Tesla Motors Australia Pty Ltd.
Level 14, 15 Blue St
North Sydney
NSW 2060

AEMO

Submitted via email: planning@aemo.com.au

1 June 2022

RE: Amendments to AEMO instruments for Efficient Management of System Strength Rule – Issues Paper: Tesla response (PUBLIC)

Dear AEMO,

Tesla Motors Australia, Pty. Ltd. (Tesla) welcomes the opportunity to provide a response to AEMO's instruments for Efficient Management of System Strength Rule – Issues Paper (the Issues Paper). We recognise the important role battery storage systems can play to support the NEM's transition, aligning with Tesla's mission to *accelerate the world's transition to sustainable energy,* and are motivated to support AEMO's implementation and efficient management of the new system strength rule. More generally, we look forward to continuing to work with AEMO and TNSPs to facilitate streamlined connection of battery storage, and more specifically, to address existing barriers faced by grid-forming (advanced) inverters.

We remain highly engaged in the development of all NEM frequency, system security and system strength reforms, and associated access and connection standards and requirements, and believe they will play an important role in unlocking the integration of storage at scale to underpin a reliable, secure, and affordable electricity system. We commend AEMO's Integrated System Plan, which highlights the critical benefits of up to 60GW of storage being deployed to support the transition, complementing investments in renewable generation and network infrastructure. As a global leader in clean energy products and the largest provider of battery storage systems across Australia, Tesla is focused on working with all stakeholders to help create clear, consistent, and fit for purpose market rules and instruments, including the System Strength Requirements Methodology (SSRM) and System Strength Impact Assessment Guidelines (SSIAG), to ensure system strength requirements continue to be met efficiently and effectively.

The following note outlines Tesla's response to relevant questions raised in the Issues Paper. These observations are based on our experience designing, developing and deploying over 1GWh of grid-following and grid-forming battery storage systems across the NEM to date, including the 50MW/75MWh Wallgrove Grid Battery project (with TransGrid / Lumea); and the expanded 150MW/194MWh Hornsdale Power Reserve (with Neoen) – both trialing Tesla's Virtual Machine Mode (VMM) grid forming inverter capability. Tesla has also recently been selected by Edify to build their 150MW/300MWh battery at Darlington Point, which will include grid-forming inverters from the outset.

Summary of Tesla recommendations:

- **Storage proponents need more confidence in a streamlined connection process for advanced inverter capabilities and industry (including SSSPs) need greater upfront clarity on how the new system strength assessment framework will apply.**
- **Tesla recommends AEMO appropriately consider what provides the best balance between modelling complexity / resource requirements and sufficient accuracy at a first approximation for what impact IBR has on system strength provision going forward, and views the first EMT option as the likely best outcome, acknowledging that it is time consuming.**
- **Worked examples of a battery system with grid-forming inverter capabilities would be beneficial to help demonstrate and clarify our current understanding that these types of assets should have zero system strength charges applied (as a connecting generator / integrated resource provider), whilst also being viewed to positively contribute to system strength remediation.**
- **There would be significant benefit if Advanced Inverters had a clear pathway to connect with access standards appropriate for allowing the full benefits of virtual synchronous machines to be realised (for example a pathway similar to that for synchronous generation or a hybrid of the asynchronous and synchronous generation pathways).**

Noting the highly technical nature of this consultation, we would welcome the opportunity to workshop any of the points raised in our submission, and would look to include our experienced in-house power systems engineering teams in discussions to clarify and expand on any areas of interest to AEMO.

Yours sincerely,

Tesla Energy Team

Energypolicyau@tesla.com

ONGOING PROCESS

As noted above, Tesla remains highly engaged in the development of all NEM frequency, system security and system strength reforms, and recommends an overarching long-term strategy tying these processes together in order to underpin a secure transition (i.e. requisite system strength, inertia and frequency requirements) to achieve 100% VRE penetration. This will be vital not just as part of AEMO's detailed engineering framework and ISP work, but also ensuring NSP requirements and standards and related NER clauses are updated by AEMC / ESB and are complementary to this vision.

In particular, Tesla recommends AEMO (working with AEMC as relevant) provide a clear pathway for grid-forming inverters to provide not just system strength, but other critical grid services. As part of this, Tesla recommends AEMO:

- Considers extended performance data from HPR, Wallgrove, and other systems that are operating with advanced inverters. With a detailed assessment and comparison to equivalent synchronous condenser performance to cement confidence in the capabilities of the technology for all stakeholders.
- Builds in learnings from both the Victorian RDP process (and potentially ongoing projects) and the ongoing ARENA Large Battery advanced inverter funding round.
- Ensures upcoming inertia, reactive current requirements, and PFR rule changes further build on these learnings.

Lessons learnt will provide opportunities to implement and streamline the connection process for future advanced inverter projects, including the opportunity to progress 5.3.4A/B directly, eliminating the need for a separate 5.3.9 modification application to better enable advanced inverter functionalities.

Through Tesla's experience we continue to build knowledge and understanding across industry and stakeholders more broadly, and welcome AEMO's consultation process to develop effective system strength instruments to build on these lessons and capture developments in technology capabilities.

Overview of barriers to Grid-forming Inverters

Updating and developing fit for purpose instruments to enable system strength provision will be critical to accelerate demonstration of advanced inverter capabilities, overcome existing barriers, and improve industry understanding to accelerate deployments. Currently, both project developers and system strength service providers (SSSPs) are hesitant to explore grid-forming inverters as a potential remediation solution and supplier of system strength, given the additional complexity to connect (i.e. higher costs, longer time) and uncertain treatment under the system strength framework (both existing and proposed).

In particular, if connecting in a 'weak' part of the grid, projects are likely to consider traditional synchronous solutions over grid-forming inverters (despite commercial benefits of battery systems) purely to mitigate the additional uncertainty of connection risks or assessment processes.

Storage proponents need more confidence in a streamlined connection process for advanced inverter capabilities (given the connection process is already the key bottleneck for projects), and **industry (including SSSPs) need greater upfront clarity on how the new system strength assessment framework will apply** (i.e. projects cannot face additional delays and/or costs). We believe AEMO is well placed to work with industry to achieve these objectives.

Relevant questions raised in the Issues Paper

Assessment of stable voltage waveforms in the future

We note the three options outlined in AEMO's Issues Paper:

1. Apply generic EMT models as a 'stand-in' for plant that has not been committed or connected.
2. Available fault level calculation, using an RMS-based proxy study method.
3. Simplified switching studies to test voltage robustness.

Tesla recommends AEMO appropriately consider what provides the best balance between modelling complexity / resource requirements and sufficient accuracy at a first approximation for what impact IBR has on system strength provision going forward. From the perspective of battery inverter models, Tesla views the first EMT option as the likely best outcome, acknowledging that it is time consuming. Option 2 is not considered appropriate for assessing inverter-based resources (IBR) and is not recommended (we note that available fault level is a proxy value – and does not provide any detailed insight into the actual network condition – e.g. there are connection points with 0 or negative AFL – which does not make sense in practice). Tesla is open to consider Option 3, but would require further detail to understand how it would apply in practice to battery systems (both grid-forming and grid-following). Tesla would welcome a technical workshop on the subject to further unpack these issues and trade-offs across the Options and explore any viable alternatives not yet considered.

Assessment of grid-forming inverters

Tesla seeks greater clarity on how AEMO will implement the updated methodology to be used in calculating System Strength Locational Factors (SSLFs), *"which must be representative of the impedance between the connection point and the applicable system strength node, and use available fault level as the basis for the methodology"*, and how this is intended to align with the criteria for a stable voltage waveform in practice. In other words, more detail on how the new standard also known as the 'efficient' level of system strength will be applied to grid-forming inverters, noting it "*can be met by any means, not limited to fault level"*.

Ideally, AEMO can propose a methodology which also accounts for actual grid impedance and essentially differentiates between "low impedance & low short circuit systems" vs "high impedance & low short circuit systems". In general, Tesla believes the proposed voltage and angle sensitivity indices would be a better indicator compared to SCR.

In addition, AEMO should also establish a protection only minimum short circuit-level guidance so that "controls" (ie Grid forming inverters) and protection short circuit MVA can be segregated. Protection remains an independent issue and industry would benefit from having AEMO treat it separately.

For all of the above reasons, worked examples of a battery system with grid-forming inverter capabilities would be beneficial to **help demonstrate and clarify our current understanding that these types of assets should have zero system strength charges applied** (as a connecting generator / integrated resource provider), whilst also being **viewed to positively contribute to system strength remediation** (as a potential supply side asset to support system strength contributions for individual plant and/or SSSPs). We note this is shown in equation form on page 47 of the issues paper, where AEMO proposes the following redefined AFL methodology:

$$AFL(MVA) = S_{SG} - k * \alpha * ES_{rated} * SCR_{\_withstand}$$

k: Technology coefficient, where:

k = 0 when grid forming IBR (not used for SSS)

k = -1 when grid forming IBR is used for SSS

k = 1 for grid following IBR and HVDC links (for grid forming HVDC, the k factor shall be decided on a case-by-case basis in consultations with OEM and AEMO).

It would benefit industry if **AEMO could clearly confirm the above interpretation for battery systems with grid-forming inverters** through the next phase of the consultation and/or via any supplementary guidance notes that can be developed to inform project proponents.

<u>Maintaining synchronism of distributed energy resources (DER)</u>

Tesla is keen to understand AEMO's thinking on this issue and would welcome a follow up workshop to discuss. In general, we note that active DER offers much greater value than passive DER and should be incentivised to help contribute to system stability and reliability outcomes.

A key feature and underlying principle of all reform should therefore be that orchestrated, controllable, 'active' DER is better for the electricity network than passive DER. Orchestrated DER can be used to provide valuable market and network services (e.g. frequency control ancillary services, fast frequency response, inertia, voltage support, peak demand reduction and a variety of other new and emerging services). Orchestrated DER can also be optimised to respond dynamically to network and market signals to ensure that AEMO's system operations are supported across both distribution and transmission layers.

However, the ability for the industry to make the shift from passive to active DER is dependent on customers being incentivised to hand over control of 'their' DER; and on operators, aggregators, and service providers investing in the engineering development for products, platforms and optimisation software, as well as understanding the associated regulatory and legal compliance burden from providing these services. If this upfront cost and burden outweighs the incentives, and the customer has a choice in passive DER as an alternative, then the DER industry will likely self-select a focus on passive DER, which would be a sub-optimal long-term outcome and likely result in unnecessarily heavy handed 'blunt' mitigations such as mandatory remote disconnection that has been recently considered.

Related barriers in the Rules

Beyond the specific system strength instruments, Tesla observes that an unintended consequence of the current Rules (notably the access standards in Schedule 5.2 for asynchronous generation) is that a project with grid-forming inverter technology is assessed against access standards that appear more suited to asynchronous generating systems that are of a grid-following nature, which can trade-off some of the benefits offered by advanced inverters. Ideally the Rules would promote these grid-forming technologies and encourage targeted system strength capabilities that actively support grid stability with high levels of IBR, delivering more beneficial outcomes for the power system overall. **There would be significant benefit if Advanced Inverters had a clear pathway to connect with access standards appropriate for allowing the full benefits of virtual synchronous machines to be realised (for example a pathway similar to that for synchronous generation or a hybrid of the asynchronous and synchronous generation pathways).** Tesla would welcome a technical workshop on the subject to further unpack these issues and associated trade-offs.