



NEM Virtual Power Plant (VPP) Demonstrations Program

July 2019

Final Design

Important notice

PURPOSE

This document outlines the Virtual Power Plant (VPP) Demonstrations framework, including final objectives, program design and participation requirements.

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VERSION CONTROL

Version	Effective date	Changes
#1	31 July 2019	First issue of the NEM VPP Demonstrations Final Design
#2	21 January 2021	Change to section 3.4.1 to highlight the linkage with the Interim Arrangements for FCAS Provision from DER

Contents

1.	Introduction	4
1.1	Purpose of this paper	4
1.2	Why is this important?	4
1.3	VPP Demonstrations objectives	5
1.4	ARENA funding	6
1.5	Knowledge-sharing commitments	7
2.	Consultation feedback	8
2.1	Key topics of stakeholder feedback	8
3.	Key design elements	13
3.1	Minimum duration of 12 months	13
3.2	How will VPPs operate in the energy market?	13
3.3	Metering and settlement of energy	13
3.4	Testing a new approach for DER to deliver FCAS	14
3.5	Relationship to DER technical integration work program	14
3.6	Eligibility criteria	15
3.7	Testing new capabilities	16
3.8	Cyber security requirements	16
3.9	Social science study	17
4.	Trial participation	18
4.1	Enrolment process	18
4.2	Terms of participation	19
4.3	Waiver of registration fees	19
A1.	Consultation submissions	20

1. Introduction

1.1 Purpose of this paper

This document:

- Defines the Virtual Power Plant (VPP) Demonstrations framework, including final objectives, program design, and participation requirements.
- Provides the context and reasoning for establishing the VPP Demonstrations and the specifications for participation. These specifications have considered the extensive stakeholder feedback received during the consultation process that began when the VPP Demonstrations Consultation paper was published in November 2018¹.

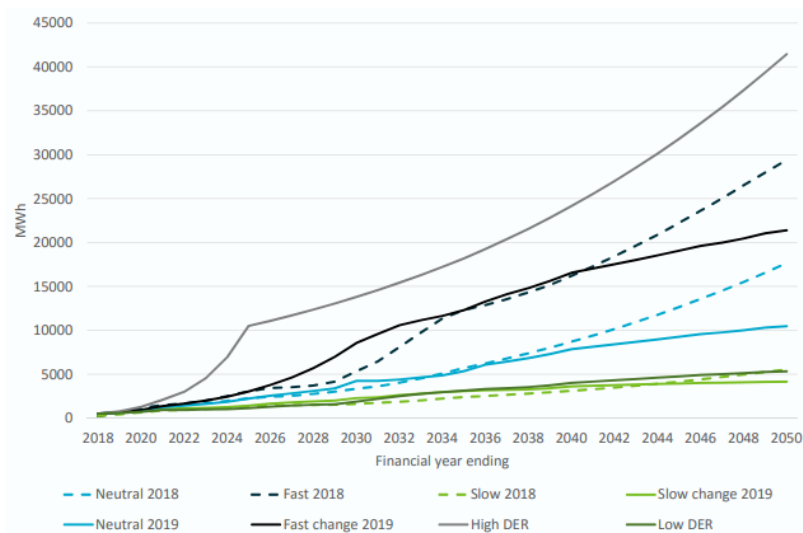
1.2 Why is this important?

A VPP broadly refers to an aggregation of resources, coordinated using software and communications technology to deliver services that have traditionally been performed by a conventional power plant.

In Australia, grid-connected VPPs are focused on coordinating rooftop photovoltaic (PV) systems, battery storage, and controllable load devices.

Rooftop PV continues to be installed at high levels (currently in excess of 1 gigawatt [GW] a year across Australia), and installations of battery storage and smart controllable load devices are projected to rapidly increase in the coming years. The figure below shows projections for residential battery storage installations.

Figure 1 CSIRO residential battery capacity forecasts



Source: CSIRO 2019 Projections for Small Scale Embedded Technologies Report.²

Since the VPP Demonstrations Consultation Paper was published in November 2018, the New South Wales Government has announced a target of 300,000 battery installations in the next 10 years. In Victoria, the

¹ AEMO, 2018. *VPP Demonstrations Consultation Paper*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Virtual-Power-Plant-Demonstrations>.

² CSIRO, 2019 *Projections for Small Scale Embedded Technologies Report*, at: <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Inputs-Assumptions-and-Methodologies>.

Government will issue 1,000 battery rebates in 2019-20, and the South Australian Government has an ongoing battery subsidy for 40,000 South Australian households, together with the continued development of the South Australian Housing Trust VPP of up to 50,000 systems.

Given the potential scale of distributed energy resources (DER) installations over the next decade, AEMO is taking prudent action to integrate DER to the power system safely and securely. Appropriate frameworks will incentivise these resources to deliver value for all electricity consumers by providing grid services that make the power system more efficient.

In April 2019, AEMO published a report on the *Technical Integration of DER* that shared its preliminary findings to date on the behaviour of DER during disturbances³. The report highlighted some potential risks to system security of continued growth of DER under status quo arrangements, and proposed the development of improved DER performance standards.

The uplift of DER performance standards will contribute to the technical integration of DER, while the VPP Demonstrations program is more focused on examining the market integration of DER, noting that these two elements are heavily inter-related.

The VPP Demonstrations will explore the capability of aggregated DER to deliver frequency control ancillary services (FCAS) and develop AEMO's understanding of how VPPs respond to energy market price signals.

It is anticipated that coordinating DER through VPPs can benefit both:

- Consumers owning VPP assets, who earn value from delivering grid services such as Reliability and Emergency Reserve Trader (RERT), FCAS, or energy. The value received by consumers depends on the business model offered to them by VPP operators.
- All other electricity consumers, who benefit from a more efficient power system, as more resources respond to market price signals rather than operating independently.

1.3 VPP Demonstrations objectives

The draft objectives from the VPP Demonstrations Consultation Paper have been refined to reflect the extensive engagement AEMO has conducted with industry stakeholders, and are intended to remain flexible to incorporate new lines of enquiry as the VPP Demonstrations develop.

The VPP Demonstrations objectives are to:

- **Understand whether VPPs can reliably control and coordinate a portfolio of resources to stack value streams relating to FCAS, energy, and possible network support services.**
 - AEMO will test a new FCAS specification for the VPP Demonstrations, consistent with section 7.3 of the Market Ancillary Services Specification (MASS)⁴, and will observe VPPs responding to energy market price signals as non-scheduled resources. AEMO also aims to learn the extent that VPPs can deliver local network support services to Distribution Network Service Providers whilst participating in the VPP Demonstrations.
- **Develop systems that provide AEMO with operational visibility of VPPs to understand their impact on power system security, local power quality, and how they interact with the market.**
 - As VPP participants will operate unscheduled in the energy market, AEMO will establish a series of application programming interfaces (APIs) that will enable participants to submit operational forecasts and actual performance data from their VPPs to AEMO.

³ AEMO, 2019. *Technical integration of distributed energy resources*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Improving-DER-Capability>.

⁴ AEMO, *Market Ancillary Services Specification* v 5.0, effective 30 July 2017, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification>.

- Observing VPP operations is expected to help AEMO determine what systems and capabilities are needed to support VPP market participation at a large scale (potentially gigawatt-scale) in future, while maintaining system security.
- **Assess current regulatory arrangements affecting participation of VPPs in energy and FCAS markets, and inform new or amended arrangements where appropriate.**
 - The VPP Demonstrations will operate under the current regulatory framework, noting that AEMO is testing a new FCAS specification for DER. The VPP Demonstrations aim to assess the suitability of these approaches, and inform consideration of any required changes to regulatory frameworks and operational processes to ensure VPPs are better integrated into the National Electricity Market (NEM).
- **Provide insights on how to improve consumers' experience of VPPs in future.**
 - AEMO intends to engage a social science specialist⁵ to conduct a study with willing VPP consumers to evaluate their experience of being part of a VPP, encapsulating the initial sales and marketing process, installation of equipment, operation of a VPP, perceived/realised value delivered, and whether consumers have experienced any changes to their electricity consumption after joining a VPP.
- **Understand what cyber security measures VPPs currently implement, and whether VPP cyber security capabilities should be augmented in future.**
 - AEMO is including cyber security as a specific area of research in the VPP Demonstrations, recognising the importance of collaborative action to address cyber security risks. Gaining a thorough understanding of DER-related cyber security risks and taking appropriate action in the near term will set the foundation for reliable and secure large-scale integration of DER in the medium to long term.

1.3.1 Future DER integration trials

This is the first in a series of pilots that AEMO intends to run, to learn how to integrate high levels of DER into Australia's power systems and electricity markets.

A subsequent phase of pilots will focus on the testing operational and regulatory frameworks explored in the Open Energy Networks collaboration with Energy Networks Australia (ENA)⁶. These are expected to examine:

- How to incorporate distribution network constraints into the DER dispatch process.
- Possible frameworks to facilitate trade of network support services, such as local voltage support.

1.4 ARENA funding

In April 2019, the Australian Renewable Energy Agency (ARENA) announced it is co-funding the VPP Demonstrations with AEMO up to \$2.46 million through its Advancing Renewables Program⁷. This funding is being used to gain knowledge on VPPs and to develop AEMO's capability to facilitate the VPP Demonstrations, including a series of APIs related to:

- Registration/enrolment systems.
- FCAS data transfer and AEMO's verification process.
- Operational data transfer.

This marks the first time AEMO has directly sought ARENA funding to facilitate an innovative project.

⁵ Subject to sourcing appropriate funding arrangements for this study.

⁶ AEMO-ENA, 2018. *Open Energy Networks*, at <https://www.energynetworks.com.au/joint-energy-networks-australia-and-australian-energy-market-operator-aemo-project>.

⁷ ARENA, 2019, at <https://arena.gov.au/news/aemo-to-trial-integrating-virtual-power-plants-into-the-nem/>.

1.5 Knowledge-sharing commitments

AEMO is committed to sharing the insights learned throughout the VPP Demonstrations by publishing knowledge-sharing reports, which will include analysis of the rich data set that VPP participants share with AEMO and insights that address the objectives outlined above. Research questions may include, but are not limited to, the following.

VPP capability for market participation

- Can VPPs reliably deliver the contingency FCAS that they bid, and are enabled, for?
- What is the typical extra fleet capacity that VPP operators dispatch, over and above the target that they have been enabled for, to reliably meet that target?
- What are appropriate ongoing operational arrangements for DER to participate in the FCAS and energy markets?

Operational visibility

- To what extent are VPPs able to accurately forecast their operational capability over various timeframes?
- What VPP operational data does AEMO require to facilitate very large VPPs operating without negative impacts on power system reliability and security?
- Is it appropriate for large-scale VPPs to become scheduled resources in the energy market and, if so, at what threshold?

Market dynamics and planning

- To what extent do VPPs respond to energy market price signals?
- If this behaviour is extrapolated to reflect the potential for very large VPPs in future, what impact could VPPs have on energy market dynamics?
- How much reliance should be placed on VPPs responding to energy market price signals for integrated system planning studies?

Local power quality

- To what extent do local power quality or fleet communication issues impact VPPs' capability to meet their operational objectives?
- Can the VPP operational data provide useful insights to distribution network service providers (DNSPs) about the real time status of low voltage networks?

Consumer insights

- What are consumers' experiences of participating in Australia's early stage VPPs?
- Is VPP participation attractive enough for consumers to give up control of their assets?
- How can the consumer experience of VPP participation be improved to make it more attractive for consumers to sign up in future?

Cyber security

- To what extent do VPPs, and DER more generally, present cyber security risks that could pose a threat to power system security?
- Are VPPs appropriately incentivised to independently address cyber security risks?

2. Consultation feedback

The VPP Demonstrations Consultation Paper, published in November 2018, received a total of 26 public submissions and three confidential submissions. The organisations that made non-confidential submissions are listed in Appendix A1, and their submissions have been published on AEMO's VPP Demonstrations webpage⁸.

Since publishing the VPP Demonstrations Consultation Paper, AEMO has engaged extensively with interested stakeholders to discuss and refine the details of the VPP Demonstrations program. This section provides a brief summary of topics that emerged consistently in the written and verbal feedback and outlines how AEMO has incorporated stakeholder feedback into the final design of the VPP Demonstrations.

2.1 Key topics of stakeholder feedback

In almost every interaction with stakeholders there has been overwhelming support for AEMO's initiative to learn about VPPs and how to better integrate them into Australia's power systems and electricity markets.

2.1.1 Support for the VPP Demonstrations project

There is broad recognition among stakeholders that:

- VPPs are still in the early stages of development, both in terms of the size of VPP portfolios and in the sophistication of software and communication systems used to operate them.
- The VPP Demonstrations provide a useful framework to learn about VPPs' current capabilities and accelerate collective learning and development about how VPPs access new value streams through market participation.

SIMEC Zen Energy observed that there have been specific instances where investment in assets (such as reverse-cycle air conditioning and solar PV) have had a significant and unforeseen impact on the NEM. Proactive trials to understand system and market impacts that are likely to result from the uptake of VPPs can protect future security and reliability.

Energy Australia expressed some caution about whether AEMO should be prioritising the VPP Demonstrations and spending funding on this project over more urgent power system challenges.

AEMO response

AEMO sought ARENA funding for the VPP Demonstrations. As a result, ARENA is contributing up to \$2.46 million.

2.1.2 Support for the VPP Demonstrations objectives

Stakeholders expressed broad support for the objectives proposed in the VPP Demonstrations Consultation Paper, which have been refined further (see Section 1.3) based on constructive feedback including:

- **Simply Energy** advised that the objectives need to remain flexible, because new insights and lines of enquiry will arise as the VPP Demonstrations develop.
- **Origin Energy** highlighted that AEMO data requirements and visibility of plant should strike a balance between operational requirements and compliance costs.

Many stakeholders also looked further ahead, to the longer-term needs and opportunities associated with very high DER penetration.

⁸ AEMO. VPP Demonstrations, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Virtual-Power-Plant-Demonstrations>.

Some stakeholders recognised the important role that DNSPs will play to integrate high DER volumes into their network by providing the following feedback:

- **Mondo** considered that the VPP Demonstrations should assist relevant DNSPs to determine systems and capability needed to support VPPs' market participation. Mondo also recommended expanding the VPP Demonstrations to enable a deeper focus on defining and demonstrating the role of networks, and the interaction required between networks and AEMO, in coordinating VPPs.
- **Energy Consumers Australia** asked for the VPP Demonstrations to explicitly include consideration of possible futures including a Distributed System Operator function, and to consider how the full value stack, includes DNSP benefits, can be realised.
- **Sonnen** recommended that AEMO consider using this framework to develop new services which leverage the unique capabilities of the DER (for example, local network support services).
- **Energy Queensland** considered that it is important for AEMO to work closely with DNSPs to understand particular network configurations and limitations as part of the VPP Demonstrations.
- The **University of New South Wales** recommended that the VPP Demonstrations should include VPPs designed to provide network support to DNSPs.
- **Planet Ark Power** observed that voltage management needs in the low voltage network should be assessed, as well as the impact of poor voltage stability on how VPPs can operate reliably.
- **AGL** agreed with the shorter-term focus of the VPP Demonstrations to observe VPPs' capabilities to participate in electricity markets (FCAS and energy), and not to incorporate network-directed dynamic limits into the VPP Demonstrations at the outset.

AEMO response

The objectives outlined in Section 1.3 reflect AEMO's response to the feedback received. This VPP Demonstrations Program will have a tight scope and focus on the capacity and capability of VPPs to contribute FCAS services and respond to energy market price signals.

AEMO acknowledges the importance of understanding how AEMO and DNSPs can work together to support VPPs' market participation in consideration of local network constraints, which is currently the focus of the Open Energy Network process that AEMO is running with ENA. AEMO intends to test these considerations in detail through subsequent pilot programs, rather than incorporating these elements into the VPP Demonstrations at the outset.

2.1.3 VPP is a technology-neutral concept

Stakeholders expressed an overwhelming consensus that a VPP is a technology-neutral concept and that VPP operators should be able to incorporate battery technology and conventional demand response into a VPP portfolio.

Reposit Power made a distinction, however, between controllable demand response (such as pool pumps, heating/cooling systems, or hot water systems) capable of providing similar grid services as batteries, and non-controllable demand response (such as behavioural demand response) that is not suitable for VPPs participating in real-time electricity markets.

AEMO response

AEMO has designed the VPP Demonstrations program, and specifically the *VPP Demonstrations FCAS Specification*⁹, to accommodate a variety of technologies within or across VPP portfolios.

⁹ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-FCAS-Specification>.

2.1.4 Privacy and data protection is paramount

Stakeholders unanimously agreed that the VPP Demonstrations should uphold existing rules and laws on personal information and protected information.

Some stakeholders (**Mondo, Energy Queensland, Energy Networks Australia**) highlighted the need for DNSPs to have access to local power quality data to inform the systems and capability that DNSPs need to support VPPs' market participation, while other stakeholders (**AGL, Origin, Karit, Sonnen**) highlighted the commercial value of such data and the need to adopt strict rules over how data is shared in the VPP Demonstrations.

Many stakeholders also highlighted that consumer terms and conditions will need to be reviewed to ensure that consumers consent to data being shared with AEMO.

AEMO response

Information received in connection with the VPP Demonstrations is protected information under the National Electricity Law, and AEMO will not disclose that information except as authorised by law. This is reflected in the terms and conditions of the VPP Demonstration.

In addition, the terms and conditions applying to the VPP Demonstration include a requirement for participants to share reports with AEMO regarding the experience of VPP consumers. The terms clarify that personal information will not be shared with AEMO in that context. Further, AEMO will treat the reports provided by participants as confidential information of the VPP Participant and will only publish the results in aggregate (except if the consent of the participant is obtained to the publication).

AEMO is also committed to sharing knowledge gained from the VPP Demonstration, in a manner that appropriately protects information provided by the VPP Participants. AEMO may share information received regarding consumer experience of the VPP Demonstration with Energy Consumers Australia (ECA) and with ARENA to facilitate this knowledge sharing.

2.1.5 Interoperability is a key issue

Many stakeholders recognised the lack of consistent standards in Australia to facilitate interoperability. Interoperability broadly refers to the establishment of standard communication protocols that allow broad market participation, but in relation to VPPs it refers to the mechanisms that facilitate:

- Aggregators being able to integrate many different technologies into their controlled portfolio.
- Consumers switching between VPPs/retailers/aggregators.
- Aggregators integrating easily with market or network API interfaces.

Origin said AEMO should examine the ease of connecting and disconnecting sites, interaction with DNSPs (especially information-sharing about their networks), and knowledge transfers between parties.

Rheem observed that there is a need for the industry to work on a data model that can provide a standardised approach to how and what data is required for the anonymous aggregation of DER resources and how the DER resources are physically related to the network. Rheem also said it should be mandatory for batteries to provide an open local interface for control and coordination with other DER at a home.

AEMO response

AEMO acknowledges that consistent standards for interoperability are needed in Australia, although the new proposals for AS4755.2 should address the aggregator-to-device communication layer, and the VPP Demonstrations project could facilitate the technical discussion on this.

In response to this feedback, AEMO collaborated with industry stakeholders to establish the API Technical Working Group to support the development and implementation of standards for sharing DER-related data among organisations in the Australian electricity sector.

AEMO also now convenes a broader VPP Technical Reference Group to inform interested stakeholders on how various VPP-related projects are developing across Australia, including the outcomes of the API Technical Working Group. Please contact DERProgram@aemo.com.au if you wish to join the VPP Technical Reference Group.

2.1.6 Cyber security is a key issue

Cyber security has been broadly recognised as a key risk to address across the energy supply chain, and stakeholders are keen to discuss cyber security requirements in more detail.

Embertec observed there is a significant risk from unauthorised actors attaining control over energy resources, irrespective of whether they are participating as a registered resource in a market or not.

AEMO response

AEMO is using the VPP Demonstrations to build understanding of what cyber security measures VPPs currently implement, and whether VPP cyber security capabilities should be augmented in future. VPP Demonstrations participants will provide this information by completing a short questionnaire outlined in Section 3.8 of this document.

AEMO also strongly encourages VPP Demonstrations participants, or interested parties more broadly, to engage with a new Distributed Energy Resources/Emerging Technology Working Group (DERWG), which is a sub-group of the Australia Energy Sector Cyber Security Framework (AESCSF). Further information on the DERWG is outlined in Section 3.8.

AEMO is investigating cyber security for DER devices more broadly through the Standards stream of AEMO's DER Program¹⁰.

2.1.7 Improving the consumer experience

In the VPP Demonstrations Consultation Paper, AEMO sought feedback on how VPP Demonstrations participants could better capture consumer insights that could help improve the consumer experience. Stakeholders broadly supported the initiative to monitor consumer experiences during the VPP Demonstrations and to collate insights that can contribute to positive experiences of VPP participation in future.

Energy Consumers Australia highlighted that realising VPPs' immediate and longer-term goals will depend as much on partnering with consumers to save them money and delivering a positive experience as it will on overcoming technical and system challenges. Ensuring that consumers are appropriately rewarded for participation in the distributed energy system will maximise participation and engagement with new energy services.

Freedom Power recommended that the VPP Demonstrations should aim to inform and educate the public about VPPs and the potential benefits that can be felt by consumers, saying that once consumers have a knowledge base to draw from, more accurate and beneficial insights into the consumer experience can be achieved and improved upon.

Simply Energy recommended that all consumer sampling and feedback should be evaluated by an independent third party to ensure the findings remain impartial, and that the findings can be used as an authoritative basis for future market development. To facilitate this end, all participants should be required to gather data based on a common set of guidelines.

AEMO response

AEMO agrees that the long-term success of VPPs depends on partnering with and delivering value to consumers. The VPP Demonstrations represent an opportunity to capture and share valuable consumer

¹⁰ For more on the DER Program, see <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program>.

insights, which is why AEMO has added a specific objective (Section 1.3) to provide insights on how to improve the consumers' experience of VPPs in future.

To meet this objective, AEMO intends to engage a customer experience specialist to conduct a social science study alongside the VPP Demonstrations. This specialist would work with AEMO, consumer representative bodies, and VPP Demonstrations participants to design and implement a study to monitor consumer experiences over the first 12 months of the project.

Insights from the social science study would be published in knowledge-sharing reports to accelerate the industry's collective learning on how to improve consumers' experiences of VPP participation. Further information on this study can be found in Section 3.9.

3. Key design elements

This section outlines AEMO's approach to some key design elements for the VPP Demonstrations. It is important to note that the arrangements facilitating the VPP Demonstrations do not necessarily set a precedent for how VPPs will interact with the NEM going forward.

The VPP Demonstrations will provide valuable insights for the Australian Energy Market Commission (AEMC), AEMO, and the Australian Energy Regulator (AER) to develop ongoing arrangements for VPP participation in the NEM, in consultation with industry.

3.1 Minimum duration of 12 months

The VPP Demonstrations will be open for a minimum period of 12 months. Because the effectiveness of the program will depend on observing a critical mass of operating projects, the duration of the trial may be extended so sufficient operational data can be gathered to fulfil the objectives, or until ongoing arrangements for market participation can be implemented.

3.2 How will VPPs operate in the energy market?

If a trial participant is registered as a Market Customer (that is, as a retailer), it will participate in the energy market according to the general process.

The retailer will pay the spot price for the consumer loads for which it is the Financially Responsible Market Participant (FRMP) at each connection point. Periods of net generation from households participating in the VPP Demonstrations are considered 'negative load', and the retailer will be paid at the spot price for this generation, which would reduce the retailer's settlement bill for energy consumed by customers in its portfolio.

If the trial participant is registered as a Market Ancillary Services Provider (MASP), then the retailer who is the FRMP at each connection point, that may not be involved in the VPP consortium, will still pay the spot price for consumer loads under its responsibility (and receive spot price for net generation).

It is expected that the DER employed as part of the trial will meet the requirements of the standing exemption for generating units under 5 megawatts (MW), as set out in *AEMO's Generation Classification and Exemption Guidelines*¹¹, last revised on 20 November 2018. Grid-scale generation and energy storage is excluded from the VPP Demonstrations, and is considered further in the Emerging Generation and Energy Storage – Grid Scale process.¹²

A participant in the VPP Demonstrations will operate as a non-scheduled, price-taking resource with respect to the energy market. AEMO intends to use the VPP Demonstrations to inform whether VPPs should be required to schedule their aggregated fleet and, if so, at what aggregated capacity threshold.

3.3 Metering and settlement of energy

Energy provided by VPPs in the VPP Demonstrations will be settled via the wholesale market and will be metered according to current National Electricity Rules (NER) requirements. This will require a single FRMP for each connection point, and suitable NEM standard metering in place.

¹¹ AEMO, 2018. *AEMO's Generation Classification and Exemption Guidelines*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Exemption-and-classification-guides>.

¹² AEMO, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Initiatives/Emerging-Generation-and-Energy-Storage-in-the-NEM--Grid-Scale>.

3.4 Testing a new approach for DER to deliver FCAS

AEMO is using the VPP Demonstrations to test a new approach for DER to deliver contingency FCAS.

3.4.1 Classification of ancillary service loads for FCAS

VPP Demonstrations participants will be permitted to seek classification of both negative and positive flows from the connection point as part of their ancillary services load. This approach is supported by the *VPP Demonstration FCAS Specification*¹³.

January 2021 clarification update

When the VPP Demonstrations began in July 2019, under the MASS¹⁴ and AEMO's registration requirements at the time (outside of the VPP Demonstrations), where a MASP or Market Customer registers a load or market load (as applicable) as an ancillary services load, net exports from a connection point were not recognised.

This position changed when AEMO published the Interim Arrangements for FCAS Provision from DER in December 2019¹⁵. Under these arrangements AEMO will recognise the provision of FCAS from export from a load connection point in its classification process. Subsequently, there is no difference between these arrangements, and those for VPP Demonstrations participants, with regard to the classification of ancillary service loads for FCAS.

To illustrate the difference in approach now adopted, consider a 4 MW battery which is at a Market Customer's connection point:

- Under the traditional approach, the load could be classified as an ancillary services load capable of providing up to 4 MW of lower or raise response (from -4 to 0).
- Under the approach to be adopted, this connection point could be classified as an ancillary services load capable of providing up to 4 MW of lower or raise response (between -4 and +4). Participants will be required to satisfy AEMO that, as a technical matter, the VPP is capable of providing that FCAS up to the megawatt amount to be registered.

3.4.2 Measurement and monitoring of contingency FCAS

Under the current MASS, AEMO requires fast contingency FCAS services to be measured using high-speed meters at every participating site¹⁶. AEMO considers that a more innovative approach to measurement and verification should be tested in the VPP Demonstrations to promote more competition for contingency FCAS delivery (by lowering the cost of participation in contingency FCAS markets). The measurement and monitoring requirements support AEMO's approach to classification of ancillary services loads (see Section 3.4.1), and detailed requirements are set out in the *VPP Demonstrations FCAS Specification*¹⁷.

3.5 Relationship to DER technical integration work program

AEMO is conducting a parallel work stream within its DER Program on uplifting DER performance standards, and published a report on *Technical Integration of DER* in April 2019¹⁸. A recommendation in this report relates to uplifting the automatic frequency control capability of inverters in an updated version of AS 4777.

¹³ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-FCAS-Specification>.

¹⁴ AEMO, *Market Ancillary Services Specification* v 5.0, effective 30 July 2017, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification>.

¹⁵ AEMO, 2019. Available: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Participant_Information/New-Participants/Interim-Arrangements-for-FCAS-from-DER.pdf

¹⁶ AEMO, 2018. *Market Ancillary Services Specification*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/Market-ancillary-services-specifications-and-FCAS-verification>.

¹⁷ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-FCAS-Specification>.

¹⁸ AEMO, 2019. *Technical integration of distributed energy resources*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Improving-DER-Capability>.

If this recommendation were to be implemented, all new compliant inverters must provide autonomous frequency response to frequency disturbance events; previously, a small degree of ambiguity existed regarding whether this function was mandatory.

A key distinction between this capability and the payment for further frequency control services through market frameworks is the response rate and threshold at which the service is provided. The VPP Demonstrations require a 0.7% droop setting for excursions outside the normal operating frequency band, which would provide a faster FCAS response than the autonomous response that may be mandated in a performance standard (both in terms of the droop control setting and the frequency excursion threshold at which the devices are programmed to respond).

Further important distinctions between the market framework and the mandated response are that the VPPs must:

- Guarantee the frequency response is available (that is, maintain reserve or headroom), whereas the standard-based mechanism is only provided by the DER to the extent that capacity is available; and
- Provide data recording demonstrating delivery of the paid service in the event of a frequency disturbance event.

3.6 Eligibility criteria

The eligibility requirements for participation in the VPP Demonstration are set out in the VPP Demonstrations Enrolment Form and Enrolment Guide¹⁹.

3.6.1 Aggregation requirement

Only aggregated portfolios, consisting of controllable assets across more than one connection point, can participate in the VPP Demonstrations, because one of the key objectives is for participants to demonstrate basic control and coordination capability to reliably deliver grid services as a portfolio of resources.

3.6.2 Excludes registered Generators

The VPP Demonstration excludes any generating unit that is required to be registered as a Generator under the NER.

Refer to AEMO's *Generation Classification and Exemption Guide*²⁰.

3.6.3 Limit on VPP Demonstration enrolments and FCAS

It is expected that the FCAS enabled from the VPP Demonstrations will represent a small percentage of total FCAS procured. AEMO will evaluate the total FCAS capability of participants as the VPP Demonstrations progress, to determine whether there is a need to limit the amount of FCAS that is enabled from the VPP Demonstrations.

AEMO retains the right to stop accepting new enrolments or increases in enrolled capacity at any time, but will endeavour to communicate transparently with industry prior to doing so.

3.6.4 Technology neutrality

AEMO believes a VPP is a technology-neutral concept and a VPP coordinator should be able to control a variety of technologies within a portfolio to meet its strategic objectives. AEMO is keen to observe a variety of technologies operating during the VPP Demonstrations.

For FCAS, however, AEMO must be able to characterise each portfolio as providing either a proportional/variable or switched style of response:

¹⁹ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-Enrolment-Form> and <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-Enrolment-Guide>.

²⁰ At <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Exemption-and-classification-guides>.

- Proportional controlled portfolios provide a response that is proportional to the size of the frequency deviation, for instance using a droop controller.
- Switch controlled portfolios involve an on/off switch so the response is not variable in nature, for instance by switching a pool pump on or off.

It is important to note that portfolios of switch-controlled devices can be characterised as proportional if a smart control system is able to stagger the switching of each device in the portfolio to deliver an overall proportional response.

As proportional responses are more desirable than switch responses, AEMO retains the right to limit the amount of FCAS being delivered during the VPP Demonstrations by switch-controlled portfolios.

AEMO will evaluate applications for enrolment through the FCAS assessment process on a case-by-case basis. If the VPP Demonstrations capacity is dominated by a particular technology, AEMO reserves the right to restrict new enrolments of the same technology, to retain opportunities for other technologies to participate and improve the collective learning outcomes from the VPP Demonstrations.

3.6.5 AEMO discretion

AEMO retains the right to accept or reject applications to enrol in the VPP Demonstrations at its sole discretion. In applying this discretion, AEMO will consider how each applicant meets the eligibility criteria as set out in the VPP Enrolment Form and contributes towards the VPP Demonstrations objectives, in the context of existing participants in the VPP Demonstration.

3.7 Testing new capabilities

AEMO intends to use the VPP Demonstrations framework to facilitate testing of new capabilities or arrangements that are relevant to the long-term integration of VPPs into the NEM, subject to consent from relevant parties.

Participation in these tests will be voluntary only and AEMO will plan the tests in collaboration with interested VPP Participants. AEMO continues to encourage stakeholders to propose any tests that could provide valuable insights for the industry during the VPP Demonstrations.

3.8 Cyber security requirements

AEMO intends to use the VPP Demonstrations to understand what level of cyber security measures VPP consortiums currently implement and whether their cyber security capabilities should be augmented in future.

A condition of participation in the VPP Demonstrations is completion of a short questionnaire on cyber security that will inform AEMO of the level of sophistication that VPPs apply to managing their cyber security risk. This will then inform what measures AEMO takes, in consultation with industry, to augment the collective cyber security capability of VPPs.

The cyber security questionnaire should be completed as part of the enrolment process and can be found on the AEMO website with the VPP Enrolment Form and Enrolment Guide²¹.

AEMO also strongly encourages VPP Demonstrations participants to engage with the DERWG²², which is a forum designed to bring participants together to tackle the challenges that the sector faces with cyber security. A cross section of members, varying in size and complexity, work together on the unique cyber problems faced by the sector. With support from AEMO and a number of larger sector participants, the forum acts primarily to:

²¹ AEMO, 2019. VPP Demonstrations, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Virtual-Power-Plant-Demonstrations>.

²² The Distributed Energy Resources/Emerging Technology Working Group (DERWG) is a sub-group of the Australia Energy Sector Cyber Security Framework (AESCSF).

- Improve awareness and mitigation of cyber security threats and vulnerabilities in the DER/Emerging Technology energy sector.
- Share knowledge and propagate best practices to improve cyber security arrangements in the DER/Emerging Technology energy sector.
- Strengthen organisations' arrangements to prevent cyber security incidents causing disruption to business operations.
- Improve organisations' arrangements to detect and alert others of cyber security incidents affecting the energy industry.
- Strengthen coordination of cyber security response and recovery arrangements, within individual organisations and across the energy industry.

To participate in the DERWG, please contact aescsf@aemo.com.au.

3.9 Social science study

As described in Section 2.1.7, the VPP Demonstrations represent an excellent opportunity to build understanding of how consumers experience being part of a VPP and to identify how future VPPs could improve consumers' experiences of VPP participation.

The consumer experience encapsulates the initial sales and marketing process, installation of equipment, operation in a VPP, perceived/realised value delivered, and whether consumers have experienced any changes to their electricity consumption after joining a VPP.

Subject to sourcing appropriate funding arrangements, AEMO intends to engage a social science specialist to:

- Design and implement an appropriate social science study that accurately captures insights on the consumers' experiences throughout their VPP journeys, incorporating feedback from consumer representative bodies and VPP Demonstrations participants into the study design.
- Develop appropriate and timely knowledge-sharing reports to publish the insights from the social science study, including synthesising any insights that VPP Demonstrations participants have derived from monitoring their own consumers' experiences.

4. Trial participation

This section provides information about participating in the VPP Demonstrations.

4.1 Enrolment process

This section outlines how Applicants can enrol in the VPP Demonstrations.

4.1.1 How to enrol in the VPP Demonstrations as a VPP trial participant?

Applicants must apply to AEMO to enrol in the VPP Demonstrations by completing an Enrolment Form. The Enrolment Form, together with an Enrolment Guide, can be found on AEMO's website²³.

Applicants must:

- Ensure the devices used to provide the registered services comply with the NER, National Energy Customer Framework (NECF), and other applicable law and regulations.
- Agree to terms and conditions of the VPP Demonstrations as part of the enrolment form.

AEMO will also retain a right to suspend or cancel participation in the Demonstrations for a range of reasons, including the relevant participant failing to comply with the requirements of the VPP Demonstrations or posing a risk to reliability or system security.

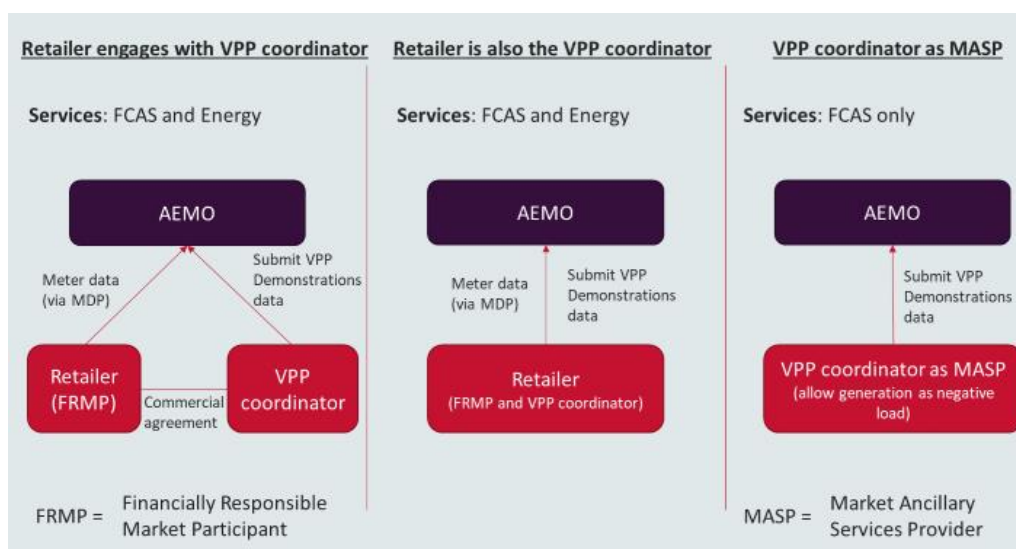
4.1.2 Models for VPP trial participation

Applicants may apply to enrol their VPP as:

- Participating in FCAS markets and being exposed to energy market price signals (as a Market Customer), or
- Participating in FCAS markets only (as a MASP).

The three different models for participation are shown in Figure 2.

Figure 2 Three models for participation in the NEM VPP Demonstrations



MDP = Metering data provider

²³ AEMO, 2019. VPP Demonstrations. Available: <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Virtual-Power-Plant-Demonstrations>.

To summarise the three models:

1. A retailer and a separate VPP coordinator (who may not be a registered participant) may jointly participate in the trial in respect of connection points where the retailer is the FRMP. This arrangement will require the retailer and the separate VPP operator to enter into a commercial agreement, and the retailer will participate as the Market Customer in contingency FCAS markets and be exposed to energy market prices.
2. A retailer, who is also the VPP coordinator, can participate as a Market Customer with respect to multiple connection points at which it is the FRMP.
3. A VPP coordinator who is registered as a MASP may participate in the trial in contingency FCAS markets only.

VPP coordinator refers to the entity that is coordinating the controllable assets to meet the VPP's operational objectives.

It is possible that a Market Customer and a MASP could operate separate VPPs using separate controllable devices behind the same connection point.

4.2 Terms of participation

The *Application Form for Enrolment in the VPP Demonstration* sets out the terms which apply to participation in the VPP Demonstration. Key obligations include:

- Sharing data with AEMO, outlined in the *VPP Demonstrations Data Specification*²⁴.
- Completing a cyber security questionnaire during the enrolment process, as described in Section 3.8.
- Sharing with AEMO the marketing and contractual information (such as standard terms) provided to VPP Consumers in connection with the Applicant's participation in the VPP Demonstrations.
- Implement systems and processes to monitor the experience of consumers participating in their VPP and to share any insights gained through this monitoring with AEMO via a short report towards the end of the VPP Demonstrations, in line with clause 3.2 of the terms and condition in the VPP Enrolment Form.
- Contacting their VPP consumers and providing them with information about how to participate in a standalone social science study on the VPP Demonstration, as described in Section 3.9 of this document and clause 3.3 of the terms and condition in the VPP Enrolment Form.

4.3 Waiver of registration fees

AEMO is waiving registration fees for applicants that apply to register as a Market Customer or MASP, and to classify *loads* as frequency control *ancillary service loads* for the purpose of VPP Demonstrations for the duration of the trials. AEMO acknowledges that the VPP Demonstrations are intended to be a learning exercise that will inform what permanent arrangements will be implemented for VPPs to participate in energy and FCAS markets once the VPP Demonstrations have been completed. Further details on fees can be found in the Enrolment Guide²⁵.

²⁴ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-Data-Specification>.

²⁵ At <http://aemo.com.au/-/media/Files/Electricity/NEM/DER/2019/VPP-Demonstrations/VPP-Demonstrations-Enrolment-Guide>.

A1. Consultation submissions

This section provides a list of non-confidential submissions received as part of the VPP Demonstrations Consultation process. These submissions are published on AEMO's VPP Demonstrations webpage²⁶.

Table 1 Non-confidential submissions received in response to the VPP Demonstrations Consultation Paper

Submissions	
ECA	Mondo
EQL	Origin
Embertec	Power Ledger
ActewAGL	Ready.Energy
AGL	Reposit
CEC	SandC Electric Company
CEEM	Simply Energy
ENA	Sonnen
Energy Australia	SZE
Freedom Power	Tesla
Karit	Tukio
LO3	Wattwatchers
Monash University	Western Power

²⁶ AEMO. *VPP Demonstrations*, at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/DER-program/Virtual-Power-Plant-Demonstrations>.