[redacted]

Australian Energy Market Operator

via email: sras.consultation.2020@aemo.com.au

3 July 2020

Re: Service Restart Ancillary System Draft Guideline Consultation

Dear [redacted]

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide feedback on the AEMO Service Restart Ancillary System (SRAS) Draft Guideline as part of the consultation process.

As a world-leading manufacturer of battery energy storage systems, Tesla is acutely aware of the role that new technologies can play in ensuring the secure and stable operation of our energy systems as we transition to predominantly renewables, given our mission to accelerate the world's transition to sustainable energy.

We are strongly motivated to work closely with AEMO, AEMC and the Reliability Panel to create a fit for purpose technical system framework to underpin the safe, secure and reliable operation of the national electricity market (NEM) in the decades to come. As such, Tesla is fully supportive of the review of SRAS guidelines to account for the National Electricity Amendment (System restart services, standards and testing) Rule recently made by the AEMC. As this rule change progresses, we provide the following considerations for AEMO:

- Tesla fully supports guideline updates that recognise the capability of new technologies, such as grid-forming battery storage systems, to provide SRAS services;
- For self-starting services, Tesla recommends AEMO define an island control automatically, or through a centrally directed manual switching (as per AEMO's current approach);
- Tesla analysis and experience to date suggests that current batteries have the capability to provide SRAS services as:
    - Black Start Services per s3.3 standalone or in conjunction with a renewable generator depending on the final energy amount that is required by the service.
    - All Restoration Support Services per s3.4.
- In particular, the 2020 South Australian separation event provides an instructive example of the existing capabilities of battery systems to respond rapidly to provide SRAS services and the critical role batteries will play going forward in a high renewables NEM;
- Nuances in the definition of black-start, system restart support, restoration and re-synchronisation services should be considered to ensure AEMO can procure necessary services efficiently, with adequate testing procedures undertaken with potential SRAS providers.

Additional detail relating to Tesla's position is included in the content below. To discuss any of the content included, please contact [redacted].

TESLA

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General Comments

As acknowledged by AEMO, given the rapidly changing mix of generation and load in the NEM, alongside the ability for new technologies to provide services with inherently different characteristics, there is the need to review how SRAS and restoration frameworks operate and how associated guidelines can be updated accordingly.

As AEMO is well aware, Tesla is looking to accelerate the integration of energy storage across Australia (at all scales) to help deliver new, low cost, low emissions technology and create greater market competition in the NEM. A key benefit of battery storage is its ability to stack multiple services and provide multiple sources of value across different time-scales. SRAS is one such potential area where battery technologies can enhance and drive additional efficiencies in its provision of services to the benefit of all participants and consumers, for example through fast and accurate dynamic voltage and frequency control. Indeed batteries have been demonstrating their ability to provide black-start functions since 2017[1]. To date, Tesla has deployed over 300MW of batteries globally on microgrid or off-grid backup sites fully utilising these SRAS capabilities.

Multiple reports have also consolidated detailed analysis on the performance and capability of battery storage systems operating in Australia since the introduction of Hornsdale Power Reserve in late 2017 – highlighting:

- "Operation of the HPR to date suggests that it can provide a range of valuable power system services, including rapid, accurate frequency response and control." (*AEMO report on initial operation of the Hornsdale Power Reserve*)[2]
- "The large-scale battery storage in SA was valuable in this event, assisting in containing the initial decline in system frequency, and then rapidly changing output from generation back to load, to limit the overfrequency condition in SA following separation from VIC (*AEMO Final Report – Queensland and South Australia system separation on 25 August 2018*)[3]
- "The plan [for managing SA islanding] involved Lake Bonney, Dalrymple, and Hornsdale batteries being constrained to zero MW output but remaining at a state of charge sufficient to allow provision of raise and lower contingency frequency control ancillary services (FCAS)" (*AEMO Preliminary Report – Victoria and South Australia Separation Event, 31 January 2020*)[4]
- "HPR has responded to three South Australian separation events since entering service. On each occasion it has supported system security for the South Australian network by responding with its Fast Frequency Response capability to reduce the severity of the disturbance and support a return to normal frequency conditions." (*Aurecon – HPR Year 2 Technical and Market Impact Case Study*)[5]

An approach that recognises the benefits of new technologies such as battery storage is also in line with the broader work program being progressed by the Energy Security Board's Essential System Services workstream as part of its post-2025 market reform agenda. As outlined by the ESB, a long-term, fit-for-purpose market framework to support reliability and system security will necessarily rely on the capabilities of fast-response and flexible resources, including demand side response, battery storage and distributed energy resource participation.

Further, ensuring appropriate frameworks now offers a much less volatile price discovery mechanism that will provide a more efficient pathway to supplement the planned exit of large volumes of incumbent synchronous generators that presently provide much of these system security services. A clear price signal for alternatives such as demand response and battery storage is required today if it is expected that these technologies will form the bulk provision of this service in the years to come, and this will also ensure a back-stop insurance against the early closure of thermal plant.

[1] www.energy-storage.news/news/california-batterys-black-start-capability-hailed-as-major-accomplishment-i
[2] www.aemo.com.au/-/media/Files/Media_Centre/2018/Initial-operation-of-the-Hornsdale-Power-Reserve.pdf
[3] www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2018/Qld--SA-Separation-25-August-2018-Incident-Report.pdf
[4] www.aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2020/preliminary-report-31-jan-2020.pdf?la=en
[5] www.aurecongroup.com/markets/energy/hornsdale-power-reserve-impact-study

Amendment to the definition of SRAS and black start capability

Tesla fully supports the changes to expand the definition of SRAS provision to include facilities that may not be (in part or as a whole) classified as generating units in the NEM. As noted by AEMO in the draft guideline, this recognises the capability of new technologies, such as grid-forming battery storage systems, to provide these services.

Whilst there are nuances in the technical capabilities across different technology providers, Tesla is confident in the ability of its own battery storage systems to meet the requirements of SRAS provision. Tesla's latest utility scale battery product, Megapack (superseding Powerpack) is now a self-contained unit that can energise the AC bus from its DC energy (we note that other non-Tesla batteries often require additional energy sources for ancillary cooling systems).

With future increases in asynchronous generation and declining real inertia, Tesla recognises the increasing potential for batteries to provide a 'Simulated' Inertia and restart service.

Self-start capability

The flexible and fast controls in a Tesla Megapack inverter can re-produce the response of a traditional rotating machine. As the inverter's inertial response is purely created by the inverter controls, not the physics of a rotating mass, the response is tunable and can be modified based on the grid's needs (unlike traditional generators that have a fixed inertial constant based on their physical characteristics).

Tesla battery systems have a virtual machine model that can mimic the response of a traditional rotating machine to provide an inertial response. The virtual machine is a blended mode (grid following / grid-forming) that brings dispatchability of current sources with stability benefits of voltage sources.

The virtual machine model is a flexible feature that can be enabled or disabled as required. Its parameters such as inertial constant, frequency droop, and impedance are fully configurable and can be tuned to obtain the desired dynamic behaviour for the grid.

For self-starting services, Tesla can activate its grid-forming mode. However, to ensure desired service outcomes can be achieved, we recommend AEMO define an island control automatically, or through a centrally directed manual switching (as per AEMO's current approach). The re-synchronisation with the power system can then be performed either automatically, or manually – enabling transition back to PQ mode (grid-following) with precise voltage and frequency control maintained throughout.

As noted above on Tesla's blended virtual machine mode, following suitable grid-forming services and the restoration of the grid, Megapack automatically transitions back to grid-following mode.

Premium voltage/reactive power services

Similar to system re-start and restoration, Tesla Megapack has demonstrated capability to provide voltage control through precise real and reactive power provision. Local voltage levels instruct the battery what real and reactive power to inject into the system. The nominal levels for both can change (and be set) dynamically – see example charts below:

Figure 1 – Voltage Forming Mode – Reactive Power

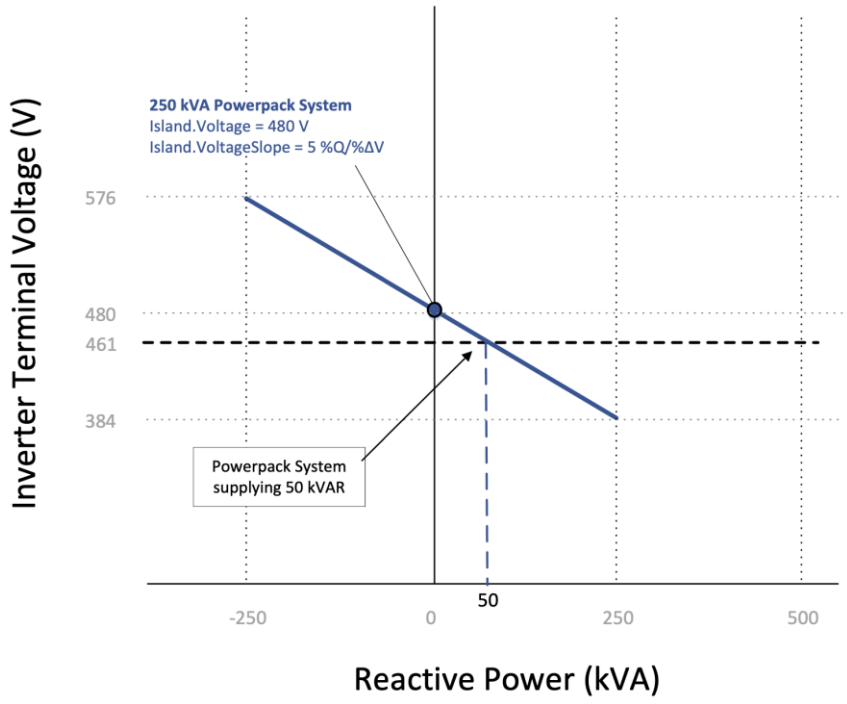
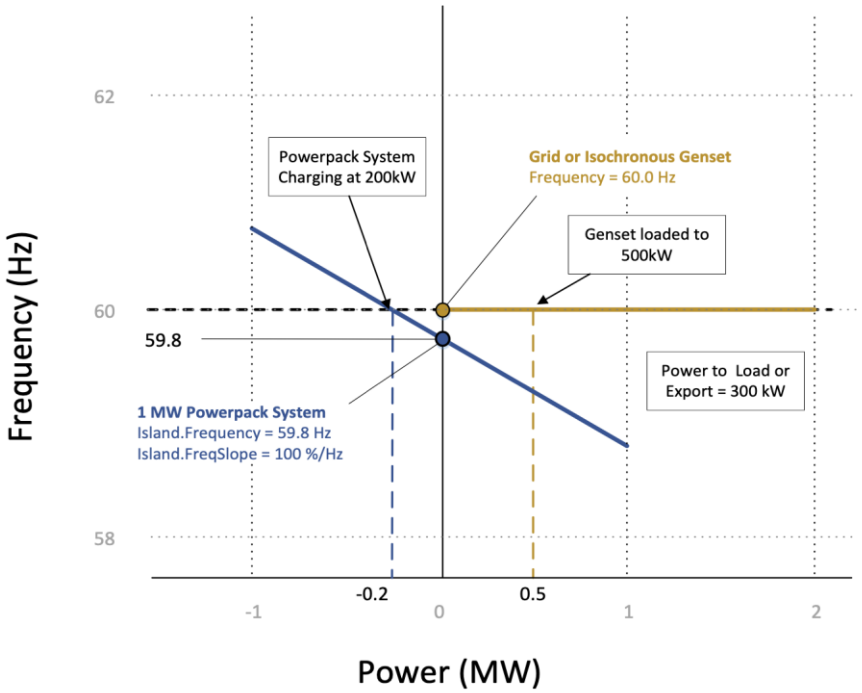


Figure 2 – Voltage Forming Mode – Real Power

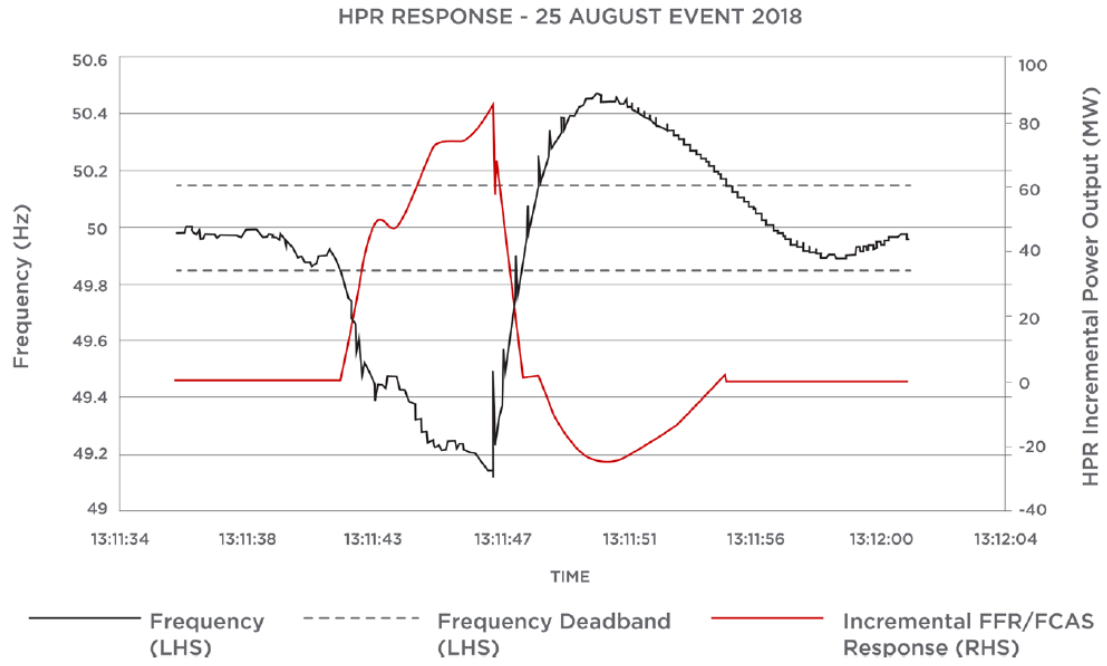


Fast Frequency Response

Tesla's battery systems react automatically and almost instantaneously to locally measured changes in system frequency outside predetermined set points.

For example, as demonstrated by Hornsdale Power Reserve (HPR), the battery's fast frequency response is well suited to supporting restoration of frequency and is of particular value in arresting a high rate of change of frequency during initial frequency disturbances. It rapidly and accurately follows the frequency and provides its required active power response for both small deviations – caused by minor contingency events or in support of the Regulation FCAS service, and large deviations caused by more significant contingency events.

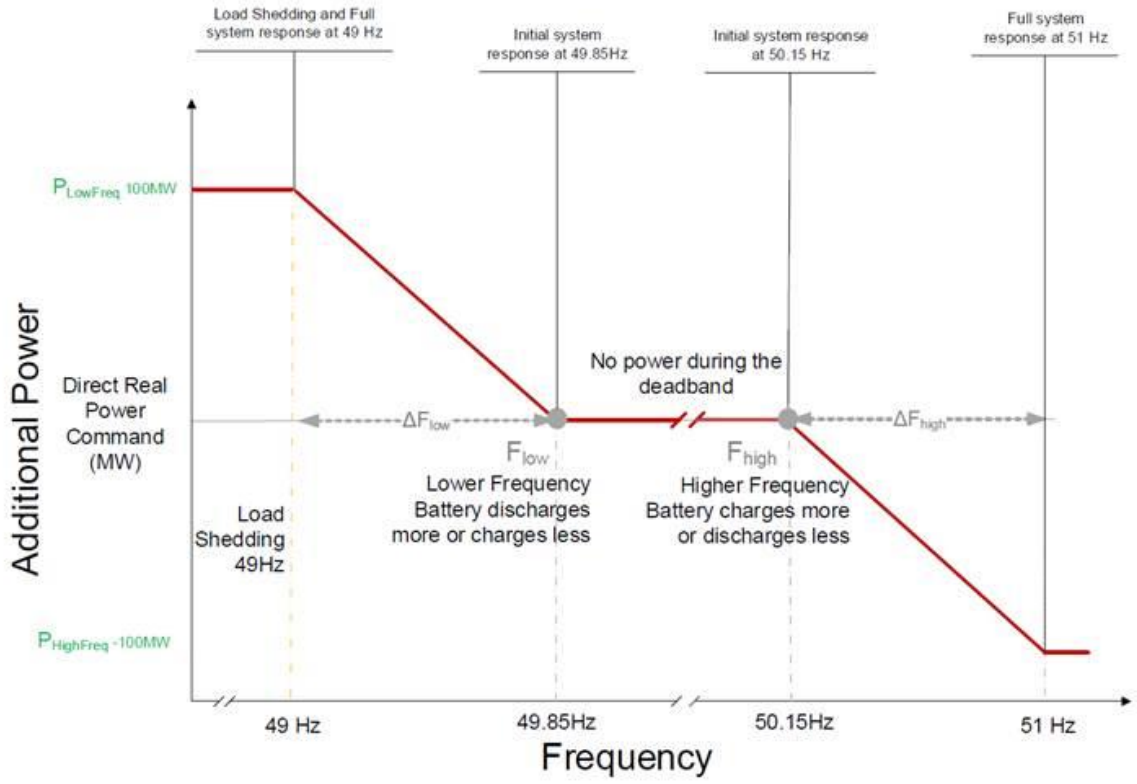
Figure 3: Hornsdale Power Reserve Frequency Response



HPR currently provides its 'premium' fast-frequency capability through participation in the existing contingency FCAS markets, albeit with a much faster response than required by these markets. Recognising that batteries are already providing a form of Fast Frequency Response, we are also working closely with relevant parties at ESB, AEMO and ESB in exploring appropriate incentives to value fast frequency services.

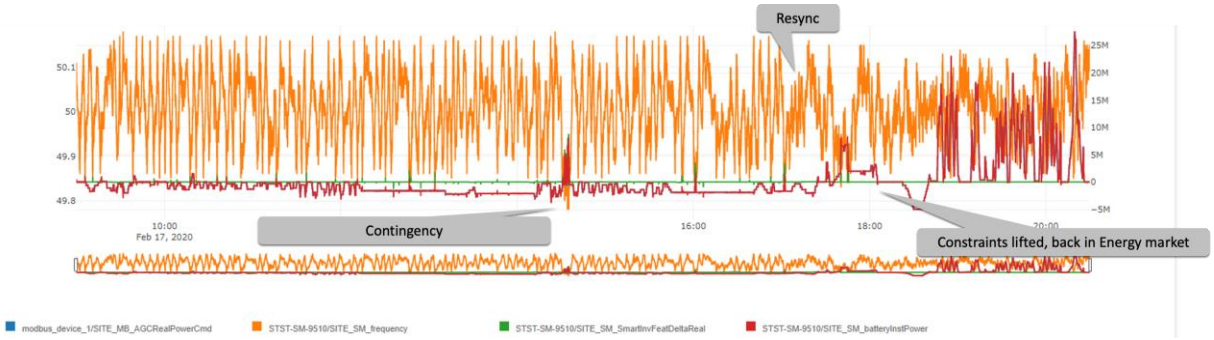
Deadband and droop can also be custom defined. For example, it can flexibly configured to be more or less aggressive for SRAS support, depending on the region, scenario or outcome being sought. This can also be dynamically changed to ensure tighter control as conditions change.

Figure 4: Frequency control response



Note that HPR has droop curve settings with deadband of 50 ± 0.15 Hz and 1.72% droop. This correlates to a 100 MW discharge at 49 Hz, in advance of the activation of any Under-Frequency Load Shedding (UFLS). These are the droop settings agreed with AEMO and as required under the MASS. Droop settings for a BESS are however highly configurable to the desired characteristic, and Tesla looks forward to working closely with AEMO as it undertakes a review of the MASS, alongside Primary Frequency Response reforms that are exploring improvements in compliance and verification of service provision, and better recognition of the relative performance characteristics of different technologies providing ancillary services.

Figure 5: Frequency control example during recent SA islanding infeb 2020



Restoration and Re-synchronisation

The South Australian separation event provides an instructive example of the existing capabilities of battery systems to respond rapidly to provide grid support (transitioning from AEMO AGC signal to support the islanded SA grid), before playing a critical role in ensuring a smooth and seamless re-synchronisation could be achieved between SA and the wider NEM network. Whilst not the standard technical definition of black-start, the role and capabilities demonstrated by battery storage in this

situation could be considered analogous to SRAS provision, including transitioning control to third-party generators once the SA island was restored.

Nuances in the definition of black-start, system restart support, restoration and re-synchronisation services should be considered to ensure AEMO can obtain necessary services efficiently, and then complemented by adequate testing procedures undertaken with potential SRAS providers.

SRAS Procurement Objective

Tesla supports the ability for AEMO to enter into long-term SRAS contracts, or procure specific combinations of services, where this is more efficient and in the lowest long-term costs for consumers. Provided this procurement is undertaken transparently, and alongside clear evaluation principles, this is a welcome opportunity to provide additional contracted revenue streams for battery storage projects that continue to await market reforms to development to recognise the full range of services and value being provided (e.g. inertia, fast frequency response, accurate regulation frequency control ancillary services, lifting network constraints etc).

Given the rapid pace of innovation being experienced in the energy technology sector, we recommend AEMO ensure its standard practice of detailed modelling of SRAS requirements includes robust consultation with industry participants and relevant equipment manufacturers. This will avoid incumbency 'lock-in' and drive the greatest efficiency in the provision of services going forward, appropriately reflecting technology advances whilst also minimising risk to power system operations.

Tesla also supports the introduction of a compensation framework (new clause 4.3.6) that will enable participants to claim compensation for any direct costs incurred as a result of test participation.

Kind regards