading parties; and
- deX Vision functions to verify dispatch in accordance with the contract.

GreenSync collaborated with Simply Energy and SAPN to scope, design and test the contracting capability of the platform.

Showcase event (26 September 2019): A showcase event was conducted to demonstrate DSO Contracting capability to negotiate and call on a service contract and execute the contracted real power dispatch.

The DSO contracting process is as follows:

1. A pre-negotiated service contract specifying the terms and conditions of the service required is agreed upon and entered into deX by the aggregator and DSO;
2. A separate dispatch request/notification from DSO to aggregator specifying the required outcome is entered into deX Vision by the DSO;
3. The aggregator determines the best methodology of fulfilling the requested outcome and accepts the dispatch request via deX Command;
4. Individual (disaggregated) telemetry is provided to the DSO by the aggregator after dispatch leveraging deX data; and
5. Verification/Settlement occurs based on telemetry data provided, post-dispatch.

Although this functionality was successfully validated as a proof of concept for real power dispatch, higher levels of market participation from both the buy and sell side are required to test the practicality of this approach and commercialise the product. Future considerations for development are to support different type of services such as reactive power dispatches and contracting for autonomous or droop type responses.

2.4.3 Lessons Learned

The deX architecture and its functionality for VPPx has been successfully demonstrated as a proof of concept for all functionalities. This outcome was a reflection of 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:

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 was 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.

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) SAPN and AEMO have been working towards a common 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 [DSO] 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; and
- 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.

2.5 Project Next Steps

2.5.1 Achievements to Date

Simply Energy has tested multiple product offerings and sales channels to attract customers to their VPP offering. A 'BYO model', where customers who have purchased an approved home battery from a select group of installers are eligible to join the VPP and receive VPP access credits is proving to be popular.

Four new battery types and two new DER controllers have been added to the eligible home battery product range in Stage 2. ESS performance results have 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. It demonstrates that VPPs enabled battery can contribute to strengthening the resilience of the grid.

Testing continues on the aggregated VPP functionality and performance. An average dispatch effectiveness for the VPP was 53% (i.e. on average 53% 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.

The deX architecture and its functionality for VPPx was successfully demonstrated as a proof of concept for all functionalities. Key learnings included the value in being able to integrate with multiple DER, the need for common API's to support ease of integration, importance of greater automation in the management of VPPs and how deX functionality could support dynamic connection agreements.

2.5.2 Next Steps

Simply Energy will continue to work with existing partners to improve customer experience whilst also onboarding new partners to expand the reach of the project. Additionally, the pool of eligible systems may be adjusted to better suit the technical requirements and challenges met with operating a VPP.

The project will continue VPP testing efforts, in alignment with a greater scale and distribution of battery storage assets. These tests will provide invaluable insights to operating a VPP at scale and its ability to be replicated in other parts of the Australian power system.