Dr Stuart Johnston

Energy Networks Australia

Provided via info@energynetworks.com.au

Dear Dr Johnston

Tesla Submission – Open Energy Networks Consultation Paper

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide both the Australia Energy Market Operator (AEMO) and Energy Networks Australia (ENA) with feedback on the important work underway regarding the future treatment of distributed energy resources (DER) in the Australian market. The Open Energy Networks Consultation Paper (Consultation Paper) provides a great opportunity to address some of the barriers to entry faced by aggregated distributed assets and virtual power plants (VPPs), as well as creating new means for compensating DER services to networks.

Tesla's position in respect of the long-term Open Energy Networks work is as follows:

- We support all work done to enable energy and frequency market participation from DER assets and VPPs. This will be critical to the future of Australia's energy mix.
- Customer experience needs to be the primary consideration. As DER asset owners are outlaying the capital for the products, the following considerations are critical:
    - Owners of small scale DER assets should have a choice in the services provided, with all other services optimised to customer need first and foremost.
    - Owners of DER assets should be fairly compensated for the services they provide to both the energy market and the networks.
- The use of DER for network services requires a more robust framework, providing proper incentives for both consumers and the networks.
- We support the development of a DSO platform that operates in the most streamlined manner to allow transparent and appropriate bidding behaviour from DER assets. Our current preference is for the Single Integrated Platform approach proposed. Over time, we believe that this approach will allow AEMO to manage the DSO platform in a similar way to their management of the TSO.

As is recognised in the Consultation Paper DER is projected to play an increasing role in Australia's energy mix in both the short and long term. As such it is critically important for the long-term system security and reliability of the NEM that distributed assets are able to provide the same services that are currently being provided by utility scale assets.

It is also important to note that there are existing frameworks in place to manage a number of the challenges raised in the Consultation Paper, as being presented by both passive and active DER. The Australian grid connection standard – AS4777 – imposes stringent requirements on all grid connected DER assets, including solar inverters. AS4777.2 2015 creates passive network protection for voltage and frequency will physically override a command from a VPP. A DSO platform will not be needed for ongoing network security, but should be developed to facilitate markets for DER assets.

In addition to the development of a DSO platform there are also early structural changes that need to be made to enable market participation. As a priority, we encourage ENA and AEMO to consider the following “quick-win” actions as a priority:

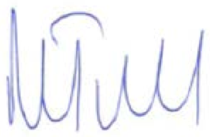
- The appropriate mechanism for aggregated DER assets and VPPs to participate in all energy and frequency markets.
- The appropriate market settings for these services – specifically revisiting whether the approach to delivering traditional contingency and regulation FCAS is appropriate for DER assets.
- Reviewing the existing network investment frameworks such as the RIT-T/D and Demand Management Incentive Scheme (DMIS) to determine whether there are appropriate incentives for networks to better use DER assets to augment network infrastructure.

The Open Energy Networks work stream is a great step in opening up the potential of DER assets for market and network contribution. However, while we agree that this work is critical to address market barriers, we do not agree with a number of the risks and challenges presented in the Consultation Paper for both passive and active DER. Our full comments against the questions asked, and challenges noted, in the Consultation Paper, are included below.

We recognise that this Consultation Paper is the first step in a long-term work program to better integrate DER assets into the market, and Tesla looks forward to working collaboratively with AEMO, ENA and relevant DNSPs in the coming months to trial market participation options, output through DSO platforms, and critical network services that can be provided on demand.

For more information on any of the commentary provided in this submission, please contact Emma Fagan (efagan@tesla.com).

Kind Regards



Mark Twidell

APAC Director – Energy Products

1. DER IN THE AUSTRALIAN MARKET – BENEFITS AND TECHNICAL CAPABILITY

In their 2018 New Energy Outlook, Bloomberg New Energy Finance (BNEF) predicted that by 2050 Australia's energy market is set to become the second most decentralised market in the world, with behind the meter solar and storage making up 44% of all capacity.

In the nearer term AEMO's Integrated System Plan (ISP) projects 3,723MW of distributed storage installed in the NEM by 2030 under their Neutral Scenario and up to 4,267MW of distributed storage installed under their high DER scenario. This amounts to 5kW storage systems on over 850,000 houses[1].

This presents significant opportunities for the future Australian energy markets, to capitalise on the significant benefits provided from DER assets, and benefit on the existing technical capability.

1.1. DER benefits

Electricity grids that leverage DER assets offer an economically better alternative to the centralised design of today. DER assets bring greater total economic benefits at lower cost, enable more affordability and consumer choice, and improve flexibility in grid planning and operations, all while facilitating the de-carbonization of our electricity supply.

Benefits of using smart DER assets include:

- **Consumer driven market solution:** DER can provide a cost-effective alternative to utility scale capital investment as consumers drive investment. The AEMO ISP "High DER" scenario shows the potential for greater use of DER to lower the total costs of supply of wholesale resource costs by $4 billion, compared with the neutral DER case.
- **Network benefits:** active DER assets also provide considerable network benefits including benefits related to voltage and power quality, conservation voltage reduction, grid reliability and resiliency, equipment life extension, and reduced energy prices.
- **Customer benefits:** DER assets capture more value across the revenue stack and are more likely to generate investment, since they can be co-optimised to reduce consumer costs, provide energy market benefits and assist with network support.

1.2. DER - Technical capability

Distributed assets are already capable of providing the same services as utility scale assets in respect of system security. To support the work undertaken in Phase 1 of the Tesla South Australian VPP, Tesla undertook tests of Tesla Powerwalls to respond to simulated contingency and regulation frequency events, to prove out the capability of DER assets to provide critical system security services.

Figure 1 below provides the outcome of a test to demonstrate the capability of aggregated DER assets to follow a simulated AGC signal (simulated regulation FCAS response). The AGC test was performed by sending a single active power signal every 4 seconds to a test group of 10 South Australia VPP Powerwalls, 9 active and 1 inactive system. As shown, the aggregated test group responds to a high degree of accuracy to meet the 4s active power set points.

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[1] AEMO, "integrated System Plan Modelling Assumptions", Strong Capcity growth (all small scale batteries MW) Scenario

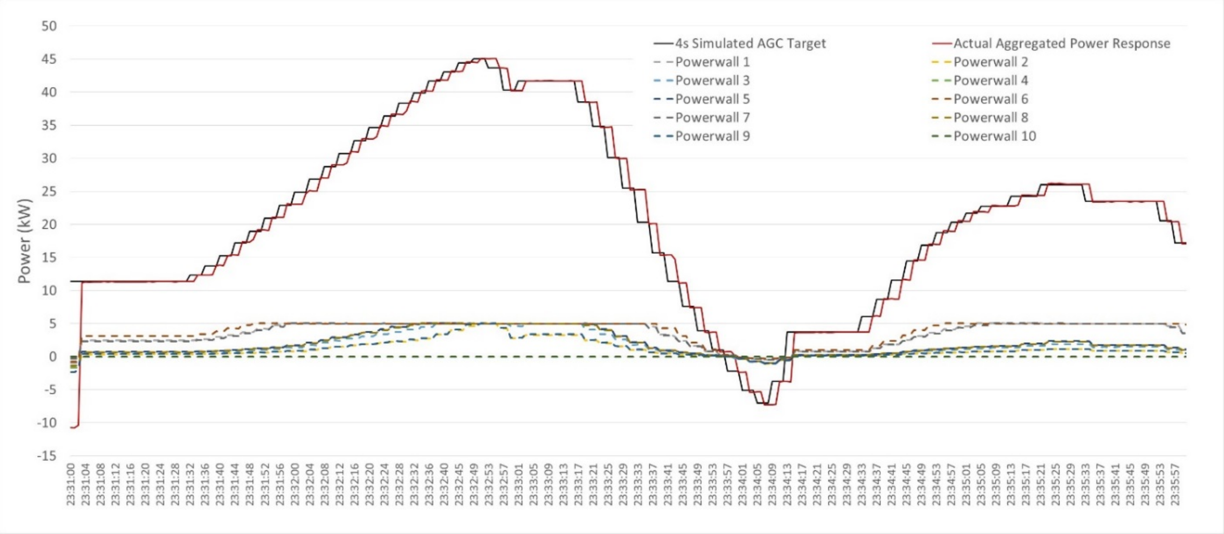

Figure 1: 4 Second AGC target and system response for a 5 minute dispatch period

The response from an aggregated DER asset base provided above is comparable to that provided by Hornsdale Power Reserve, and surpasses traditional synchronous assets both in terms of timing and accuracy in following an AGC signal. Figure 2 below shows the speed and accuracy of a large steam turbine following an AGC signal (as shown in AEMO's report on the initial operation of the Hornsdale Power Reserve).

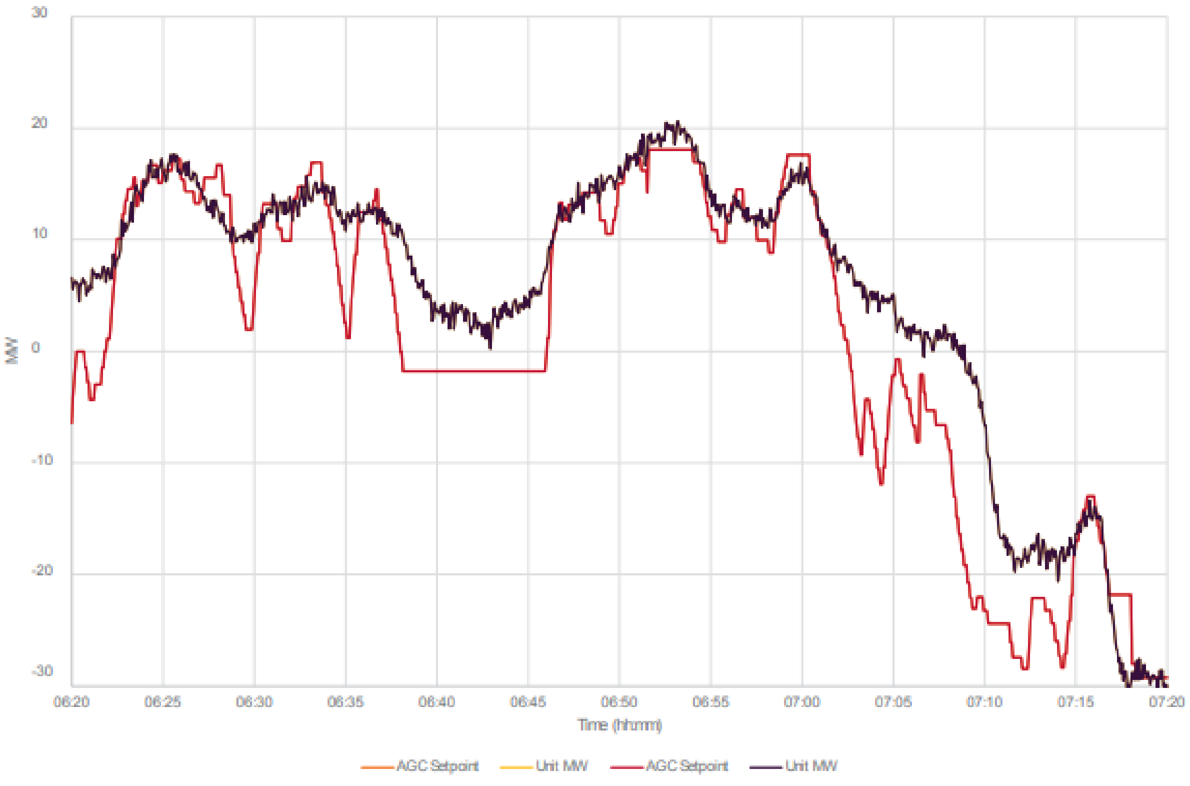

Figure 2: Accuracy and speed of regulation FCAS response – large conventional steam turbine[2]

A secondary test was also used to test how DER assets respond to frequency drops below 49.85Hz by autonomously injecting active power based on pre-applied frequency-watt droop curve settings.

2 AEMO, "Initial Operation of the Hornsdale Power Reserve Battery Energy Storage System", April 2018

This provides the same services as contingency FCAS, with frequency benefits delivered in the same way that they are delivered by the utility scale Hornsdale Power Reserve.

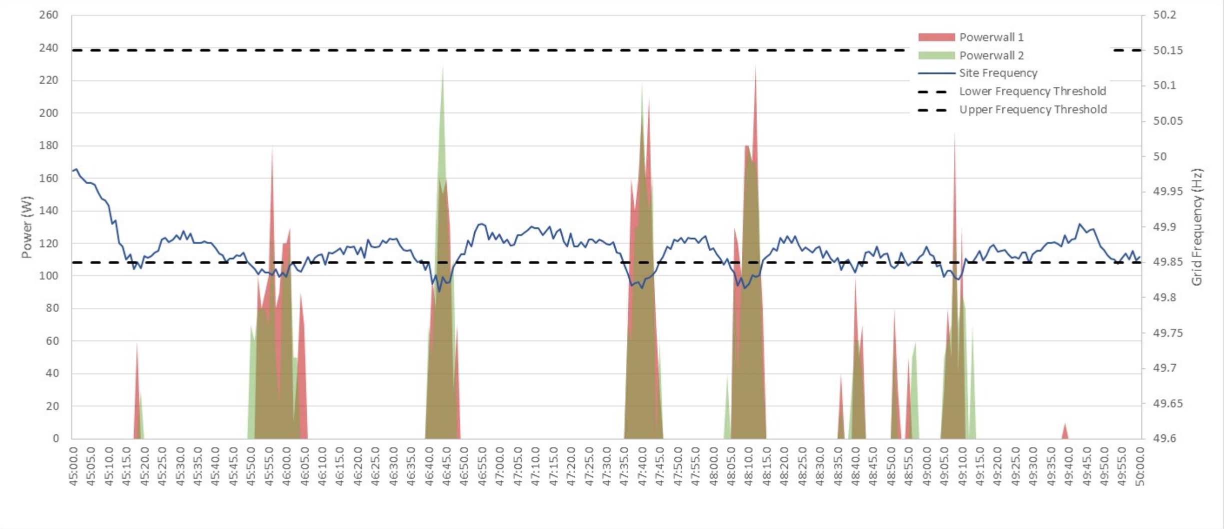

Figure 3: Frequency-watt response from two individual customer Powerwalls for a 5 minute period

The full Test Report has been included as an attachment to this Tesla submission.

DER assets are also proving out capacity to provide critical network support and reduce costs. This has been demonstrated by trials by South Australia Power Networks (SAPN Salisbury Trial) and Energex. Energex has published the positive outcomes of their trial, which found that smart management of battery energy storage assets on the Energex network reduced peak demand, reduced peak export and minimised overvoltage issues[3].

Finally, VPPs are also having a demonstrable impact on reducing wholesale price exposure of utilities that have invested in appropriate active DER infrastructure. Green Mountain Power in Vermont, has invested in a VPP consisting of 2,000 Tesla Powerwalls. Over July-18, Green Mountain Power estimates that the VPP saved the utility $500,000 over the course of a week[4].

In summary:

- DER assets have the capability to provide the same system security services as is currently being provided by utility scale assets.
- DER assets (as with utility scale storage assets) can operate in primary frequency operating mode with responses tied purely to changes in local grid frequency. This provides alternative regulation FCAS.
- BESS assets have been proven to reduce peak export and manage over-voltage issues – a key challenge noted in the Consultation Paper as related to passive DER.

It is important to recognise that the critical system services provided by DER assets may be managed differently to utility scale assets. The different characteristics of distribution network requirements, and features of DER assets should be taken into account, with market participation reflective of this and not otherwise limited. If existing utility scale requirements (such as responding

[3] https://www.energex.com.au/__data/assets/pdf_file/0006/528396/EGX170906-energex-battery-trails-report-2017-for-upload-and-distribution.pdf

[4] https://cleantechnica.com/2018/07/27/network-of-tesla-powerwall-batteries-saves-green-mountain-power-500000-during-heat-wave/

to AGC signals for regulation FCAS) is not appropriate, alternative options should be explored to create this equitable access.

2. TESLA RESPONSES TO QUESTIONS IN THE CONSULTATION PAPER

2.1. Pathways for DER to provide value

Are these sources of value comprehensive and do they represent a suitable set of key use-cases to test potential value release mechanisms?

Consumer value streams

A key value stream overlooked in the Consultation Paper is the customer benefits associated with energy independence and control. As noted in Tesla's opening statements, it will be vital that consumers are not disadvantaged by any of the work undertaken by AEMO and ENA, and retain choice in respect of the services they want to provide.

Market value streams

The Consultation Paper notes a number of market value streams that can be accessed. However, it' is important to note that access to these value streams in the current NEM is currently limited by a range of factors:

- No single DER classification (or Aggregator classification) allows aggregated assets or VPPs to participate in both energy markets and frequency markets. Recent recommendations made by the Australian Energy Market Commission (AEMC)[5] may address this to an extent, however the expanded Small Generator Aggregator (SGA) framework proposed is unlikely to be the best long-term solution for residential DER and VPPs.
- Ability to participate in energy markets is dependent on an energy retailer or through registration as an SGA, which requires a separate connection point or management as an embedded generator, both of which are costly options for small scale assets.
- Under the existing rules, frequency response for aggregated DER is limited to load side participation. Note that this may also be managed through recent AEMC recommendations[6].
- Current regulation FCAS arrangements are not well set up for DER assets.

While DER might represent significant untapped value in the market, there is significant market reform that is required to properly access these value streams. These regulatory barriers need to be addressed before DER assets can provide these services to their full value.

There are also other broader market reforms underway that should apply equally to DER assets. For instance, if we move to a pay for performance type approach to reward accurate frequency support, we would expect DER assets to be treated the same as utility scale assets.

The Consultation Paper also references bilateral contracts outside of the market, however these revenue streams are far from certain. Payments for network support are dependent on individual DNSPs valuing a specific service, and not mandating this service through technical connection requirements.

[5] AEMC, "Frequency Control Frameworks Review – Final Report", July 2018"

[6] Ibid

Are stakeholders willing to share work they have undertaken, and may not yet be in the public domain, which would help to quantify and prioritise these value streams now and into the future?

Tesla has provided preliminary data from tests already undertaken, with this submission. We are willing to continue to work with AEMO and ENA to undertake relevant tests, participate in trials and provide any relevant data to support increased participation from active DER in the energy markets. We believe that making decisions based on trials and data available will be critical to developing appropriate pathways for market participation for DER assets.

2.2. Maximising passive DER potential

The passive DER challenges outlined in the Consultation Paper provides an indication of the value of accelerating the transition to active DER. Our recommendations on ways to support this transition are outlined in detail under the approach to "Maximising active DER potential" below.

Below we provide a consideration of the key challenges presented by passive DER as outlined in the Consultation Paper.

Are there additional key challenges presented by passive DER beyond those identified here?

Local network challenges

All installed passive DER assets, such as rooftop solar PV, have their output regulated by inverters to stay within grid specified voltage and frequency ranges – as required by AS4777.2-2015. The network benefits associated with DER can be maximised through the transition to active DER, but passive DER does not cause considerable local network challenges.

Security of supply challenges

DER assets can also support existing synchronous generation assets with security of supply issues. While some synchronous generation will be required to provide fault current, DER assets provide appropriate support. If some synchronous generators were forced to remain connected despite lack of demand, the spot price is likely to be impacted due to over-supply. VPPs (and other responsive loads like EVs) would respond by charging – helping the situation.

Both inertia and fault level concerns should be able to be addressed without a distribution layer for DER assets. VPPs will be able to respond dynamically to adjustments in the spot price. If DER assets switch to charging, they make room for synchronous generation. So active DER provides increased security of supply.

New capabilities and actions required to maximise network hosting potential for passive DER?

The Consultation Paper presents a range of new capabilities and actions required to maximise network hosting capacity potential. In addition to the recommendations made regarding active DER, the challenges associated with uncontrolled passive DER can be improved by the near-term recommendations made below.

It is also important to note that residential solar and utility solar is anticipated to result in energy spot price spikes occurring outside of times of solar generation (e.g. early morning and evening). Tesla believes that the risk to system security of uncontrolled DER response to price spikes is minimal for the following reasons:

- Residential solar self-consumption will increase through improved uptake, and better use, of home storage.

- Spot prices will be low during times of high solar generation, therefore there is minimal risk of over export to extract spot price value for customers
- Large VPPs capable of providing controlled output are likely to be taken up.

However, the benefits associated with these three points is also highly dependent on the actions taken to address the additional issues raised by Tesla in respect of active DER.

What other actions might need to be taken to maximise passive DER potential?

Over the longer-term it will be critical to transition the market towards active DER, and our recommendations to support this transition are detailed in depth below. In the nearer term, there are additional short-term solutions that can be introduced to manage the impacts of passive DER, while this transition is occurring.

- Mandate the introduction of time of use tariffs. Smart meters have been introduced across much of Australia but the benefit to consumers is minimal until time of use tariffs are more readily available. Time of use tariffs have also introduced in both Victoria and NSW as a non-mandatory option[7]. Providing appropriate incentives to encourage exports during times of peak demand, will lead to a more rapid transition towards active DER.
- Plan for the uptake of EVs. Smart EV charging can provide important network support through frequency/watt responses that ensure charging from the grid is reduced when local frequency dips are detected.
- Consider alternatives to the current network planning approach. The RIT-T and RIT-D processes favour networks investing in traditional network infrastructure, or assets designed for a single purpose (such as synchronous condensers). An expanded or mandated demand management incentive scheme (DMIS) will ensure networks also consider DERs as an alternative to investment in new, traditional network infrastructure.

2.3. Maximising active DER potential

Key challenges and impediments presented by active DER

The Consultation Paper notes a number of key challenges presented by active DER, as well as impediments to DER providing their full potential.

Tesla has looked to provide more commentary on the challenges presented below, as well as providing more context on the challenges faced by DER currently looking to provide both network support and participate in the energy and frequency markets.

Consultation Paper – challenges presented by active DER

The Consultation Paper notes a number of challenges presented by active DER, specifically:

- VPPs may create market risks because they are unscheduled.
- Increased DER would require additional regulation FCAS.
- Large, sudden VPP movements could exceed the capability of regulation frequency reserves.
- Sudden movements of VPPs may trip the Heywood Interconnector.

Many of these concerns raised are legitimate, and can be managed through addressing the key impediments for DER assets to participate in the existing energy markets. Some of these challenges

[7] IPART, "Solar feed-in tariffs The value of electricity from small-scale solar panels in 2018-19" and Essential Services Commission, "2018–19 feed-in tariffs"

will be addressed through the improved market access recommendations made by the AEMC under their Frequency Frameworks Review and Reliability Frameworks Review final reports[8], which collectively make recommendations to support the following:

- An expanded SGA framework to allow aggregated DER to provide both energy and FCAS services.
- Improved ability for market ancillary service providers (MASP) to provide FCAS services.
- Trialling of multi trading relationships behind a single meter to allow customers to directly benefit from wholesale market participation.
- Support for DER trials to determine the best approach for providing FCAS.

These recommendations start to address some of the key issues preventing DER from participating in existing markets, which impacts on their ability to be scheduled and the visibility of these assets for AEMO, however even with these recommendations there will be a range of technical considerations to be worked through to establish the best approach for market participation. Tesla believes that the critical areas to address are:

- Developing an appropriate, single market classification which allows DER assets to provide both energy and FCAS services.
- Ensuring that this mechanism does not have prescriptive cost or technical requirements which make VPPs cost prohibitive at a residential level.
- Ensuring that DER assets can provide all the same services as utility scale assets, while noting that the same services can be achieved through different mechanisms (see for example the frequency-watt test referenced above which provides the same service as contingency FCAS. Tightening DER dead-bands may provide the same services as traditional regulation FCAS).

If DER are enabled to participate in existing contingency and regulation FCAS, as well as any future frequency markets, all of the noted challenges regarding ability to be scheduled and risks associated with large sudden movements will be mitigated. If DER is enabled to provide regulation FCAS, then the market will not be undersupplied. DER assets will be able to provide fast responding, accurate frequency support from behind the meter battery energy storage assets.

These issues will also be managed through the introduction of an appropriate DSO platform, which should be designed to ensure market participation within appropriate constraints, in order to manage overvoltage or overcurrent risks.

We would also expect responsible VPP developers to manage any potential risks associated with their project, by ensuring that assets are geographically diverse, and monitoring individual assets on a dynamic basis.

We would also expect VPP owners and operators to respond to market signals. Wholesale prices will be low during periods of solar production, as such, the risks of VPP exports during this period is low, as the market upside is marginal. In reality the demand (and spot price) peaks will move to evenings, and the risk of unconstrained export from a VPP overloading a residential network at this time is very low – while household batteries might all export at their full capability, they will mostly be offsetting local residential load and providing network support.

[8] AEMC, "Frequency Control Frameworks Review – Final Report", and AEMC, "Reliability Frameworks Review – Final Report"

Impediments faced by assets

The Consultation Paper also lists a number of impediments preventing DER assets from fully participating in all markets, including:

- Retailers ultimately need to make the value streams available.
- Lack of understanding of network constraints.
- Decision making framework is required to determine whether DER are likely to breach local network or system constraints.

These impediments cover off on both the operational issues at the network level, and, to an extent, the market barriers faced by DER participants. As noted above, there are a number of existing market barriers preventing full market participation from DER assets. These are the key impediments that need to be addressed in the short-term.

A further impediment is the lack of appropriate signals for networks to use DER assets as an alternative to traditional network infrastructure. With the exception of the DMIS, there are no schemes to support the use of active DER as a way of managing network constraints, and delaying investment in new network infrastructure. There is also no consistency for how DNSPs should compensate asset owners for the support provided.

Approach to mitigate challenges and impediments

Tesla makes the following recommendations to maximise active DER output.:

- Develop an appropriate mechanism for DER registration that will allow AEMO to schedule the output, and co-optimise market services with customer need. This will manage the transparency issues and ensure that the full suite of services that can be provided by active DER assets is being accessed, and would ensure that individual VPP assets are only dispatched for the purposes of central dispatch.
- VPP aggregators should ensure that a VPP is geographically diverse. Because of the way bidding works, only some VPP bids will be accepted and the strain on the residential network will be minimal due to different aggregators controlling batteries in many different areas.
- VPP aggregators should also be able to respond to voltage data at each battery's location. If there are network issues (e.g. high voltage) aggregators will operate the VPP within network constraints by selecting which units increase their output to deliver a the market bid.
- Ensure DNSPs are appropriately incentivised to use active DER as an alternative to traditional network infrastructure.
- Development of a consistent framework which outlines compensation for asset owners for services provided to networks from active DER assets.

2.4. Frameworks for DER optimisation within distribution network limits

Tesla support a DSO platform that operates in the most streamlined manner to allow transparent and appropriate bidding behaviour from DER assets. Our current preference is for the Single Integrated Platform approach proposed. Over time, we believe that this approach will allow AEMO to manage the DSO platform in a similar way to their management of the TSO.

We believe that as a long-term solution this provides least cost to consumers, and provides greater consistency across the NEM. We also believe that that this approach will result in the least latency, and best enable active DER to participate in a dynamic basis into the existing wholesale energy and FCAS markets.

We recognise that this approach is complex and may take some time to develop, but we would encourage any staging that can be managed, with the Single Integrated Platform focused on individual networks on a trial basis.

We also believe that all other recommendations made below can be progressed earlier, while the architecture of the DSO platform is being considered.

3. TESLA RECOMMENDATIONS

Tesla understands that there is a significant amount of work to be done through the Open Energy Networks work stream, but it is critical that trials start immediately as a means to demonstrating DER potential, and beginning to address the impediments noted in the Consultation Paper. Our high level recommendations for next steps are as follows:

- Manage all market participation barriers that are preventing DER assets and VPPs from extracting the full market value from the services they can provide.
- Consider the technical parameters for all DER trials that will allow DER assets and VPPs to provide all services currently provided by utility scale assets. This work should also consider the different mechanisms that DER assets can provide these services, such as tightened dead band settings for regulation FCAS as an alternative to AGC signals.
- Continue to develop the Single Integrated Platform, in a way that meets the following requirements:
    - Is developed at least cost (or cost pass through) to consumers.
    - Is consistent across the NEM, providing a streamlined approach to bidding behaviour for aggregators that may operate in a number of jurisdictions.
    - Provides the least dispatch latency, to ensure that DER assets can extract the highest possible value for the services they can provide within a single dispatch period.

To support all of these recommendations, trials will be critical. Tesla will continue to work closely with all relevant parties to ensure that AEMO and ENA have all the information necessary to support DER access into existing markets.

1. OVERVIEW

Tesla has performed two separate tests to demonstrate the capability of the Tesla South Australian Virtual Power Plant (VPP) to physically respond to 4 second Automatic Generator Control (AGC) signals for energy and regulation Frequency Control Ancillary Services (FCAS) and autonomously respond to frequency-watt droop settings for contingency FCAS. Both test results have demonstrated the desired response, which comply with what is required to provide these services for the National Electricity Market.

A simulated 4s AGC test was performed, using an AGC target curve derived from a dispatch curve previously allocated to Hornsdale Power Reserve (HPR), to mimic the SA VPP response to 4 second active power set points from the Australian Energy Market Operator (AEMO) for energy and FCAS regulation dispatch. A frequency/watt test was also conducted applying the same frequency/watt settings as what is applied at HPR to demonstrate the systems capability to provide FCAS contingency services.

2. PHASE 1 TEST RESULTS

2.1. Automatic Generation Control (AGC) 4 second Simulated Test

The AGC test was performed by sending a single active power signal every 4 seconds through Telsa's grid controller and software for the VPP. The total power response required is distributed among the active Powerwalls which, once receiving the active power set point, immediately move to the 4s target and stay at that point until the next active power command is received. The Tesla grid controller and software also ensures the actual aggregated response from the individual systems meets the AGC target power requirement.

A test group was setup of 10 SA VPP customer Powerwalls. This consisted of 9 active Powerwall systems and 1 inactive system. The inactive system was included in the group to test in order to demonstrate that the total active power response will be allocated appropriately to be met by the active systems.

The aggregated test group responds to a high degree of accuracy to meet the 4s active power set points, this can be seen from the results *in* ***Figure 4*** below. A minor offset in response is observed between the target and actual aggregated response curves, this is typical and is due to communications latency of 1-2s. The figure also demonstrates that the aggregation control platform dynamically manages the output from the individual Powerwall systems accounting for local system usage and constraints and distributes the active power requirement accordingly.

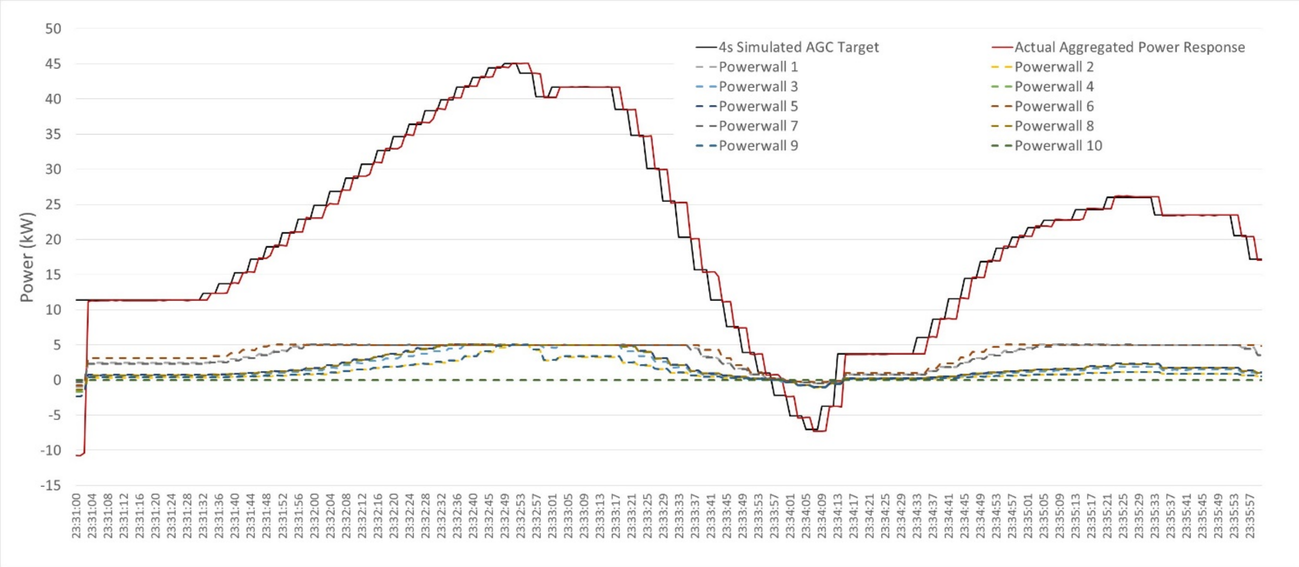

Figure 4: 4 Second AGC target and system response for a 5 minute dispatch period

2.2. Frequency-Watt Test

The frequency-watt what test was conducted utilising a droop curve of 1.7% and a frequency deadband from 49.85Hz – 50.15Hz with full discharge power at 49Hz and full charge at 51 Hz. These settings are identical to HPR.

The frequency-watt system response demonstrated in ***Figure 5*** below is from two individual customer Powerwalls. As frequency drops below 49.85Hz the systems respond by autonomously injecting active power as per the applied frequency-watt droop curve settings set up for the test. This response demonstrates the ability of the SA VPP to autonomously and instantaneously provide frequency services that help maintain the stability of the grid.

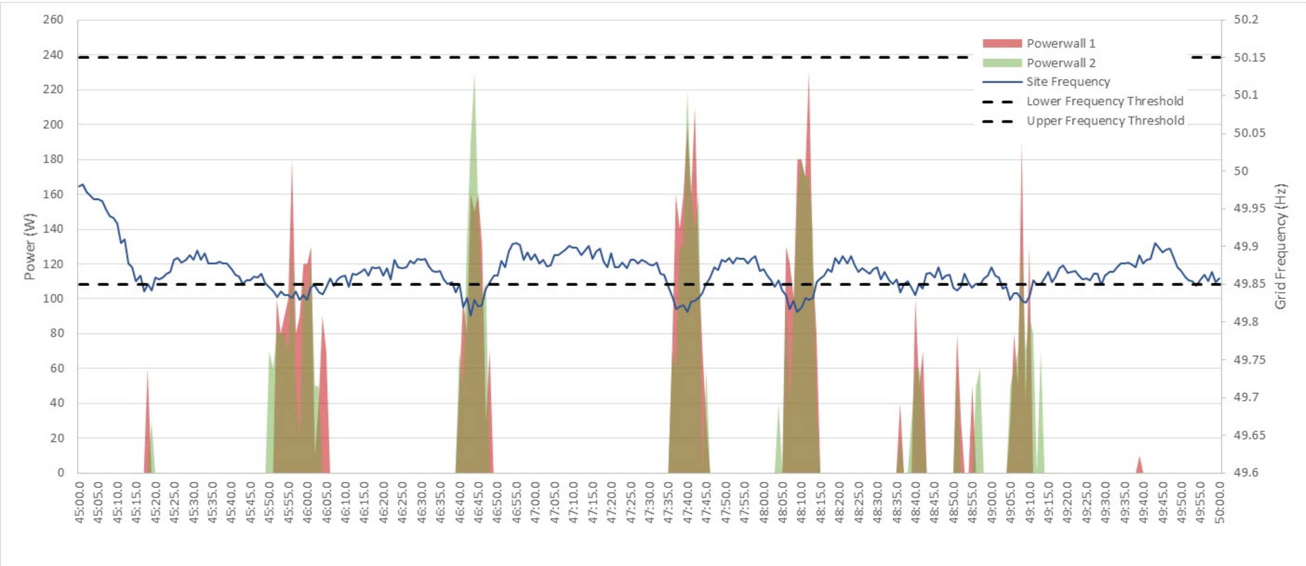

Figure 5: Frequency-watt response from two individual customer Powerwalls for a 5 minute period