Tesla Motors Australia, Pty. Ltd.
546 Gardeners Rd
Alexandria NSW 2015

Australian Energy Market Operator
530 Collins Street
Melbourne VIC 3000

via email: **gpsrr@aemo.com.au**

4 July 2025

RE: 2025 General Power System Risk Review Report – Draft

Dear GPSRR Team,

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide feedback to AEMO's 2025 General Power System Risk Review (GPSRR Report) – Draft.

Tesla's mission is to accelerate the transition to sustainable energy. A key aspect of this will be using smart, grid-forming inverters to support the increased penetration of variable renewable energy in the grid. Battery energy storage systems (BESS) are highly flexible and can value stack across a multitude of services, including energy arbitrage, Frequency Ancillary Control Services (FCAS), and Essential System Services (ESS) like inertia and system strength. In Australia, Tesla has a pipeline of 4.5 GW / 12 GWh+ of grid-forming batteries installed or under development across Australia, including the globally acclaimed Hornsdale Power Reserve (HPR) in South Australia.

Tesla welcomes AEMO's GPSRR Draft Report, which covers a broad range of current and emerging risks that reflect the evolving conditions and generation mix of the NEM. In particular, Tesla supports AEMO's recognition of the critical role that BESS can play in addressing many challenges, such as inertia shortfalls and Minimum System Load (MSL). Tesla's response to the GPSRR Draft Report reflects the structure of the Report, with comments and feedback on the relevant areas to Tesla's expertise across the following four sections:

1. Inverter-based resources (IBR) response to remote frequency events
2. Minimum system load (MSL)
4. Increasing risks of non-credible contingencies
5. Current and emerging system operator risks

Tesla looks forward to continued engagement with AEMO and actively participating in ongoing discussions on the finalization of the GPSRR.

Kind regards,

Tesla Energy Policy Team

energypolicyau@tesla.com

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1. IBR response to remote frequency events

The Draft GPSRR Report acknowledges the many operational and performance benefits to the power system of having BESS, including its fast active and reactive power response capability, and emerging provision of new services and capabilities. Tesla strongly aligns with AEMO's findings and looks forward to continuing to explore new applications and use-cases for BESS to support power system needs.

Tesla welcomes AEMO's modelling that identified there was no current risk for BESS locational concerns and that aggregated BESS frequency response is not an issue for the NEM. While AEMO considered the risk of BESS being concentrated in one location, potentially led to stability concerns, the BESS development landscape in the NEM sees a healthy pipeline across all NEM regions, and Tesla does not see a material risk of BESS development in South Australia only. Therefore, Tesla supports AEMO's findings that the most credible pathway in the modelling here is BESS are integrated across all NEM regions, leading to the stability threshold across the Heywood interconnector and the magnitude of the resulting frequency excursion are both improved.

Similarly, Tesla strongly aligns with AEMO's position that there are benefits of an aggressive frequency droop setting to the power system, as well as the BESS owner. If an NSP or AEMO were to mandate a 4% frequency droop configuration, this would have material impacts that could deter future investment. Furthermore, in Figure 7, while AEMO compares the levels of damping across various frequency droop settings, Tesla notes that a more important consideration is whether the BESS modelled are grid-following or grid-forming. Grid-forming BESS will provide better damping capabilities and is a more significant modelling assumption than the frequency droop response.

Tesla agrees with AEMO's statement that BESS can be used to support challenging operating conditions such as LOR or MSL. While not a suggestion within the draft GPSRR report, Tesla reiterates the general push back from industry when government underwriting schemes such as the CIS or LTESA, included an LOR related operational requirement clause, given that BESS inherently address LOR or MSL issues given market dynamics and following the price signal. Rather than using restrictive directions or operational requirement clauses, Tesla supports the use of opt-in contracting or new services created.

Tesla supports AEMO's acknowledgement of the synthetic inertia capability of grid-forming BESS to respond to changing operating conditions and retirement of traditional synchronous generation. While Tesla has demonstrated its grid-forming capability to provide inertia through site data, including the ARENA-funded Hornsdale inertia trial[1], there are still challenges in their acceptance, including in the existing RIT-T process and the AEMC's draft decision to not further consider the operational procurement of inertia (discussed further in this consultation).

Similarly, Tesla aligns with the voltage support capabilities of grid-forming BESS, and the benefits that can be unlocked through developing BESS in strategic locations. However, Tesla notes that are currently no incentives for such development, and AEMO should consider utilising NSCAS or transitional services contracts for voltage support.

Tesla supports Recommendation 1 of the GPSRR and encourages greater exploration of how to appropriately incentivize and compensate damping and voltage support services.

2. Minimum System Load

Minimum System Load (MSL) is another emerging risk in the NEM due to the declining minimum operational demand caused by an increase in distributed PV.

From a utility-scale storage perspective, Tesla does not support the use of directions to manage MSL risks, given the uncertainty in the directions compensations framework for non-energy directions (such as for maintaining a minimum state of charge in the lead up to an MSL period).

[1] https://arena.gov.au/assets/2024/09/Neoen-HPRX-Final-Project-Report_2024.pdf

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Comparatively, the Type 1 Transitional Services procurement for a contracted service with large-scale BESS are preferable, given their opt-in nature and simplicity relative to the directions compensations framework. As a longer-term solution to managing MSL risks, Tesla encourages an initiation of the Clean Energy Council's rule change request to create a new market ancillary service – the minimum system load (MSL) reserve service. This would be a co-optimised ancillary service for the provision of defined volumes of load response to help AEMO manage the system security issues associated with minimum system load events. From a residential-scale storage perspective, Tesla aligns with AEMO's statement that greater investment and coordination of CER will similarly address MSL risks.

More generally, Tesla notes that a benefit of grid-forming BESS is that even when they are acting as load, they can still provide inertia (noting there is less negative power headroom while charging_ and system strength, which may reduce the level of minimum synchronous generation required in the MSL thresholds.

Tesla broadly supports Recommendations 2 and 3 of the GPSRR.

4. Increasing risks of non-credible contingencies

Tesla supports AEMO's review of the increasing contingency sizes of current non-credible contingencies, given the rapidly evolving state and operation of the NEM, and particularly supports greater consideration for 4.1.2 system strength and inertia impacts and 4.1.4 severe weather impacts. Both these challenges demonstrate the benefits of a dispersed procurement of system strength and inertia from a range of grid-forming BESS, promoting system resiliency in the event of a non-credible contingency.

In Figure 11 Hypothetical contingency scenario, AEMO outlines the operational challenges around an N-1 contingency for a transmission line that supports a large volume of generation, such as within a REZ. In addition to the mitigation measures considered by AEMO, Tesla notes the application of BESS as virtual transmission to address such challenges.

5. Current and emerging system operator risks

5.1 Retirement of synchronous generation and system strength impacts

Tesla challenges some of AEMO's assumptions on the role of fault level for protection and voltage control systems. While today, the main application for fault current is to distinguish between a fault and normal operation in protection relays, almost all transmission networks already use differential relays for primary and distance for backup rather than legacy overcurrent relays for their protection schemes.[2] For the distribution network that still uses overcurrent protection relays, a deep fault in distribution is a shallow fault in transmission – therefore there is not a significant overload contribution required. Furthermore, as we see an increase in generators, the base MVa will increase with more plants contributing to fault current, reducing the need for significant overcurrent capability.

Consequently, Tesla encourages AEMO to consider an area of future research to review the appropriate requirements for reliable protection relay operation within distribution networks, by surveying existing distribution network over-current protection settings, including relay pick-up levels, delays, and margins.

Similarly, with respect to the role of fault levels in supporting the stable operation of voltage control systems such as capacitor banks, reactors, and dynamic voltage control devices, Tesla notes the following:

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[2] Powerlink, "Protection Design – Standard Version 11.0", December 2024

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- Capacitor banks and reactors do not require fault current to operate.
- Power electronic-based devices, such as STATCOMs or D-VARs, may depend on fault level for stable operation.
- SVCs, by contrast, typically do not require much fault current support.

Tesla also notes that grid-forming batteries are capable of providing dynamic voltage control even when their active power output is zero. In contrast, synchronous machines are generally not expected to provide voltage support when operating at zero active power output. Therefore, requiring grid-forming batteries to provide uncompensated voltage support at zero power output is not consistent with conventional expectations for synchronous machines. Such services should be appropriately compensated and not treated as a free obligation by TNSPs.

Tesla fully supports AEMO's identification of the challenges with engaging with SSSPs on system strength solutions and expands on the barriers within the existing RIT-T procurement process, especially the time requirements. Technology is evolving at a faster rate than the procurement rounds in the regulatory processes. Reforms could include ensuring technology neutrality in the regulatory design by re-evaluating the total economic cost framework. Non network options like batteries provide multiple services to multiple parties which are not captured as "total economic benefits", artificially inflating their cost relative to alternative single-use assets. Making the RIT-T open and transparent will allow for more flexible and efficient market participation.

5.3 Small Signal Stability

Tesla encourages AEMO's consideration of the small-signal stability challenges within the NEM, and consideration for the negative damping of inter-area modes as introduced by synchronous condensers. As various NSPs lean heavily into the procurement of synchronous condensers for system strength, the issue of a lack of damping is likely to become a more significant issue for AEMO. Tesla aligned with AEMO's position in the Draft GPSRR in a previous consultation to the AEMC on the Efficient Provision of Inertia, stating:

Furthermore, synchronous condensers, like traditional synchronous generators, are susceptible to angle stability issues. These occur when a disturbance (such as a fault or sudden change in demand) causes the rotating elements of the condenser to fall out of sync with the rest of the grid. Maintaining synchronisation across a large network is critical for system stability. Historically, angle stability issues were less of a concern because the grid relied on dispersed, centralised synchronous generators with high inertia and coordinated control. Now, with reduced inertia, clustered synchronous condensers, and a more decentralised grid, these challenges are becoming more pronounced. Also, high penetration of synchronous condensers could introduce small signal stability issues in the NEM. These could be subtle, persistent oscillations in the system that can weaken overall grid stability over time. Such risks should be considered by AEMO and the AEMC when considering the future inertia supply mix.[3]

Consequently, Tesla encourages AEMO to explore the consideration of a damping service or contracts through the Transitional Services Type 2 Contracts.

5.8 System restart with the transitioning power system

SRAS has been traditionally provided through large thermal generation which are likely to retire in the coming few years and already face greater reliability challenges. Tesla welcomes both AEMO and the Reliability Panel's exploration of how to broaden the pool of potential SRAS providers, including to inverter-based resources such as grid-forming batteries.

Tesla's grid-forming batteries have the potential to play a significant role in SRAS by providing rapid, controlled power restoration (black-start) across all Australian jurisdictions. Tesla has provided

[3] https://www.aemc.gov.au/sites/default/files/2025-02/Tesla_0.pdf

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black-start capability in other markets, most famously with the 185MW/565MWh Kapolei Energy Storage facility (KES) in Oahu, Hawaii, which is described as the 'ultimate pacemaker for the grid'.[4] The KES's ability to perform black-start functionality, among a suite of other grid-forming services such as FFR and synthetic inertia, means it is possible to retire and replace coal powered generation and functionality.

However, the current SRAS contracts have several structural challenges, including the relatively short contract duration and the procurement timeframes. Tesla welcomes further discussion on this topic, but notes that SRAS contracts will likely have to be confirmed with grid-forming BESS early in the plant site design, and have a greater tenure, to be appealing to BESS developers.

5.10 Maximum allowable active power ramp rates

Tesla does not support AEMO's exploration of introducing additional control schemes designed to prevent the unintended operation of BESS active power ramping in 5.10.4 and seeks further clarification on defining 'unintended operation'. Tesla welcomes further discussion with AEMO to find appropriate pathways to address any risks associated with rapid active power ramp rates. BESS contributes to R1/L1 FCAS and can therefore help reduce system inertia requirements, particularly as the NEM transitions to higher levels of renewable energy penetration. If fast ramping is a concern, BESS can mitigate this by adjusting its droop settings or by constraining its power output.

5.11 Limited visibility of participant systems

For 5.11, Tesla acknowledges AEMO's concerns around the limited visibility of system participants for CER – noting this is seeking to be addressed through the implementation of the Integrating price-responsive resources into the NEM Rule Change [5]. Another key area to address this challenge is through the work on developing National Technical CER Regulator to set appropriate standards, monitor conformance and improve outcomes, noting this is dependent on the legislation being introduced in 2026.

5.12 Generator compliance

Within 5.12.1, Tesla strongly aligns with the risks to power-system security from the non-compliance from synchronous machines close to retirement, with greater scrutiny required to ensure a secure power system. Tesla also seeks further clarification from AEMO regarding 5.12.4, given PFR is typically tested during the hold-point testing process. Similarly, while Tesla acknowledges the oscillatory challenges addressed in 5.12.5, there are inherent challenges with attempting to address this through benchmarking plant models. However, the model can be used to investigate oscillations given they are native and representative of the specific plant behaviour.

5.13 Inverter limit violations due to inability of generator response

Regarding 5.13, Tesla recommends that this consideration is limited to grid-following inverters only, as grid-forming inverters play a key role in supporting system security.

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[4] https://www.canarymedia.com/articles/energy-storage/hawaii-building-huge-new-battery-bidding-farewell-to-coal
[5] https://www.aemc.gov.au/rule-changes/integrating-price-responsive-resources-nem