TESLA

John Kim

Australian Energy Market Commission (AEMC)

Submitted online

31 March 2023

Dear John

Re: Efficient Provision of Inertia (ERC0339)

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide the Australian Energy Market Commission (AEMC) with our submission to the Efficient Provision of Inertia Consultation Paper.

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 Electricity Market (NEM) in a manner that is efficient for consumers, timely for system operations, and sustainable over the long-term.

Accordingly, we recommend AEMC assess the costs and benefits of all reforms against not just costs to consumers, but also include an emissions reduction criterion. For new system service market considerations, we recommend AEMC seek to structure any new market or mechanism in a way that enhances the integration of new, low-emission, secure, low-cost energy technologies into the NEM (and avoid any unnecessary additional payments to high-emission, high cost, high risk ageing thermal plant). This will be particularly important as the work underway to include emissions in the National Electricity Objective (NEO) has not yet been finalized and as such will not be considered within the scope of this rule change.

While Tesla believes that emissions reduction is an integral component of the Australian energy transition and should be considered as a key feature of all AEMC considerations while the NEO change is being adopted, we are also supportive, in principle, of the work being done to monetise new services that effectively enable the energy market transition.

Grid-forming battery energy storage systems (BESS) assets will be critical to providing grid inertia in a 100% renewable energy grid. The major challenge in setting a BESS up as a grid-forming, rather than grid-following, asset is that there is no financial incentive to do so. To date the drivers for establishing grid-forming mode have been support from state-based policies (such as the South Australian Grid Scale Service Fund (GSSF) and the Victorian Renewable Energy Zone (REZ) Development Plan) or through federal ARENA funding. While there is some positive early signs, it is unclear the extent to which these programs will support the future minimum inertia requirements of the grid.

To this end, Tesla is supportive of the following work being done:

- AEMC working on a more detailed technical study that looks at the inertial requirements in the changing grid, including the interactions with system strength.

- More structure put around both the spot market approach and the alternative approaches outlined in the consultation paper to enable a more fulsome consideration of the risks and benefits of each option – our initial views are included in the body of the response.
- Aligning on a more inclusive, technology agnostic approach to participant eligibility.

Tesla has significant in-market experience with the deployment of grid-forming inverters and we can continue to support the AEMC with understanding the technical capability, process or regulatory challenges, and market drivers for enabling grid-forming mode.

For any questions in respect of this submission, please contact Emma Fagan (efagan@tesla.com).

Kind regards

Emma Fagan

Response to Consultation Paper questions

1. Technical information on inertia

Need for additional technical information

Tesla is very supportive of additional work being done to support the consideration of the actual inertia shortfall expected across the grid as we move to a 100% renewable energy grid. A technical assessment of inertia should include the following:

- Inertia needs for all jurisdictions in normal operating conditions and when islanded.
- Levels of inertia provided by existing synchronous fleets with known retirement dates
- Levels of inertia provided by utility scale batteries that are, or will be, operating in grid-forming mode (i.e. Hornsdale Power Reserve[1], Wallgrove Grid Battery[2] and the Riverina Energy Storage System[3].
- Levels of inertia that will be provided by 2GW of BESS assets which will be deployed with funding from the ARENA Large Scale Battery Storage funding round[4]
- Grid-forming batteries which may come online supported by other state policy priorities such as the Victorian REZ Development Plan
- Levels of inertia that will be provided by all synchronous condensers that are currently operating or planned for deployment
- The level of inertia that can be replaced with fast frequency response (FFR). We note that with the 2020 inertia shortfall in South Australia, AEMO directed that the inertial gap be filled with FFR[5]. If all or some of the long-term inertia requirements can be provided by FFR services then this provides an additional asset pool –virtual power plants (VPPs) and distributed residential batteries that can also address any inertial needs.

We note that in the Consultation Paper, the AEC had noted that an inertia spot market may support efficient entry and exit decisions. In determining the level of technical requirements we believe that the AEMC should consider planned exit and entry as relatively firm, and work backwards to determine the gap. We would see an inertia market or alternative procurement mechanism as being a good driver for continued technology advances, but should not be designed in a way in which it delays plant exit.

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[1] https://www.pv-magazine-australia.com/2022/07/27/hornsdale-big-battery-begins-providing-inertia-grid-services-at-scale-in-world-first/
[2] https://www.lumea.com.au/news/wallgrove-grid-battery-operational
[3] https://edifyenergy.com/energy-storage-systems/financial-close-on-the-largest-approved-grid-forming-battery/
[4] https://arena.gov.au/funding/large-scale-battery-storage-funding-round/
[5] https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-security-market-frameworks-review/2020/2020-notice-of-south-australia-inertia-requirements-and-shortfall.pdf?la=en

Technical studies

An aspect of the proposed AEC rule change which Tesla is not supportive of, is the proposed eligibility criteria. The Consultation Paper makes the following initial participant eligibility recommendations based on the AEC proposed rule change:

- Synchronous generators that are also dispatched into energy
- Grid forming inverters "to the extent that AEMO deems them capable"
- Synchronous generators capable of remaining synchronised at zero generation.

Tesla is concerned that this approach is not technology-agnostic. It assumes automatic eligibility from the synchronous fleet of assets, but allows AEMO to make a subjective call on whether grid-forming inverters should be able to participate.

If a spot market was to be developed as an additional ancillary services spot market, then we would expect that participation eligibility would be determined based on the ability of an asset being able to comply with an updated Market Ancillary Services Specification (MASS). We would not expect that the Rules be updated to include automatic participation for one class of asset, and a subjective assessment for another asset class. We also note that AEMO have already published an “Application of Advanced Grid-scale Inverters in the NEM” White Paper which highlights equivalent inertia capability from grid forming BESS assets as with synchronous machines[6]

Table 2 Performance comparison of grid-connected generation

Service/capability	Grid-following inverter system	Grid-forming inverter system	Synchronous machines
Can contribute to system strength		✓	✓[A]
Can have positive disturbance withstand (active power oscillation damping)		✓	✓
Can have positive disturbance withstand (fault ride-through capability)	✓	✓	✓
Can contribute to system inertia		✓[B]	✓
Can contribute to FFR	✓	✓	
Can contribute to primary frequency response	✓	✓	✓
Can support a power system island with supply balancing and secondary frequency response	✓	✓	✓
Can initiate or support system restoration	✓[C]	✓	✓

A. Synchronous machines can usually contribute to system strength much more than IBR due to their higher overload capacity.
B. A grid-forming inverter system requires energy storage to deliver inertia. See Section 2.4.
C. Grid-following inverters can support but not initiate system restoration.

[6] https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/application-of-advanced-grid-scale-inverters-in-the-nem.pdf

Tesla is also happy to work with the AEMC and AEMO, providing insights to further the technical understanding of how grid-forming inverters can provide inertia services. Tesla has supported the operationalization of a number of grid-forming batteries across the NEM, and we have mature grid models available for the Tesla grid-forming Virtual Machine Mode (VMM) in both RMS and EMT environments which have been the subject to the rigorous assessment under NER 5.3.4A/B and 5.3.9 for NEM connected projects.

Virtual Machine Mode is a feature implemented on Tesla inverters that mimics the behaviour of a traditional rotating machine. The virtual machine component runs in parallel with the conventional current source component.

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. Like more traditional inverters, under stable system conditions, the inverter's behaviour is driven by the current source component. The inverter charges and discharges in accordance with commands received from the operator.

If there is a grid disturbance, the rotating component responds by producing a reactive current in response to changes in voltage and producing an active power response proportional to the rate of change of frequency (RoCoF).

Though these features can be provided by current-source inverters in response to a predefined feedback control mechanism, the rotating component in Tesla's batteries can respond on a sub-cycle basis – responding to phase angle changes (within 10ms) rather than root-means-squared (RMS) values (within 150ms) – mimicking the electromagnetics of a synchronous generator, but with the additional benefit of flexibility and configurability of the response.

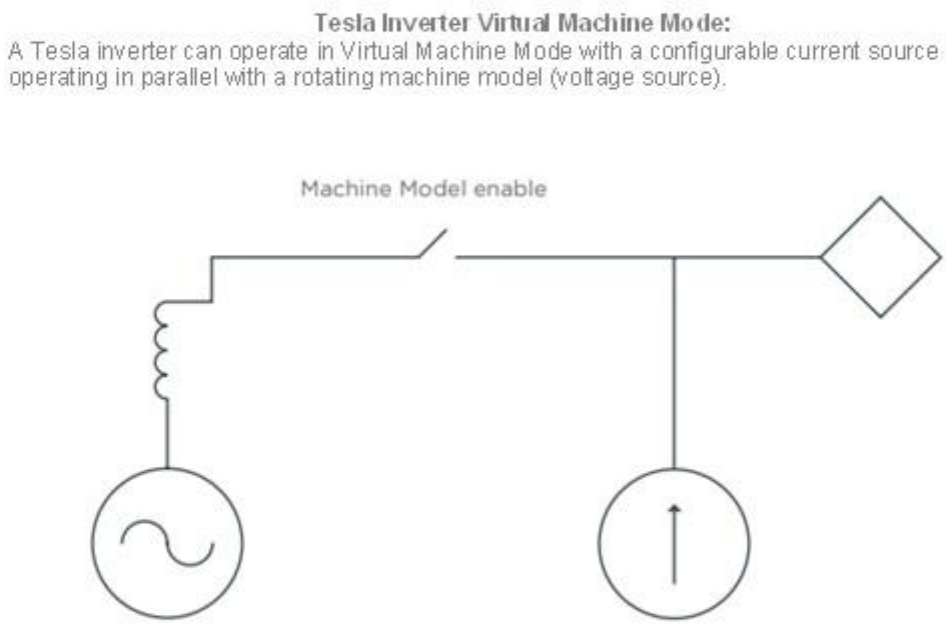

Figure 1: Representation of Tesla VMM

2. Inertia procurement and allocation in real-time

Tesla would like to see more information on how AEMO can reasonably determine the inertia requirements of the grid in real-time. If a spot market approach is progressed, it will be critical that the expected response of eligible assets are based on an agreed static configuration and are not expected to be dynamic in response. Under the current Rules, the inertial constant for a grid-forming inverter is agreed upon at the time of connection and is not able to be changed without going through appropriate change processes defined in the Rules (typically the existing 5.3.9 process).

3. Investment signals for inertia

We understand the concerns raised by the AEC, and as noted above, Tesla is in-principle supportive of new and/or iterative approaches to procuring new services to ensure safe and secure grid operation. A key proposed benefit of the AEC Rule Change is that it will reduce the risk of over-investment in inertia services. Noting that the current procurement approach is based on TNSPs needing to procure sufficient inertia during the event of an island, which is higher than the system inertia needs during standard grid operation.

As per the response to Question 1, we are very supportive of the proposed approach for AEMC to undertake a detailed assessment on inertial needs of the grid in a forward-looking manner. This assessment should consider whether the existing regulatory and procurement framework will necessarily lead to over-investment. As an example, the recent ElectraNet procurement of FFR[7] to address the South Australian inertial shortfall required only that those services be provided (and paid for) in the event that the South Australian grid was islanded, and only for a short window to address the impacts of the initial islanding event.

In considering the alternative solutions put forward – including possible adjustments to existing TNSP procurement frameworks – it would be prudent to consider whether a tiered approach to inertial procurement may be the most cost-effective solution going forward. The AEMC may want to consider whether procurement of inertia is required to manage baseline system requirements – to be guided by the technical review, and whether additional reserve contracts could sit in place for additional services, triggered only by event-based scenarios like an islanding event.

4. AEC solution

Tesla believes that it is too early at this stage to rule out either the spot market, or any of the alternative options.

Some concerns and/or questions that would be helpful to explore in the development of a spot market are:

- How are bids proposed to be submitted and what will the interaction with other ancillary services markets look like? Note that the time-scale of inertia means the same power capacity of the system can be used to provide multiple services across different timescales, i.e. inertia is a complementary service – the same MW used for inertia can be sustained in an FFR / C-FCAS response
- Why would participant eligibility be limited to synchronous generators "dispatched into energy". In the case of a grid-forming inverter, where it is configured to operate in grid-forming mode it will be effectively be armed and

[7] https://www.aer.gov.au/system/files/ElectraNet%20-%202022-23%20Inertia%20network%20service%20cost%20pass%20through%20-%20February%202022%20-%20Application.pdf

able to provide inertia at all times when connected to the grid, notably when providing any grid service – not just when it is dispatched for energy – and even when the system is in an idle (0MW dispatch) state. As such, understanding the relationship with other ancillary services will be critical in informing the preferred approach to procurement.

5. Alternative solutions

At this stage it is too early to definitively rule out any of the alternatives put forward as a preferable option. We expect that this will very much be guided by the additional technical assessment that the AEMC has proposed. In addition to the market approaches noted by the AEMC in their Consultation Paper, we would also consider whether federal or state policy solutions could support with efficient management of inertia in a grid with far higher penetrations of variable renewable energy. As an example, the Victorian Energy Storage Target or the Capacity Investment Scheme could both be developed with design features that create grid-forming obligations for successful assets.