TESLA

AEMC – System Services Consultation Response

LAST EDITED
August 2020

Sebastien Henry
Australian Energy Market Commission
Sydney NSW 1235

13 August 2020

RE: AEMC – System Services Consultation

Dear Sebastien

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide a response to the AEMC's System Services consultation paper consolidating the seven rule change proposals currently under consideration.

Tesla's mission is to accelerate the transition to sustainable energy. Within this objective, Tesla is committed to working with all market bodies to improve power system security and reliability outcomes in the National Energy Market (NEM) in a manner that is efficient for consumers, timely for system operations, and sustainable over the long-term. Therefore, we believe emissions reduction should also be central to any future market design and we recommend AEMC assess the costs and benefits of each reform against this criterion - to structure system services in a way that enhances the integration of low-emission, secure, low-cost energy technologies into the NEM.

We recognise the real and immediate need for action to improve the current system service frameworks in the NEM and agree with the AEMC and AEMO position that system security, frequency, and reliability have all been deteriorating over recent years. At the same time, battery storage has proven particularly valuable in managing system security issues and providing premium stability, voltage and frequency services, as recently demonstrated in South Australia's islanded power system - where grid-scale batteries were controlled by AEMO to support grid stability following extensive storms, bushfires and unexpected outages. Going forward, storage at all scales – transmission, distribution and behind the meter – and in all forms – stand-alone, co-located, and aggregated – will be an increasingly critical component of Australia's energy mix. As such, it is essential that new reforms and requirements do not directly, or inadvertently disincentivise the uptake of future storage projects.

Tesla looks forward to working with the AEMC in addressing the priority objective to improve the efficiency and effectiveness of power system security and reliability in the NEM, ideally through a long-term market based approach that can ensure the National Electricity Objective remains central to the reform agenda and investor certainty is improved. Ultimately, investment and innovation in the energy sector will flourish when market design principles focus on achieving outcomes, rather than mandating specific short-term requirements, or procuring services on a reactive and ad-hoc basis.

Our feedback on each of the consultation papers is included in the following submission, along with our recommendations as to how principles based system service design can deliver optimal outcomes whilst not resulting in increased costs for consumers or disincentivising the entry of new technologies. For more information contact Dev Tayal (atayal@tesla.com).

Kind Regards

Emma Fagan - Head of Energy Policy and Regulation

Summary of Key Consultation Considerations

- **Tesla supports the AEMC's approach to parallel process multiple related system service reform proposals and seek to outline a coordinated reform pathway**
  - Whilst the individual proposals present a range of solutions, the problems they collectively seek to address form a critical part of NEM design, and have become an increasingly important area. We acknowledge the case for change across all elements of system service provision – inertia, system strength, operating reserves, and the broader frequency control ancillary service (FCAS) arrangements, in particular Primary Frequency Response (PFR) and Fast Frequency Response (FFR).
  - We note that under current frameworks, inertia and system strength are procured on an ad-hoc basis, highly reactive, and without any transparent, competitive remuneration; FCAS has long awaited improvement in design and incentives, both within the scope of the Market Ancillary Service Specification (MASS) and more broadly to consider how incentives could be strengthened / introduced for PFR and FFR services; and the current reliance of in-market operating reserves warrants re-design, alongside other key structure changes being explored such as resource adequacy mechanisms, unit-commitment improvements, and enhanced dispatch visibility.
- **Given existing overlaps with several ESB market design initiatives and AEMO's Integrated System Plan and Renewable Integration Studies, it will be critical for all market bodies to provide much greater transparency on how these related market reform developments interact and plan to be progressed**
- We note this consultation has been released in parallel to the ESB's Essential System Services Draft paper, with responses to AEMC due around the same time the ESB will publish an overarching Post 2025 Draft Report, but with next stages on both AEMC and ESB processes appearing to be out of step, where defined at all. At best this creates an overly burdensome and duplication of effort for industry, and at worst this could lead to contradictory assessments on what market reform options are likely to be optimal and will be considered in more detail.
  - The hierarchy of decision making also remains unclear – with multiple overlaps and ongoing rule change proposals introducing additional uncertainty for stakeholders. AEMC (and ESB/AEMO) must provide industry with clear governance, timeframes for consultation, option design, and implementation – noting the above on level of urgency across individual elements. Of particular note are the trade-offs and interactions between complementary/competing market designs. (e.g. inertia and FFR; or Operative Reserves vs Resource Adequacy vs Retailer Reliability Obligation)
- **Tesla supports the AEMC's System Services Objective, and highlights the role storage and inverter-based technologies will play in service provision alongside synchronous plant**
  - As demonstrated in day to day operations as well as during non-credible power system events, storage technologies are well aligned with the objective of efficient provision of services to meet "multiple system needs, including security, reliability, and resilience". Storage assets have the ability to optimise across multiple services and multiple markets – to provide what is needed when it is needed the most – driving increased flexibility, improved competition and enhanced stability to the local grid and the NEM more broadly. Multiple services can also be provided by a single asset simultaneously – ensuring the cost of service provision maximises efficiency, and can be co-optimised across energy and system services.
  - We note that many of these services can be, to varying degrees, partial substitutes of each other, so that the provision of one service may reduce the need for another service. For example, both AEMO studies and international experience suggests a strong interplay between FFR and inertia, with GB's National Grid recently announcing the introduction of a new rapid response frequency product to support system operations with less inertia.
- **The reform of system service mechanisms must be cognisant of impacts on investment signals for low-carbon technologies – storage in particular requires removal of existing barriers and recognition of its capabilities to unlock the required levels of deployment in the NEM**
  - The NEM currently provides mixed signals for investors looking to develop storage projects, highlighting a significant gap in meeting AEMO's forecast levels of storage deployment by 2030 (i.e. up to 19GW by 2040 as projected in the 2020 ISP 'step change' scenario). These projects are crucial to contribute to both reliability and system security outcomes in the short term, and to drive affordability and efficiency outcomes for consumers over the longer term.
  - AEMC must consider both the individual and collective impact of the rule change proposals against a broader assessment of what potential market design features will be necessary to stimulate the requisite levels of private investment in a low-carbon future, whether through the ESB's post 2025 work stream on resource adequacy mechanisms, or parallel explorations of pay for performance arrangements.

Key Recommendations and Design Principles for System Services

1. **Tesla recommends the acceleration of discrete reform elements that present immediate net benefits – most notably the introduction of FFR markets in 2021**
   - Maintaining independence of individual rule changes will allow for varying speeds of implementation based on assessed level of need; complexity; and level of net benefit delivered.
   - Some aspects of system services are likely to have ongoing complexity (e.g. defining/procuring system strength), whilst others (FFR services) already hold demonstrated benefits and can build on precedents set in other jurisdictions to be implemented quickly, and much sooner than 'post 2025'.
   - Following the 'no-regrets' introduction of FFR, assessments on the suitably of complementary proposals, such as operating reserve markets or resource adequacy mechanisms can be undertaken, providing a pathway that allows for evolutionary design that can leverage optionality benefits to align with AEMO's ongoing technical Renewable Integration Studies.
   - Inertia markets could also be progressed in parallel – potentially focusing on trials in regions where urgency is greatest (e.g. South Australia)

2. **A first principles approach to service provision is critical – i.e. defining outcomes that uphold technology neutrality, rather than restrictions based on synchronous classifications**
   - As the NEM transitions towards a high renewables and low-carbon future, synchronous services are increasingly being substituted by proven (and asynchronous) technologies that can contribute to fault current and actively support voltage waveforms. E.g. electrical inertia measured in MWs can be derived both from synchronous machines (kinetic energy) or asynchronous (chemical potential).
   - Structuring markets to value service provision (rather than mandates based on asset type, or size or classification etc.) becomes increasingly relevant for evolving market designs that will need to integrate a suite of technologies providing comparable services across the grid. As a principle, all technologies should be able to access all revenue streams for which they can provide services – it is the MWs of inertia that is important – not how it is derived.

3. **As renewables and supporting technologies increase their penetration levels, innovation in service provision should be encouraged through structured incentive-based mechanisms**
   - Market reform must use future proofed terminology rather than relying on prevailing / outdated assumptions that only synchronous generators can provide specific system services, as suggested in several rule changes. Participation should appropriately reflect the capacity of all resources to contribute to system services, noting this may include procuring new services from existing technologies, or may incentivise innovation and bring forward power system contributions from future technologies. Innovation will flourish when design principles focus on achieving outcomes, rather than mandating specific short-term requirements.
   - Synthetic, digital or 'virtual inertia' is a current prime example where technological advancement is demonstrating the ability of equivalent service provision through non-traditional assets. These developments should be encouraged – and ideally be rewarded through pay for performance mechanisms that recognise premium service provision (accuracy, speed etc.).
   - The ramping requirements highlighted in the rule changes can also be mainly addressed by inverter-based technologies, with large and rapid ramps well suited to the capability of fast-response battery storage in particular. The increasingly variable supply-demand mismatch will be improved from the introduction of 5 minute settlement, and may also be supported by additional incentives to provide operating reserves.

4. **AEMC need to consider/address how long-term investment signals will be maintained or strengthened where required**
   - Whilst economic theory might naturally drive design decisions towards pure spot markets, it will be important to balance how investors perceive market price signals and whether volatility and unpredictability can be sufficiently managed to support adequate volumes of long-term investments (e.g. through financial CFD type products, or other contracted revenue streams).
   - Regulatory checks and balances will play a critical role, and Tesla supports additional work to ensure AEMO and networks service providers are appropriately incentivised to explore and integrate new technologies and services – e.g. through trials or refinements to the RIT-T/D in particular for non-network opportunities.

5. **Any changes to system service frameworks must also consider the potential role and benefits of DER, demand response, and VPPs in supporting the objectives**
   - Tesla notes that the future NEM, under any credible future scenario, will see a significant contribution from distributed energy resources (DER), and aggregated fleets operating as VPPs that should be enabled to participate in all energy and system service markets given their ability to provide many of these services much more efficiently and at a localised level. Many of these capabilities are already being demonstrated as part of AEMO's Virtual Power Plant trials.

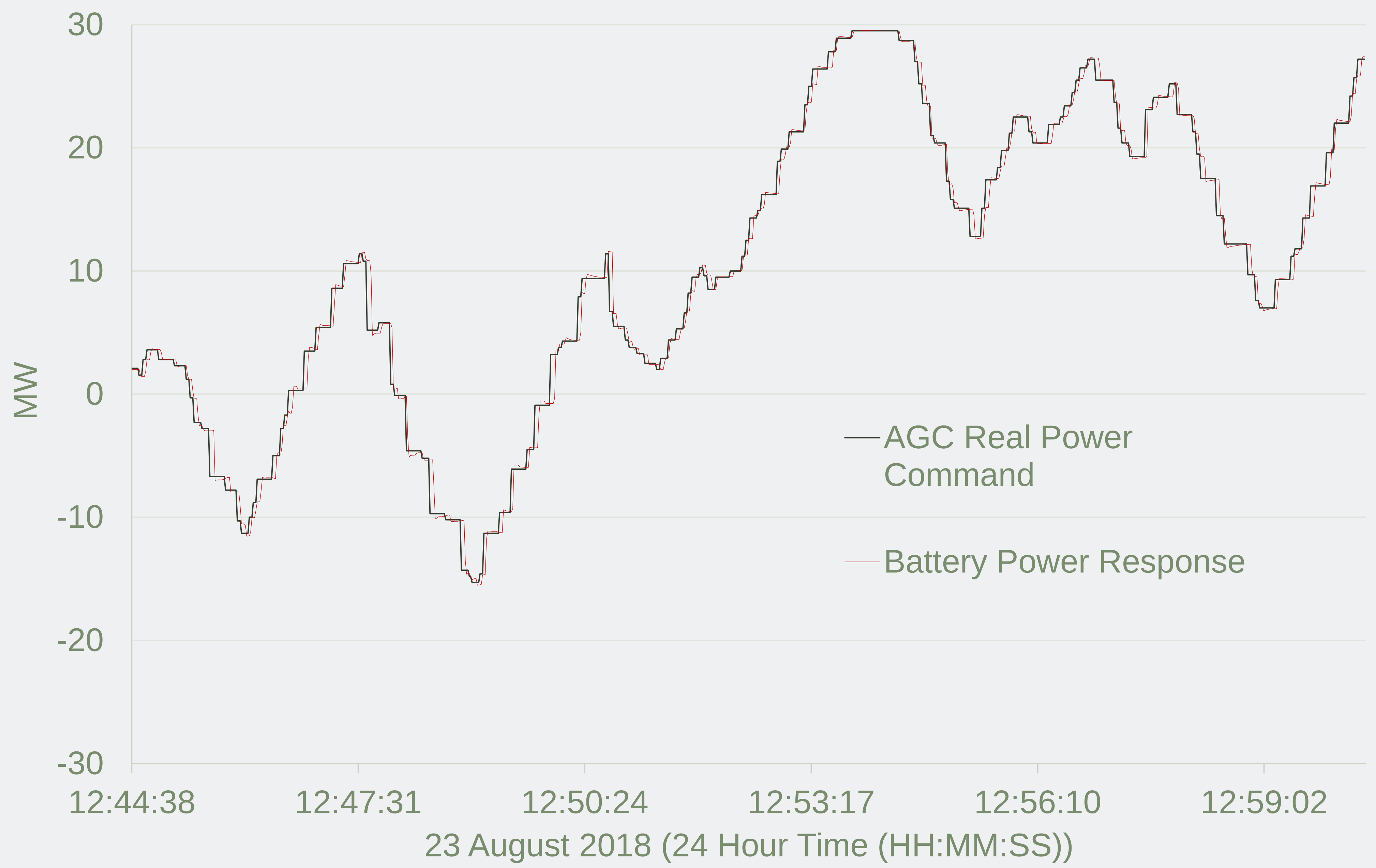
Battery storage system service capabilities

Summary of Battery Storage System Services

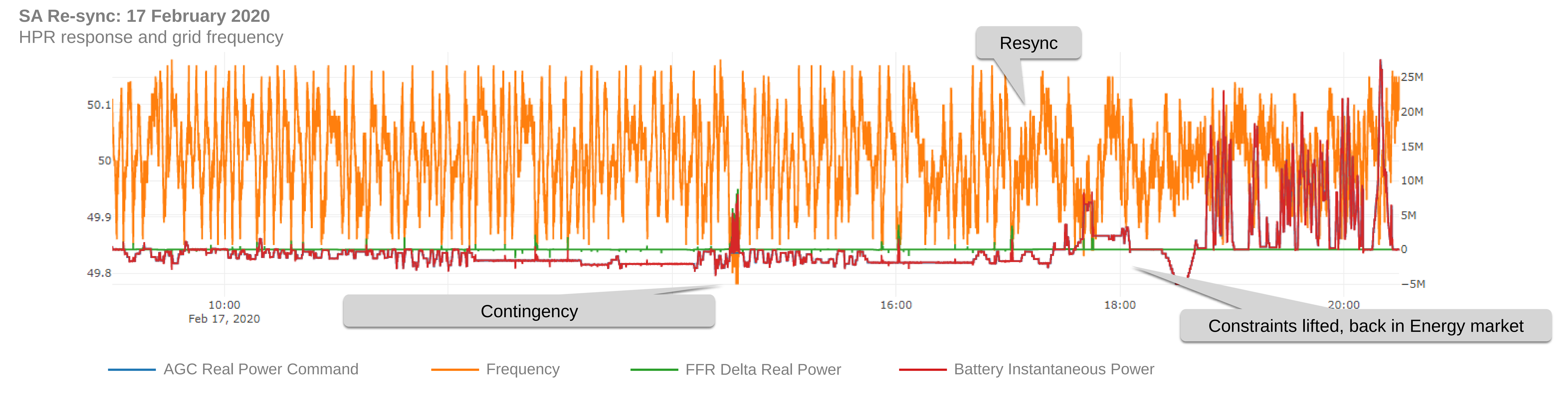
- A key benefit of battery storage is its ability to stack multiple services and provide multiple sources of value across different time-scales. System services provide a critical area where battery technologies can enhance and drive additional efficiencies in service provision to the benefit of all participants and consumers.
- To date, Tesla has deployed over 3GWh of battery storage providing a range of system services, with around 300MW of batteries on microgrid or off-grid backup sites fully utilising grid-forming and system synchronisation capabilities in particular.
- Key system services from battery storage include:
  - **Frequency stability**
  - **Fast frequency response**
  - **Voltage stability**
  - **Primary frequency response**
  - **Virtual inertia services**
  - **System strength**
  - **Special Protection Systems for fast active power injection for network support**
- Multiple reports have also conducted 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)
  - "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 over-frequency condition in SA following separation from VIC (AEMO Final Report – Queensland and South Australia system separation on 25 August 2018)
  - "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)
  - "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)
- 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.
- Ensuring appropriate frameworks are set up 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 services from 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 also ensure a back-stop insurance against the early closure of thermal plant.

FREQUENCY STABILITY

- Grid-scale battery storage has consistently demonstrated its ability to provide both rapid and precise regulation FCAS, particularly when compared to the service typically provided by conventional synchronous generation units.
- Whilst this premium response has been demonstrated by Hornsdale Power Reserve (HPR) over 2 years of operation, regulation FCAS arrangements in the NEM do not currently recognise differences in the speed or accuracy, the ‘quality’, of service delivery.
- Operational data shows that HPR provides very rapid and precise response to regulation FCAS signals, see figure right. This is in contrast to large conventional steam turbines, which can lag the Automatic Governor Control (AGC) signal by up to several minutes.
- HPR provides a high quality Regulation FCAS service. Increased deployment of such high quality frequency regulation would assist in maintaining network frequency within the 50 ± 0.15 Hz normal operating range
- **Recommendation:** implement findings from the AEMC’s 2017-18 Frequency Control Frameworks Review, which highlighted: “the best approach to the procurement of frequency services in the longer-term will need to be performance-based, dynamic and transparent”.



FREQUENCY STABILITY
SA ISLANDING EVENT



- 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 resynchronization could be achieved between SA and the wider NEM network
- During islanding, AEMO constrained SA batteries to zero MW output but allowed 50% state of charge to allow provision of raise and lower contingency FCAS
- Data also highlights that frequency management during the islanded and NEM connected periods were not remarkably different
- It demonstrates technical feasibility in providing system security service today, and the critical role batteries will continue to play going forward in a high renewables NEM

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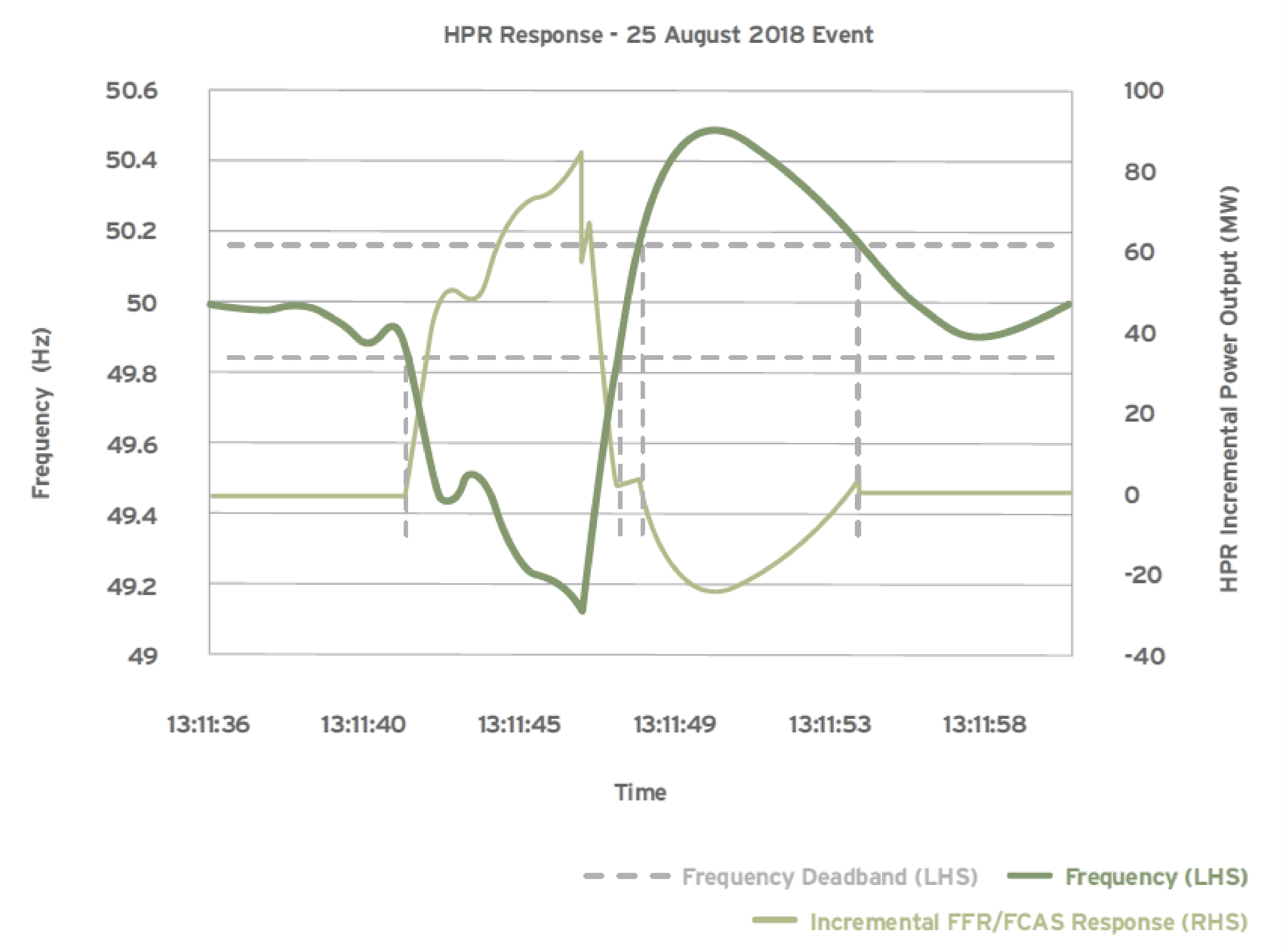
FAST FREQUENCY RESPONSE

- The fast frequency response from battery storage is well suited to supporting restoration of frequency and is of particular value in arresting a high Rate of Change of Frequency (RoCoF) during initial frequency disturbances. It rapidly and accurately follows the frequency deviation and provides proportional 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.
- HPR currently provides FFR while participating in all six of the existing Contingency FCAS markets. It provides a premium service in this market through its fast response time of approximately 100ms, as compared to the minimum required 6 second response under existing Contingency FCAS markets. This premium service supports a reduced RoCoF and total deviation in frequency during contingency events.
- **Recommendation:** exploring appropriate incentives to value fast frequency services should be accelerated, particularly as frequency control continues to loosen across the NEM. This is increasing the occurrence of the frequency falling outside the normal operating band of 50 ± 0.15 Hz: strengthening the case for new mechanisms such as FFR to be introduced. Again, this aligns with the Frequency Control Frameworks Review recommendation from 2018: “Although FFR services could be procured through the existing six second contingency service, this does not necessarily recognise any enhanced value that might be associated with the faster response.”



Source: https://www.aurecongroup.com/-/media/files/downloads-library/2018/aurecon-hornsdale-power-reserve-impact-study-2018.ashx?la=en

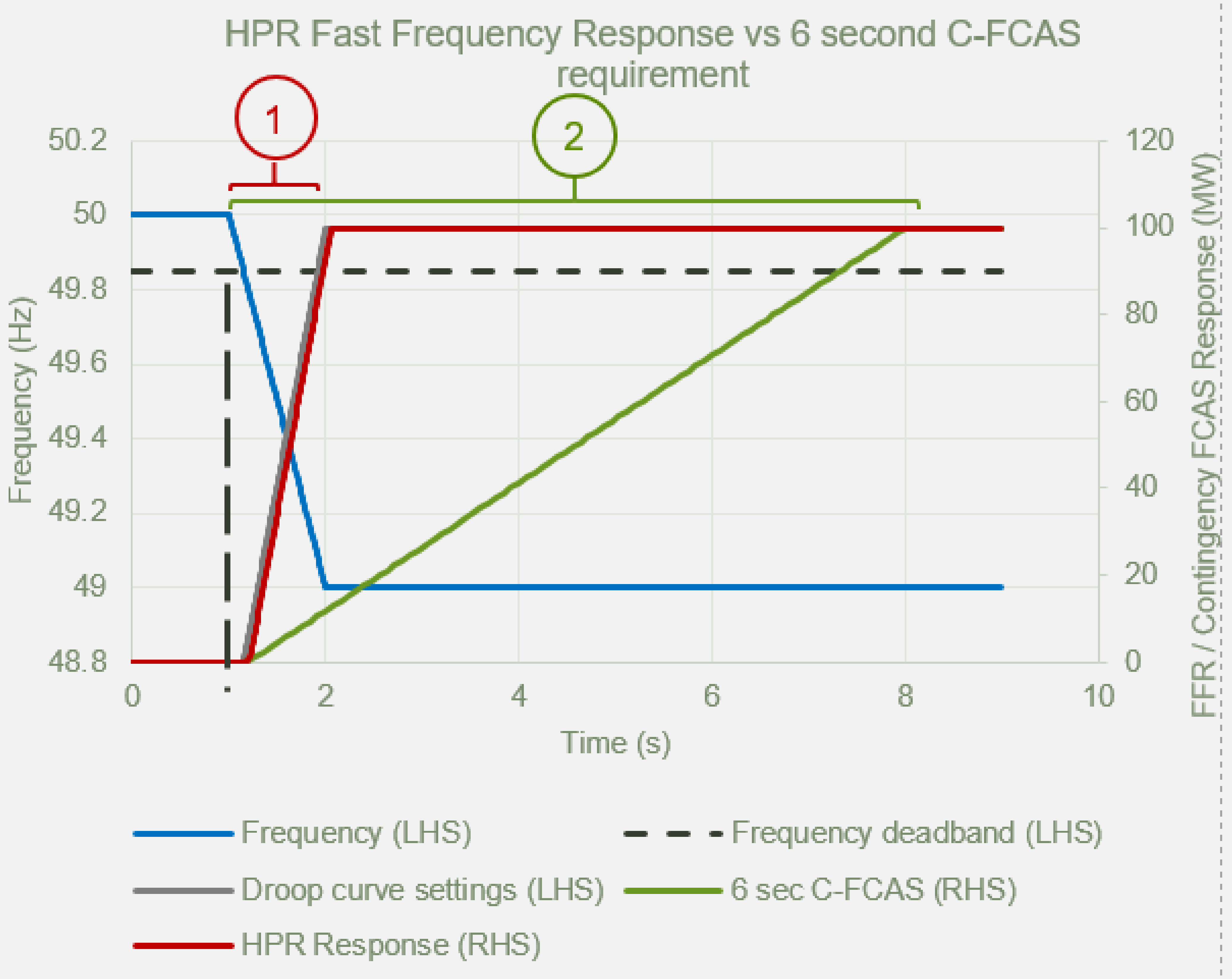
FAST FREQUENCY RESPONSE
AURECON CASE STUDY

HPR provides Fast Frequency Response more rapidly than existing market requirements, which were structured on the response capability of thermal generators

- Fast Frequency Response is the fast dispatch of active power in response to a frequency disturbance outside the normal frequency operating range of 50 ± 0.15 Hz. The active power dispatch is in accordance with a frequency droop curve, generally proportional to the magnitude of the frequency deviation.
- The chart to the right compares the FFR response characteristic of HPR to the minimum requirement for the 6 second Contingency FCAS service, based on a drop in frequency at a RoCoF of 1 Hz per second, down to 49 Hz:

1) HPR closely tracks the droop curve power dispatch requirement, with minimal delay (response based on lab test results of inverter response characteristic).

2) This contrasts with the relatively slow minimum required response characteristic for the existing ‘Fast Raise’, or 6 second Contingency FCAS service.

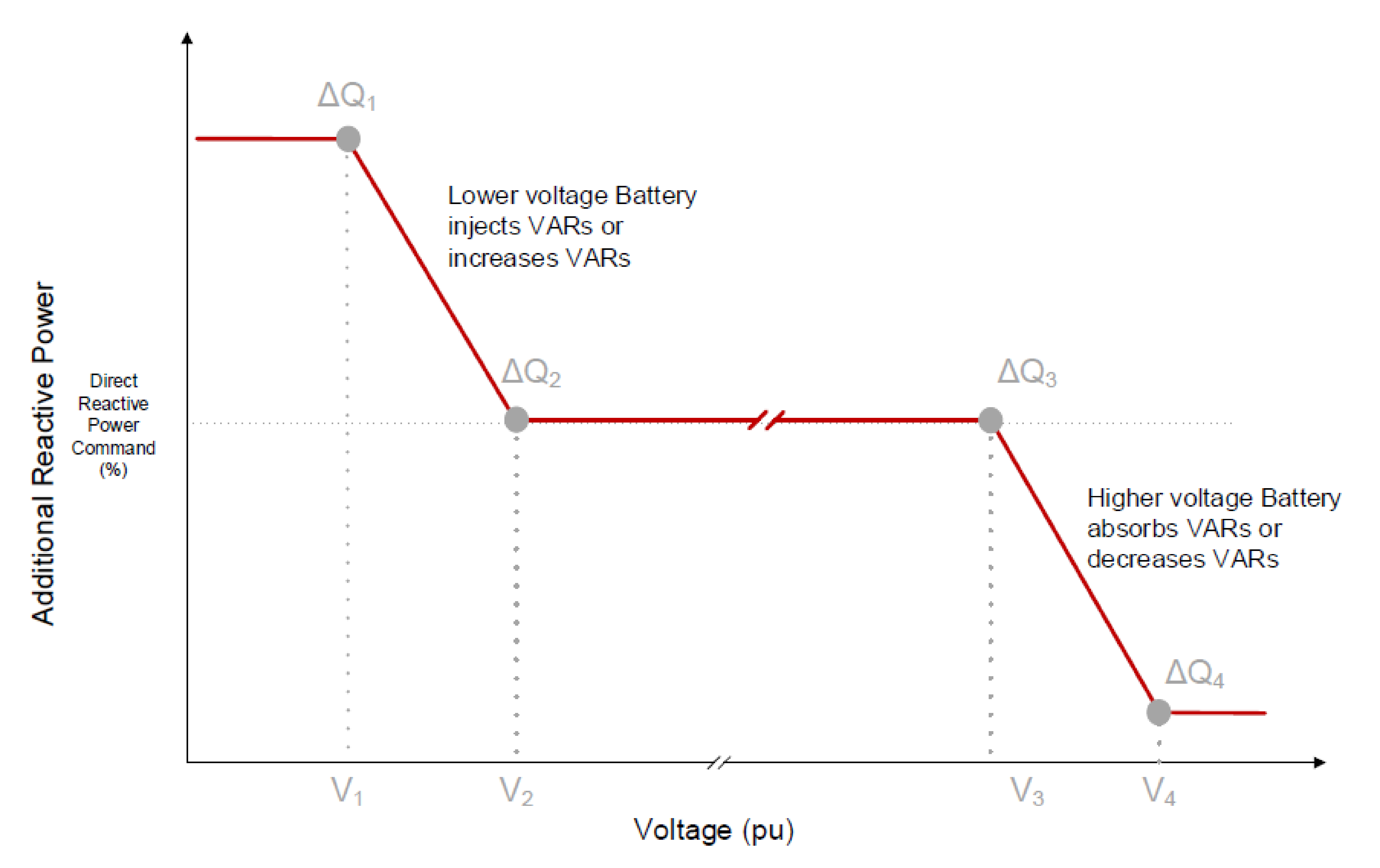


Source: https://www.aurecongroup.com/-/media/files/downloads-library/2018/aurecon-hornsdale-power-reserve-impact-study-2018.ashx?la=en

VOLTAGE STABILITY

- Tesla inverters have demonstrated capability to provide voltage support through precise reactive power injection / absorption based on direct command, fixed power factor setpoint or closed-loop voltage control approaches.
- The system can also provide fast acting voltage support through a configurable Volt/VAR droop curve.
- Reactive power support from an inverter-based technology can be a credible alternative to dedicated static VAR compensators (SVCs) or static synchronous compensators (STATCOMs).
- **Recommendation:** ensure any system service procurement process and incentives remain transparent and competitively neutral (avoiding technology 'lock-in' based on existing view of capabilities) and streamline process for network utilities to utilise capabilities of batteries as non-network options.

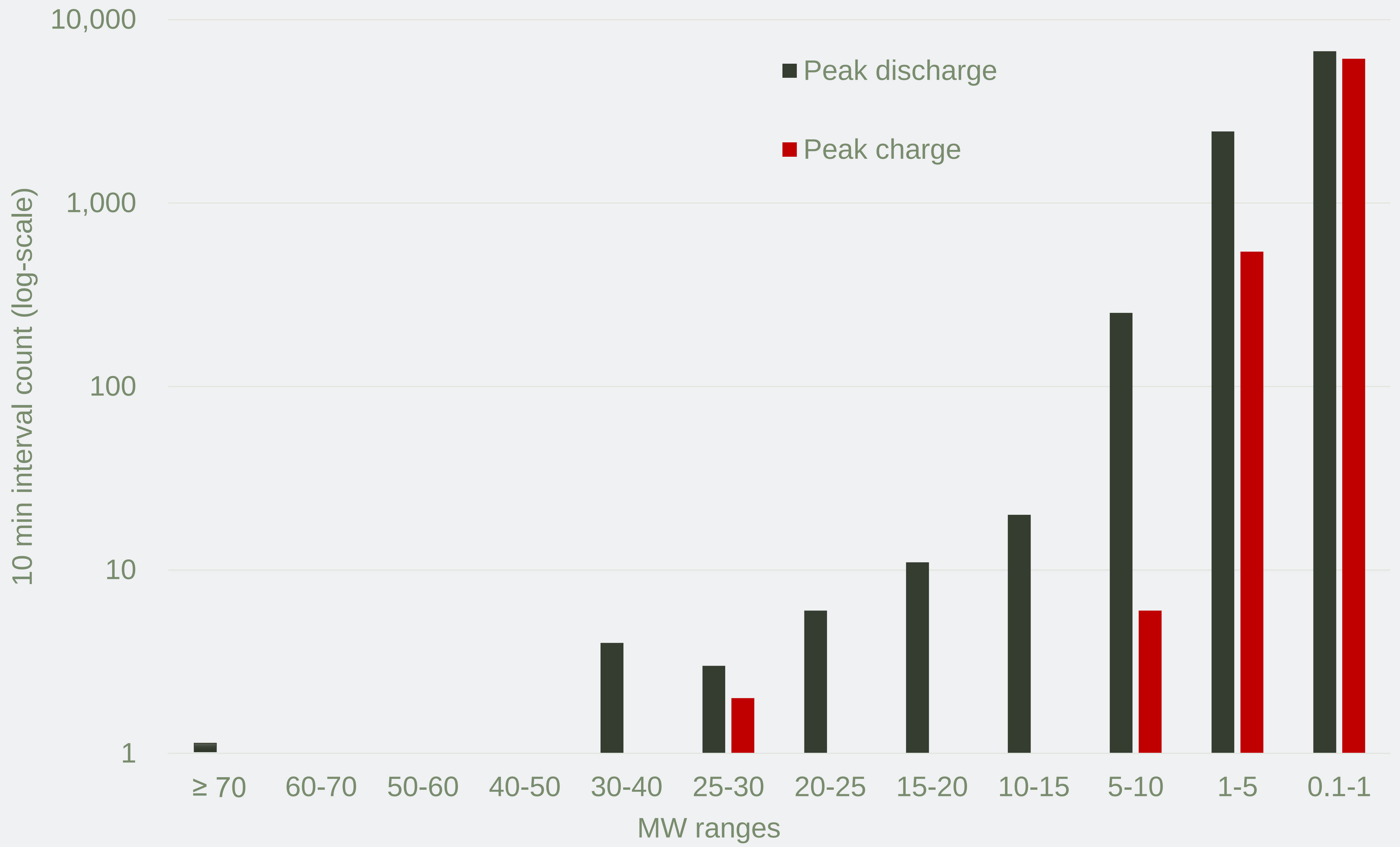
Configurable voltage support features of Tesla's inverter:



PRIMARY FREQUENCY CONTROL

- Tesla's battery energy storage systems can react automatically and almost instantaneously to locally measured changes in system frequency outside predetermined set points.
- Under existing NEM arrangements, primary frequency control services that operate outside the normal operating frequency band of the frequency operating standard are procured through the fast and slow contingency FCAS markets, with new mandates introduced for generating units to provide service within the normal operating frequency band when dispatched for energy.
- HPR is regularly responding to small frequency disturbances outside the normal operating frequency band. The demand for this frequency control is related to the effectiveness of Regulation FCAS in maintaining the frequency within the normal range.
- As discussed with AEMO, battery systems can be incentivised to tighten their frequency droop curve setting and/or deadband and provide an enduring Primary Frequency Control service. This could be a complementary service to Regulation FCAS, and should ultimately be supported through an incentive-based approach.
- **Recommendation:** early consideration of a market mechanism ahead of the mandatory PFR sunset in 2023 (as suggested under AEMC's Frequency Control Frameworks Review).

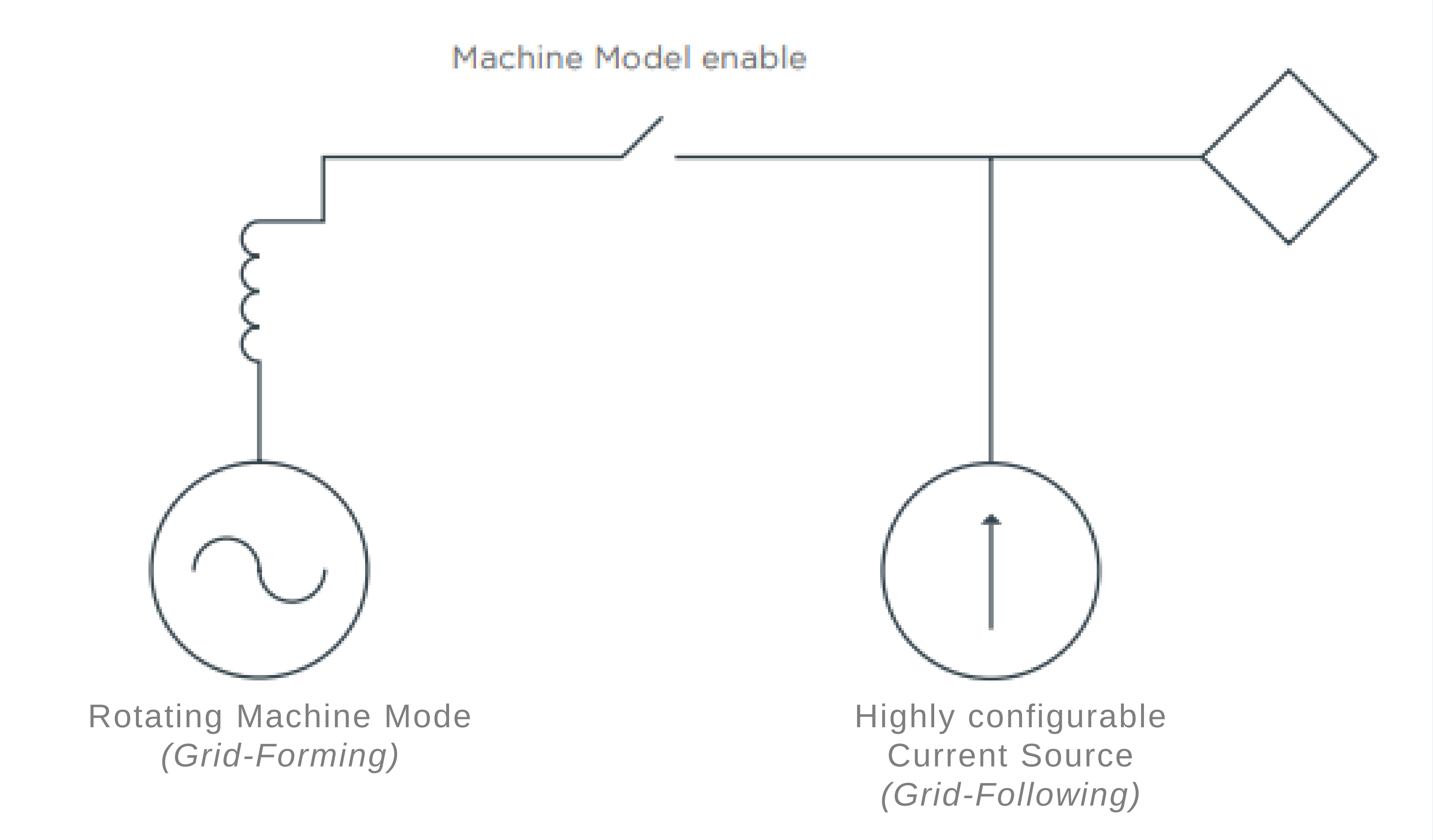
HPR Contingency response over 1st year :
HPR is regularly dispatching Contingency FCAS services for minor frequency disturbances, and responding occasionally, as required, to large contingency events



VIRTUAL INERTIA

- With increasing asynchronous generation and declining inertia from synchronous machines, there is increasing potential for batteries to provide a ‘virtual’ inertia service.
- Tesla battery systems have a virtual machine mode that can mimic the response of a traditional rotating machine to provide an inertial response. The virtual machine is a blended mode that brings dispatchability of a current source operating in parallel with the stability benefits of a voltage source.
- The flexible and fast controls in a Tesla battery inverter can replicate the response of a traditional rotating machine. As the inverter’s inertial response is created by the inverter controls 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).
- The virtual machine model is a flexible feature that can be enabled or disabled as required. Its parameters such as inertial constant and impedance are fully configurable and can be tuned to obtain the desired dynamic behaviour for the grid. The inertial constant of a Tesla battery can be configured from 0.1 to 20MW.s/MVA.
- **Recommendation:** progress incentives for ‘inertia services’, defined neutrally through requirements (e.g. response time and active power level required).

Tesla Inverter Virtual Machine Mode:
A Tesla inverter can operate in Virtual Machine Mode with a configurable current source operating in parallel with a rotating machine model (voltage source).



VIRTUAL INERTIA
AMERICAN SAMOA - CASE STUDY

- The island of Ta’u in American Samoa historically relied on expensive diesel generators to supply all of their electricity needs – facing frequent outages, rationing and high emissions.
- In 2016, Tesla commissioned a renewable microgrid – using 1.4MW of solar PV paired with 750kW / 6MWh battery storage to provide affordable, reliable, and clean power to the island.
- With the battery providing all critical power system services, the microgrid now provides energy independence to the nearly 600 residents of Ta’u - allowing the island to store and use solar energy 24/7, reduce diesel costs, remove the hazards of power intermittency and make outages a thing of the past.
- The microgrid allows the island to stay fully powered for three days without sunlight, and the Tesla battery system recharges fully in seven hours – providing back-up power, peak shaving and seamless grid stability through Virtual Machine Mode (the battery operating as grid forming – setting frequency and voltage reference for the grid).
- The microgrid has no grid-connected synchronous generation and, whilst a small system, illustrates the capability of inverter based technologies to support the grid at all times.

VIRTUAL INERTIA
ADDITIONAL CASE STUDIES

- Since 2017, Tesla's Virtual Machine Mode has been operating on a 13MW / 52MWh energy storage facility on the island of Kaua'i, Hawaii. This system has allowed increasing renewable penetration on the island by time-shifting energy generated from solar PV and providing critical grid services including inertia and voltage smoothing.
- As part of the expansion of the Hornsdale Power Reserve to 150MW, inertia services from a grid-scale battery storage system will be demonstrated in the NEM context. Once expanded, the Hornsdale Power Reserve could provide up to 3,000MWs of inertia to the local South Australian grid.
- We note that inertia/system strength events are typically transitory events before frequency response kicks in, meaning inverter based technologies are able to provide the initial response just as well as traditional plant (and this hierarchy can be considered within the operating regime of the battery system).
- Studies by EirGrid and SONI in Ireland have also shown the benefits of incorporating virtual inertia into energy systems (lower $'s, less CO_2, reduced oscillations).

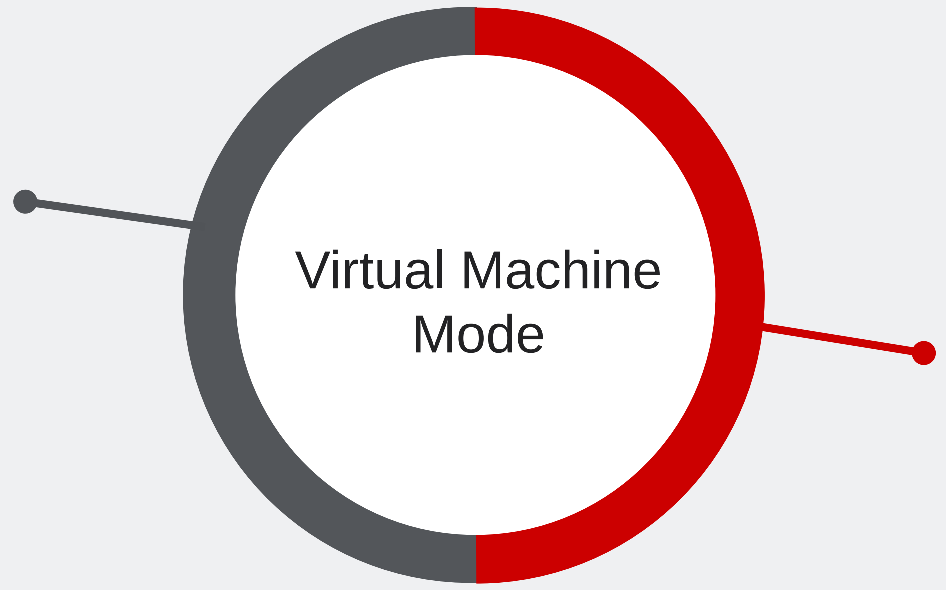
TESLA

SYSTEM STRENGTH

- The Tesla Inverter operating in Virtual Machine Mode can provide inertia and fast acting voltage smoothing to support regions of low system strength. Because the Rotating Machine Model component of Virtual Machine Mode is modelled as a low impedance source, it responds to fluctuations in voltage with a countervailing current response. For example, if voltage suddenly drops, the machine model will inject reactive current temporarily in response. This has the effect of smoothing and stabilising voltage in regions of low system strength, where voltage disturbances can be more prominent and propagate further through the grid.
- In addition, inverter based technologies can utilise their short term overload capability to provide fault current contribution, improving the short circuit ratio at a connection point
- **Recommendation:** continue to explore incentive based mechanisms to drive service outcomes, ensuring procurement remains a transparent and competitive process. It is currently unclear what drivers will underpin and reward grid-forming capability for inverters.

Tesla Inverter Virtual Machine Mode:
A Tesla inverter can operate in Virtual Machine Mode combining the benefits of a configurable current source and a rotating machine model (voltage source) to support grid stability in regions of low system strength.

Configurable Current Source (Grid-Following)
- Real power dispatch
- Reactive power dispatch
- Frequency support
- Voltage support



Rotating Machine Model (Grid-Forming)
- Virtual Inertia
- Dynamic voltage smoothing
- System strength support
- Standalone operation

Detailed Consultation Response

System Service Rule Change Consultations – Summary impact for storage (1/2)

	Proponent	Rule Change Proposal	Battery storage Impacts	Recommendation
1	Infigen	Fast Frequency Response Market	• Batteries have rapid and accurate response capabilities that will be well suited to FFR services and can deliver greater benefits for the system and savings for consumers • We note AEMO has already expressed support for FFR mechanisms in both its Renewable Integration Study and SA Technical report findings • AEMC also previously flagged the potential benefits in its 2018 Frequency Control Frameworks Review • Detailed design must ensure full load-side participation and include ability for DER / VPPs to participate • Further technical analysis should also consider the cost/benefit of targeting even faster response requirements (e.g. <1second or <500mS;) and/or pay for performance to reward rapid response • Trade-offs with the introduction of inertia markets can also be explored, but should not be seen as reason to delay FFR implementation	• **Tesla is strongly supportive of the introduction of an FFR market, as soon as 2021** • We note it could be implemented with minor changes to the MASS – whilst parallel changes could also be drafted in rules to codify new requirements and impose timeframes on AEMO • We suggest AEMC accelerate implementation as a 'no-regrets' reform (high benefit, negligible cost) ahead of other more complex system service reforms
2	Infigen	Operating Reserves Market	• The proposed design holds several benefits for implementation/integration in the NEM – maintaining real-time markets that simplifies dispatch and optimisation for storage assets in particular • Further detail and analysis on interactions with existing RERT and RRO mechanisms would be valuable – as there would likely be overlap/complexity with the RRO that needs to be resolved. However, in general it will improve optimisation flexibility - allowing current out-of-market resources (e.g. under RERT contracts) to be used in-market when appropriate – as quantity can vary dynamically • Depending on detailed market design, there may be new incentives for old thermal plant to hold-off retirement and further dampen investment signals for new assets, but we note payments are unlikely to be sufficiently high when/if reserve levels remain high – so there is a counterbalance embedded • The longer term impacts on battery storage projects should be positive – providing another revenue stream in a battery's value stack • Interactions with the load-side and WDRM are unclear, as well as why the proposal is seeking a raise-only service, noting the recent minimum operational demand risks (e.g. in SA)	• **Tesla supports ongoing consideration of operating reserve markets** • AEMC / ESB can explore the viability for real time operating reserves to act as a direct substitute for day ahead market design work, as real-time markets would better align with signals provided from the introduction of 5MS and the 2-sided market work • Market design could also include specific characteristic principles to drive investment signals towards required plant capabilities (e.g. rapid ramp response; low emissions) • We also recommend considering the benefits of a lower service (i.e. to incorporate the load-side services and address negative load issues). As it stands, it is unclear why loads are unvalued. • We note operative reserves could also be compatible with additional resource adequacy mechanisms – as would address and introduce incentives at different timescales – should the ESB work determine additional investment signals are required for reliability
3	Delta	Ramping	• As proposed the rule change would have unnecessary and negative impacts on all assets aside from retiring synchronous generators • Longer term a ramping service *could* be designed to provide a new price signal for demand response and all types of storage (hydro, BESS, hydrogen) – but this would necessitate a speed characteristic • The proposal seems to ignore the benefits of 5MS and improved forecasting (which will ensure high ramp intervals send high price signals). In US markets, the combination of wind, solar and storage has already demonstrated an optimised portfolio solution that does not rely on slow-ramp services from thermal plant	• **Tesla does not support the introduction of a slow-ramping payment** • The costs of the proposal appear greater than the purported benefits, and the principle suggesting solar is the sole cause of inflexible/slow-start response is incorrect and over simplistic • Ramping would be better addressed via 5MS together with ensuring adequate levels of operating reserves can provide intraday flexibility • We also note the likely need for fast-response ramping more than slow ramping in the future
4	Delta	Capacity Mechanism (synchronous plant)	• As framed, this proposal runs counter to real-time / market based designs for essential system services / network services under consideration by AEMC and ESB – (unless framed as a reliability resource adequacy mechanism for all plant) • Delta suggest "these system services [are] not typically provided by asynchronous generators" however this is an increasingly outdated view – as demonstrated by the ongoing developments and provision of virtual inertia, and the ability for many existing services provided by thermal plant to be replaced by a combination of batteries, syncons, and grid forming inverter technologies • We also note the proponent's acknowledgement of non-neutrality - "will appear to favour one technology over another, it does so to permit full participation from slow-start thermal generators in addressing the identified issue."	• **Tesla does not support the capacity mechanism as framed for synchronous plant, but notes a broader mechanism for resource adequacy may be required to support new plant** • We do not disagree that some form of capacity mechanism could be required given market based price discovery for capacity may not be sufficient for new generation investments • However, this mechanism needs to be technology neutral – or include actual characteristics required in future (e.g. flexible, fast ramp, accurate dispatch output, low emissions) • For system services – it will be much better to define services rather than asset types, to ensure ongoing innovation is incentivised and is valued under other reforms proposed on reliability / operating reserves.

System Service Rule Change Consultations – Summary impact for storage (2/2)

	Proponent	Rule Change Proposal	Battery storage Benefits / Impacts	Recommended Principles
5	TransGrid	System Strength	• Battery energy storage systems (BESS) have demonstrated a suite of services for providing current and voltage stability services, allowing benefits to exceed the costs relative to standard syncon installations • Direct benefits could be achieved if TNSPs are allowed/can be incentivised to procure new technologies and non-network solutions (such as grid-forming inverter BESS) to address system strength and complement network investments • Indirect benefits can also flow through to the integration of storage if updating 'do no harm' provisions can remove current barriers to grid-scale renewable connections, and associated/co-located investments in battery storage assets by project developers	**Tesla supports a revision to the 'do no harm' provisions and ongoing consideration of incentive-based frameworks for system strength (noting their complexity)** • AEMC should continue to explore incentive based mechanisms to drive service outcomes; as it is currently unclear what drivers will underpin and reward grid-forming capability for inverters • Ensuring procurement remains a transparent and competitive process (avoiding technology 'lock-in' based on existing view of capabilities) will be critical • Future network planning must include broader assessment of incentives for non-network solutions (refinement of RIT-T/D processes or additional mechanisms) to overcome network investment biases
6	HydroTas	Synchronous services markets	• There is an increasing role for the provision of system services from inverter based plant, most notably virtual inertia – but the proposal as currently framed suggests this service would be ineligible by definition • Needs to be framed as technology neutral 'inertia market' – otherwise BESS locked out if only synchronous plant can provide services and participate in market and would not satisfy assessment framework principles of efficiency or neutrality • Potential to be flow on impacts in the dispatch co-optimisation process – distorting price discovery in FCAS markets or other new system service markets being introduced	**Tesla does not support integrating a synchronous service payment into dispatch. Instead, inertia markets should be considered more holistically** • System service procurement must be technology neutral as a matter of principle, and ideally seek the provision of services rather than specifying the type of provider or technology • A pay for performance mechanism can also ensure premium and targeted service provision (speed, accuracy) rather than broad categories of service. • AEMC and AEMO would need to consider interactions between real-time service provision and unit commitment for scheduling purposes • It is unclear how/if load-side would be able to participate
7	AEMO	Primary frequency response incentive arrangements (ongoing)	• Potential to be paid for service (from June 2023) would remove current distortions from the mandatory, fleet-wide provision of PFR – and underpin longer term efficiency by providing another value stream for batteries to access in providing fast and accurate response • We note AEMO commentary in the SA technical report suggesting potential to layer some form of compensation: "introducing arrangements to reward higher performers would be suitable, while maintaining a minimum requirement for all capable market participants" • Interactions with existing and proposed system service markets would need to be assessed – with BESS being able to optimise across PFR, inertia, FFR and the 8 existing contingency and regulation FCAS markets	**Tesla supports the introduction of a market-based PFR mechanism as quickly as possible, and preferably ahead of the 3 year sunset date, given the investment signal impacts on new entrants** • As AEMC acknowledged through the MPFR consultation process, incentive-based mechanisms are more efficient than mandating services • Mechanisms could include exploring deviation pricing; markets, and potentially bilateral contracting as a near-term trial of procurement • More visibility on, and commitment to, accelerated timeframes in the Frequency Control Work Plan would provide much needed investment certainty
8	AEMC (self initiated)	Investigation into System strength frameworks in the NEM (ongoing)	• n/a - we note detailed implementation will be undertaken through the TransGrid and HydroTas rule changes above	n/a

1. Fast Frequency Response Market

Tesla is strongly supportive of the introduction of an FFR market, as soon as 2021

- **Investment: The existing FCAS registration route for battery systems is not transparent, and undervalues the speed and accuracy of response - an additional barrier to investment**
  - The requirements of contingency service provision is defined in the Market Ancillary Service Specification (MASS), which assesses the level of contingency response under the standard frequency ramp (i.e. 350mHz at 0.125Hz/s for mainland NEM). In reality, contingency events are not as predictable as the MASS suggests, demonstrated by multiple events (QNI trip on 25 August 2018; Heywood trip on 16 Nov 2019; and SA islanding on 31 Jan 2020 as prominent yearly examples).
  - In January 2019, AEMO formalised droop requirements for all future battery projects in guidance: "*Unless an alternative droop limit is specified by AEMO, the minimum allowable droop setting of any BESS is 1.7%, regardless of its capacity*". To satisfy the Frequency Operating Standard, FCAS contingency registration levels also appear to be limited by reference to the generation/load containment band of 49.5 - 50.5Hz (but it is not clear how / if the standard frequency ramp rates outlined in the MASS interact with these values)
  - Fast response frequency control can be valuable, particularly following a large disturbance (e.g. network events), or when the power system is operating with low inertia – as already acknowledged by AEMO and recognised by AEMC in the Frequency Control Frameworks Review: "although FFR services could be procured through the existing 6 second contingency service, this does not necessarily recognise any enhanced value that might be associated with the faster response".
  - The value of fast response will only grow as the level of inertia continues to fall with increasing levels of renewables penetration. Most recently demonstrated by the SA islanding event in Jan/Feb 2020, grid-scale batteries were critical to support SA grid stability ahead of re-synchronisation with Victoria.
- **Interactions: Relying on the provision of an unvalued 'free' or 'under-valued' rapid response service from battery storage is not sustainable. Enabling assets to register full technical potential could significantly improve the investment signal for storage - lowering costs to consumers and reducing system security risks in parallel**
  - We note the AEMC's 2018 Frequency Control Framework Recommendations recognised the importance of conducting "a broader review of the MASS that seeks to address any unnecessary barriers to new entrants, or any aspects of the MASS that may not appropriately value services provided by newer technologies where these services are valuable to maintaining power system frequency", and specifically noting consideration of "the timing specifications for each of the different FCAS; overlapping interactions amongst other changes that may be necessary".
  - A technology focused MASS review could create an even playing field that rewards battery energy storage on a performance basis. This could consider market setting improvements for battery and DER assets across all FCAS and energy markets more broadly. For example, AEMO could clarify and codify the calculations used in the MASS to underpin contingency registration levels.
  - Over 2 years since the FCFR was published, this focused MASS review is yet to progress, and instead the NEM has seen short-term fixes to address system security risks in preference to enduring incentivise based approaches that can underpin market efficiencies. Tesla remains committed to working with the AEMO and AEMC to ensure these recommendations can be addressed and the MASS can be reviewed to better reflect capability and value of new technologies. We note these issues may also align with the frequency control work plan being progressed alongside the Primary Frequency Response reform package.
- **Implementation: As an immediate 'no-regrets' (high benefit, negligible cost) market reform, Tesla strongly supports the introduction of a Fast Frequency Response service in 2021**
  - Our understanding is FFR could be implemented outside of the NER, as there is significant room within the NER definitions to redefine the desired response timeframes and still retain the defined terms of fast raise, slow raise, and delayed raise. The fastest approach would be updating the definition of fast response contingency in the MASS from 6 seconds to require response within [2] seconds. Parallel changes could also be worked up in the NER to specifically address network contingency events, and to codify new requirements and impose arrangements on AEMO, or explore rule changes if it is was determined that an additional FFR service should be layered onto the existing contingency services (i.e. retain 6 sec, 60 sec and 5 minute response)
  - FCAS procurement volumes could be layered (as per the UK / Ireland markets), e.g: first response primary frequency services (narrow deadband, continuous operations); FFR (with <1 or <2 second response, rewarding speed and accuracy); contingency response (e.g. existing 6 second, slightly wider deadband).This approach would not necessarily require procurement of additional volumes, but existing volumes could be staggered.
  - Further analysis on the speed of the response is also be warranted, noting the interplay between FFR and ROCOF at low levels of inertia. For example, there may be even greater net benefit moving to a <1 second FFR market, which may also incentivise innovation and underpin ongoing investment in rapid-response flexible assets ahead of thermal plant retirements.

2. Operating Reserve Market

Tesla supports ongoing consideration of operating reserve markets
- **We recommend AEMC / ESB continue to explore the viability for real time operating reserves to act as a direct substitute for day ahead market design work, as real-time markets would better align with signals provided from the introduction of 5MS and the 2-sided market work (and could be expanded to include 'lower' services)**
- **We note operating reserves could also be compatible with additional resource adequacy mechanisms – as each would address and introduce incentives at different timescales – should the ESB work determine additional investment signals are required.**

- **Investment:** if efficient pricing is achieved, an operating reserve would provide greater incentive to invest in dispatchable resources to increase ramping capability and decrease start-up times (as higher pricing might only apply to a few dispatch period intervals). The approach could also provide increased incentives to invest in resources in regions experiencing more frequent or larger capacity shortages. Our initial view therefore is that impacts on battery storage projects will be net positive – providing another revenue stream in a battery's value stack.
- An additional benefit of the proposed mechanisms is its explicit technology neutrality – the market would be open to all types of technologies, and there would be no need for central determination of 'de-ratings' or other 'firmness' factors as with other capacity mechanisms. However, one potential and notable exception needing to be addressed is the eligibility and participation of demand side response – and how an operating reserve market would integrate with the Wholesale Demand Response market proposed, or other 2-sided market initiatives under development by the ESB. Both demand response and DER are valuable resources that should benefit more from the mechanism given their relative flexibility to be made available during scarce conditions.
- In general, we view the proposed operating reserve market aligning with optimisation flexibility – allowing current out-of-market resources (e.g. under RERT contracts) to be used in-market when appropriate. This holds as a relative advantage to other market designs been considered, such as the day ahead reforms under consideration by the ESB and AEMO.
- We also note that there may be new incentives for old thermal plant to hold-off retirement and further dampen investment signals for new assets, but depending on detailed market design, payments are unlikely to be sufficiently high when reserve levels remain high. To provide extra certainty, the design could also include specific characteristic principles to drive investment signals towards required plant capabilities (e.g. rapid ramp response; low emissions)

- **Interactions:** further detail on potential or expected interactions with the RRO need to be further explored – including any greater reliance that may be placed on the RRO mechanism in the future, which is likely to create mixed investment signals and/or disadvantage assets that are seeking market-based returns relative to others that hold reliance on RRO-supported retailer contracts. To address overlaps and complexity, we would support the phase-out of the RRO being triggered if a real-time operating reserve market is established
- We also note the operating reserves mechanism can be implemented independently of other ESB decisions being made on resource adequacy mechanisms (including the existing RERT and RRO). All else being equal, a NEM with a co-optimised operating reserve market could be expected to reduce the use of RERT as well as the likelihood of the RRO being triggered.
- As noted above, further clarification on the interactions with the load-side and WDRM would prove valuable, as well additional analysis on whether the design should include both raise and lower services, noting the recent minimum operational demand risks (e.g. in SA)

- **Implementation:** we note implementation costs are relatively higher than other proposals given the need for re-design of AEMO dispatch processes, suggesting timelines would also be longer, but potentially still achievable ahead of 2025. In addition, the RRO and RERT (as a back-stop) could provide near-term measures to address any capacity shortfalls ahead of operating reserve activation. Our view is that the benefits would still substantially outweigh the complexity.

3. Ramping Services

Tesla does not support the introduction of a slow-ramping mechanisms as proposed by Delta

- **The costs of the proposal appear greater than the purported benefits, and the principle suggesting solar is the sole cause of inflexible/slow-start response is incorrect and over simplistic**
- **Ramping would be better addressed via 5 minute settlement (5MS) together with ensuring adequate levels of operating reserves.**
- **We also note the likely need for fast ramping more than slow ramping in the future.**

- **Investment:** As structured in the rule change proposal, the design of a slow-ramp payment would have unnecessary and negative impacts on efficient investment in the NEM. Aside from retiring synchronous generators who may receive additional incentives to defer their retirement timeframes, all other asset types being developed and deployed as part of a future energy market would face increased costs directly (e.g. solar plant as proposed), or indirectly through distorted price signals.
- The AEMC assessment should not encourage a regulatory framework that is designed around the capabilities of old and retiring technology.
- As AEMO notes in its latest VPP knowledge sharing report, “evidence indicates that VPPs could alleviate operational challenges such as low generation reserves and low minimum demands as they grow in scale”, highlighting the role VPPs will play in firming variable resources.

- **Interactions:** Tesla recommends the service characteristics being targeted under this proposal are better driven more broadly by the shift to 5MS, and introduction of other new market mechanisms, such as operating reserves, or resource adequacy mechanisms, to ensure appropriate energy assets are both incentivised to enter and operate in dispatch. The proposal seems to ignore the benefits of 5MS and improved forecasting (which will ensure high ramp intervals send high price signals). In US markets, the combination of wind, solar and storage has already demonstrated an optimised portfolio solution that does not rely on slow-ramp services from thermal plant

- **Implementation:** We suggest this rule change is not progressed and instead more appropriate markets / services are implemented that also incorporate price signals for demand-side response, and support the entry of new flexible capacity from all forms of storage (hydro, batteries), with consideration of ‘speed’ factors or characteristics to ensure dynamic ramp response is in place to complement increasing levels of renewable generation.

4. Capacity Mechanism

Tesla does not support the capacity mechanism as framed by Delta for synchronous plant, but notes a broader (technology neutral) mechanism for resource adequacy may be required to support the entry of new (particularly fast-ramp, low emission) assets

- **Investment:** As renewable penetration increases, we note considerable structural changes may need to be made to the NEM's wholesale market design to ensure investment in storage technologies keeps pace. New markets must incentivise flexibility and low-emission characteristics to avoid favouring incumbents and prolonging an ageing thermal fleet. Whilst network and renewable investments have established processes and development pipelines, the integration pathway for new storage is less clear. Without new mechanisms, there are very few contracted revenue steams for storage, and FCAS markets that provide much of the value have already proven to be shallow and highly volatile – further challenging investment certainty.
- Tesla supports the approach taken in the PJM and Californian markets. Both are undertaking distinct, yet effective, approaches to enhance the provision of market services – focusing on the integration of new technologies through a combination of centrally planned targets, direct contracting, and capacity availability payments that complement existing wholesale market dynamics.
- California remains a great example of a market that is creating appropriate investment signals for new assets – whereby capacity contracts have been allocated to both storage and other plant - demonstrating technology neutrality and showing that storage can compete successfully when it is allowed to (unlike Delta's proposal that acknowledges it will "favour one technology over another").

- **Interactions:** the NEM's current structure relies on a series of inefficient, expensive, and ad-hoc mechanisms (e.g. out of market reserves, network utility obligations, or directions issued to generators). There is also concern around the availability of the ageing synchronous thermal fleet to maintain system integrity. This leads to not only energy risks, but flow on impacts to system strength and inertia. Whilst one approach may be to mandate requirements on new connecting generators, or obligating TNSPs to address system services, an incentive based mechanism is more likely to meet the reform objectives of efficiency, neutrality, transparency, flexibility and appropriate risk allocation.
- As noted in the recent FTI advice to the ESB, policy makers must provide greater clarity on how the RRO will or will not interact with any capacity mechanisms (and how 0.0006% trigger changes and longer term RERT will influence), recognising that an RRO mechanism that becomes frequently triggered would introduce significant overlapping obligations with a capacity market approach.

- **Implementation:** To avoid ongoing and ad-hoc government intervention (that may provide a short term fix but ultimately decreases investor certainty), new market features that reward and value resource firming and investments in essential system services need to be considered and rapidly implemented. However, as with all policies, we note resource adequacy mechanisms do not come without their challenges, most notably the complexity, cost and risks – e.g. potentially stifling decarbonisation efforts by locking in payments for incumbent thermal plant; or the high switching costs for energy-only market participants and investors to transition. Detailed design will also heavily influence the type of capacity that is awarded contracts. For example, the setting of 'de-rate' factors (MW adjustments applied based on a technology's contribution during periods of system stress) can either completely restrict the participation of battery storage, or create generous incentives to participate.
- Some potential risks that need to be carefully monitored in exploring future design:
  - May not incentivise flexible capacity - mechanisms in US have been used to prop up legacy thermal plant to provide system security services / incentivise additional thermal generation.
  - Uncertainty on requirements/barriers for DER participation (could incentivise only utility-scale, centralised assets)
  - Risk of being a short term fix – i.e. excess generation is built – dampening prices and halting case for future projects. In some overseas markets prices are too low to drive investment in new storage
  - Relies on accurate centralised planning forecasts (over-procurement risk) to avoid extra cost
- Recommended design principles:
  - Must incentivise buildout of flexible capacity to enter market – type of resource(s) should be clearly defined; whilst allowing 'value stacking' across energy and service markets
  - Must not favor incumbents and non-flexible assets – i.e. don't just reward based on traditional measure of peak capacity (MW output) and ignore flexibility characteristics (MW ramp)
  - Can include low-emission factor requirement (<200gCO_2/kWh) to avoid delaying exit of old/inefficient plant at expense of new
  - Must reward the true reliability and performance of assets based on system requirements (i.e. speed of response/start/ramping) and to meet operational goals: Scaling factor based on storage durations to avoid influx of short-duration assets and avoid overly burdensome energy capacity requirements (e.g. no need to have availability of >6 hours if the peak system events are <4 hours)

5. System Strength

Tesla is largely supportive of the intent of TransGrid's system strength rule change proposal. In particular, we support a revision to 'do no harm' provisions and ongoing consideration of incentive-based frameworks for system strength (noting their complexity) in order to drive future service outcomes from new technologies (e.g. grid-forming inverters)

- **Investment:** Battery storage systems have already demonstrated their ability to provide a suite of services across current and voltage stability, in addition to the full spectrum of market and network services, highlighting their potential benefit relative to the cost of other assets such as syncon installations. Noting the existing barriers to investment and significant future pipeline of storage required in the NEM, any additional system service mechanisms that provide an avenue for storage participation will have the potential to significantly improve the investment environment.
  - Direct benefits could be achieved if TNSPs are allowed/can be incentivised to procure new technologies and non-network solutions (such as grid-forming inverter BESS) to address system strength and complement network investments. Streamlining and incentivising network-led investment in storage will provide critical system advantages and also unlock an important investment stream for storage owners/operators who can layer innovate commercial models to help monetize capacity deferrals, and in parallel provide a suite of system security services.
  - Indirect benefits can also flow through to the integration of storage if updating 'do no harm' provisions can remove current barriers to grid-scale renewable connections, and associated/co-located investments in battery storage assets
- From a service design perspective, the commercial case for BESS is heavily reliant on value stacking and leveraging the great deal of flexibility and optionality relative to other assets. As such, mandating system strength services without corresponding payments is less favourable to incentive-based frameworks, where they can be introduced appropriately. As the AEMC also note (e.g. in the Mandatory Primary Frequency Control Rule change), mandating provision of services more broadly is unlikely to be the most efficient solution in the long-term.
- In general, Tesla supports mechanisms that are introduced that allow for technology neutrality - in the sense that whether it is AEMO, NSPs or any other body - they seek outcomes, rather than presume a specific technology solution. In practice, we hope this would better allow battery technologies to offer services to address issues, if that is part of their capability - and to be recognised for this if they can meet the appropriate cost/quality of service trade-off.

- **Interactions:** As noted with other the rule change proposals, there is additional complexity arising from interactions / dependencies on the ESB's P2025 workstreams. The AEMC must ensure much greater transparency is introduced to provide industry visibility on how potential system strength frameworks review may feed into ahead market, ESS, or other market design initiatives being considered in parallel.

- **Implementation:** Noting there is much ongoing work in this space (including highly technical implications), from a policy principles perspective, Tesla recommends the AEMC:
  - Ensure procurement remains a transparent and competitive process (avoiding technology 'lock-in' based on existing view of capabilities)
  - Also look to include broader assessment of incentives for non-network solutions (e.g. via refinement of RIT-T/D processes or additional mechanisms)

6. Synchronous Services

Tesla does not support integrating a synchronous service payment into dispatch. Instead, inertia markets should be considered more holistically, together with how complementarity can be achieved with FFR

- System service procurement must be technology neutral as a matter of principle, and ideally seek the provision of services rather than specifying the type of provider or technology
- A pay for performance mechanism can also ensure premium and targeted service provision (speed, accuracy) rather than broad categories of service
- AEMC and AEMO would need to consider interactions between real-time service provision, operating reserves, and unit commitment for scheduling purposes

- **Investment:** There is an increasing role for the provision of system services from inverter based plant, most notably virtual inertia. However, the proposal as currently framed suggests this service would be ineligible by definition. As noted across Tesla's response to other system service rule change proposals, this will create unnecessary inequities and inefficiencies in the overall NEM market design, and will continue to introduce investment barriers to much needed energy storage.
- To drive the right investment signals, this proposal needs to be framed as a technology neutral 'inertia market' – otherwise inverter-based storage technologies would be locked out by definition, and only synchronous plant would provide services and participate – clearly voiding the AEMC's assessment framework principles of efficiency or neutrality

- **Interactions:** we note 2 main interactions to be considered by AEMC:
  - (1) Coal retirement strategy being explored by ESB: There are significant advantages tying inertia markets with state-based emission reduction ambitions, particularly for net zero targets. For example, the CO_2 intensity of energy output from the existing fleet of synchronous generators (and in particular ageing thermal plants) will continue to increase as wind and solar deployment ramps-up. (e.g. greater reliance on ramping from fast-response gas). If system service markets are introduced in a technology agnostic way, then much of this emission intensive output can be avoided - i.e. virtual inertia from grid-forming batteries can unlock the true system wide potential of renewables by making the supporting generation portfolio cleaner, and reducing operational constraints on the system, allowing older, less efficient plant to be retired or mothballed
  - (2) AEMC and AEMO's ongoing consideration of the role of FFR and technical operational requirements under a high renewables future – noting that whilst FFR and inertia services are not directly substitutable, there is no reason an 'exchange-rate' can't be determined based on AEMO's existing frequency analysis and Renewable Integration Study (RIS) work

- **Implementation:** whilst there are many moving pieces across multiple rule change proposals alongside ESB-led reform developments, there is still value in progressing the implantation of new service pathways in a way that can maximise optionality benefits. For example, one potential pathway for the NEM on inertia services could include:
  1. AEMC (together with AEMO, ESB) lead definition of 'inertia services' (either through adaption to HydroTas rule change proposal, wider system strength frameworks review, or ESB P2025 work program). This definition must not lock out digital inertia by restricting participation to 'synchronous service' (this is short term, inefficient, and would not be technology neutral). Instead seek to define service requirements (for example response time and active power level required).

     1a. Definition refinement could leverage ElectraNet (ESCRI) and HPRX findings locally; as well as Eir-grid studies going back to 2016
  2. Establish both FFR and inertia market urgently (ideally from 2021) - and enable inertial and FFR substitution
  3. Revise RIS findings/limitations to reduce non-synchronous vs inertia safety nets as confidence in a high renewable penetration system grows
  4. Ongoing - improve detection and compliance, with finer time resolution measurement and detection protocols, to further incentivise grid-forming inverter based assets

7. Primary frequency response incentives

Tesla supports the introduction of a market-based PFR mechanism (with AEMO support) as quickly as possible, and preferably ahead of the 3 year sunset date, given the investment signal impacts on new entrants.

- **Investment:** Tesla re-iterates its position that implementing arrangements that minimise impacts on the broader investment and commercial outcomes, and do the least to prejudice future market reforms, will be the most effective way to implement primary frequency response in the NEM. Tesla's feedback to this ongoing reform builds on our responses to the Mandatory Primary Frequency Consultation and Draft Determination Papers, and aims to re-focus the AEMC's attention on a fit-for-purpose market-based solution to ensure long-term reliability and cost efficiency. At the same time, we recognise the principle driver behind the AEMC progressing a mandatory approach in the short term is addressing the immediate system security needs, as highlighted by AEMO, and the decision to mandate provision of PFR for up to 3 years.
- Tesla supports the development of a PFR market as one element to provide adequate commercial drivers to incentivise new flexible plant to enter the market. Creating the right incentive structures will be critical to ensuring that appropriate flexible and responsive capacity is built to replace the existing synchronous fleet as it closes over the coming years. The use of market mechanisms to procure primary frequency response will enable fair competition between all technology types providing this service. Markets for frequency response would support resource efficiency, price formation and additional value streams for resources, and comparable treatment between new and existing resources.
- More broadly, Tesla remains concerned with the lack of clear reform pathway that would introduce appropriate incentives for fast-response and flexible generation – particularly in the near-term when capacity is needed to replace retiring thermal fleet. However, accelerated implementation of FFR and PFR incentive-based frameworks would be a significant improvement on the status quo.

- **Interactions:** the frequency control work plan timeframes should be transparent, and reflect the need to quickly introduce alternative arrangements that better align with energy market and commercial developments. More visibility on an agreed frequency control work plan would also ensure appropriate governance and best-practice regulatory reform can be maintained to drive efficient and optimal decision making – avoiding future threats of system security risks over-riding market designs.
- Given the pace of the energy transition, the AEMC must balance AEMO's operational conservatism with the broader reality of generation and network changes occurring and forecast to accelerate (as highlighted by AEMO's 2020 Integrated System Plan). It is worth considering that primary frequency control, whilst critical, is just one of the elements of maintaining a secure power system. For example, in addition to frequency degradation, AEMO highlights the very real potential for "supply interruptions during peak summer periods" in its 2019 Electricity Statement of Opportunities report, suggesting "that targeted actions must be taken now to provide additional dispatchable capacity to reduce the risks".
- As such, this ongoing PFR consultation must be placed within the broader context of NEM reforms that are required to support the transition towards a high renewables generation fleet, whilst simultaneously ensuring a coordinated and coherent market and regulatory framework. It would be unhelpful to embed one element of a secure system (mandating PFR on an ongoing basis) that makes it harder for AEMO to achieve another element (ensuring investment signals are improved to introduce "additional dispatchable capacity").

- **Implementation:** quantification and analysis of the level and interplay between inertial, primary, and secondary frequency response will provide helpful bounds to the market design process.
- AEMO still needs to work with the AEMC to better quantify the PFR requirements of the NEM. Once the required level of PFR is determined, industry will then have a much clearer idea of the best long-term mechanism for providing PFR in the NEM. A primary response could be facilitated through the creation of a new market (so as not to compete with services offered under existing regulation FCAS) and similarly introduce positive factors or incentive payments for quality performance. For example, the viability of a 'deviation pricing mechanism' could be explored to efficiently value the provision of frequency services under normal operation, progressively ramping up the $/MWh price offered as the level of deviation increases.
- Tesla points to the UK's introduction of an 'Enhanced Frequency Response' (EFR) service through direct contracting, with National Grid citing significant economic benefits and operating a procurement level of only 200MW in conjunction with tighter deadbands than the NEM – allowing EFR to be largely satisfied by fast responding inverter based technologies competing on price. The AEMC could build on this model (and avoid incentivising single-use, short-duration assets), by also allowing service stacking - with tenders for PFR requiring: high response accuracy; fast response (e.g. <500ms); and complementary service provision (e.g. availability in other FCAS markets). Different contract specifications could be designed to ensure an appropriate mix of fast and slow start technologies to ensure adequate PFR levels.