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Nicola Falcon
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via email: isp@aemo.com.au

11/02/2022

RE: AEMO Draft 2022 Integrated System Plan – Tesla Response

Dear Nicola,

Tesla Motors Australia, Pty Ltd (Tesla) welcomes the opportunity to provide AEMO with feedback on its Draft 2022 Integrated System Plan (ISP), building on our previous submissions to the Inputs, Assumptions and Scenarios consultations over the past 2 years.

Tesla commends AEMO's continued efforts and the significant work that has gone into developing detailed and transparent modelling across the spectrum of engineering and system challenges faced by the National Electricity Market (NEM), and in particular the time spent working closely with industry and government on refining the ISP since first publication in 2018. The finalised 2022 ISP will continue to drive Australia's energy market discussions forward, and will undoubtedly be used as a credible reference for the next tranche of critical energy policy decision making.

Tesla's submission focusses on storage, recognising it will play a critical role in a highly renewables grid, and the storage mix in Australia will likely include a portfolio of long-duration pumped-hydro energy storage, grid-scale battery storage, and distributed energy resources operating both as coordinated virtual power plants and stand-alone distributed assets. Ultimately, this mix will be driven by investment and market factors, technical need, policy drivers and deployment flexibility, and the commercial value of each new project will need to be assessed against alternative technologies and applications.

Specifically, Tesla recommends AEMO's final 2022 ISP is **(1) more clear on the role of grid-forming inverters** (aligning with the Engineering Framework objectives); **(2) incorporates the full value of storage assets** beyond simply energy time-shifting (aligning with actual investment and policy decisions and ensuring a credible storage capacity mix forecast); and **(3) recognises battery storage now outcompetes gas peaking plant** as the preeminent firming technology.

Tesla looks forward to continued engagement and actively participating in ongoing discussions to support AEMO in the finalisation of the 2022 ISP.

Kind regards

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Embedding the role of grid-forming inverters

We recognise a key priority of AEMO's is to ensure system security and reliability in the decade to come as the NEM transitions from centralised thermal assets towards a largely renewable and distributed, flexible fleet of assets. We also note the leading work by AEMO in defining the technical challenges emerging with renewable penetration rapidly closing in on 100% of generation. Of particular note is the decoupling of essential system services such as inertia and system strength to drive investment in, and incentivise provision of, these critical services going forward. AEMO's publication of the Advanced Inverter White Paper[1], alongside the wider Engineering Framework[2], has provided industry with a clear roadmap highlighting how these technical challenges already have the requisite technical solutions, with the outstanding issue being how to deploy the solutions at scale and ahead of the inevitable early closure of coal plants.

Within this context, our recommendation is for AEMO take a more consistent view of the role of grid-forming (advanced) inverters across its 2022 ISP and parallel engineering and system security publications. We understand the ISP focuses on optimised modelling for resource adequacy (assuming essential system service requirements are solved as necessary), but this does not preclude AEMO highlighting the role that grid-forming battery storage will need to play beyond simply time-shifting of energy, and alongside other storage technologies, the full suite of services that will be provided to support the transition to an efficient, secure and low-emission future NEM.

As a practical demonstration, we point to ARENA's recently announced ARENA's $100m Large Scale Battery Storage Funding Round[3] that aligns with this ambition, and will help build momentum for grid-forming batteries, and ultimately lead to a removal of the spectrum of technical, regulatory, and commercial barriers currently holding back streamlined deployments at scale. As ARENA state (consistent with AEMO's Advanced Inverter White Paper):

> *"Advanced inverters enable grid scale batteries to provide system stability services traditionally provided by synchronous generation, such as coal or gas. Finding new ways of providing stability to the electricity system will enable the grid to operate with higher shares of variable renewable energy."*

Whilst relatively new to Australia's national electricity market, grid-forming battery storage systems are well-known and a long-proven technology globally, particularly in microgrid environments that are seeking to manage energy systems at 80-100% renewable penetration with solely renewable and storage assets. Virtual Machine Mode is a 'grid-forming' feature implemented on Tesla inverters that mimics the behaviour of traditional rotating machines, effectively matching or outperforming the functionality of synchronous condensers ('syncons') across key network features. In practice, this means Tesla Inverters operating in Virtual Machine Mode can provide inertia and fast acting voltage smoothing to support regions of low system strength. For example, once coal retires, system strength can be provided by:

- Syncons (single-purpose, single-application, limited dampening, longer deployment, stranded asset risk); *or*
- Grid-forming batteries (active harmonic dampening, configurable settings, multiple applications, flexible and expanding role in market, quicker deployment)

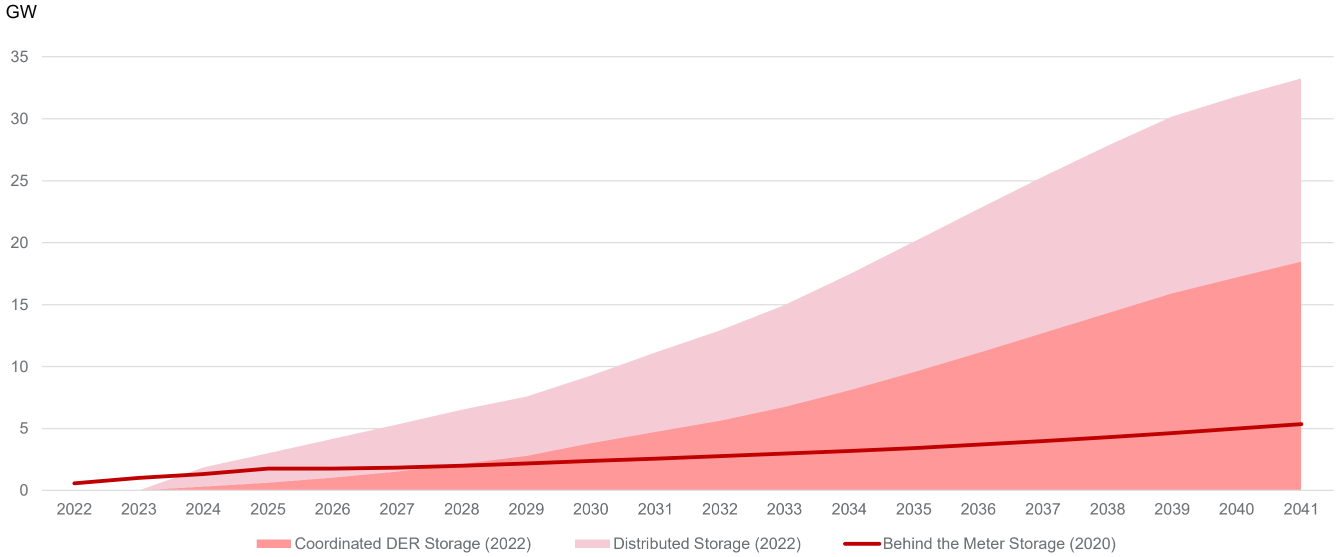
Given a single battery can be used for system strength and a suite of other services (i.e. energy, frequency, inertia, voltage stability etc.) batteries provide lower net present cost & higher value for consumers. Both Hornsdale Power Reserve in South Australia and the Wallgrove Grid Battery in NSW will expand their suite of system support services through Virtual Machine Mode, offsetting the need for synchronous condensers, reducing the risk of stranded assets across the NEM, and ultimately reducing overall network capital spend required for network infrastructure upgrades.

[1] AEMO Application of Grid-scale Inverters in the NEM – August 2021
[2] AEMO Engineering Framework
[3] ARENA Grid-forming Battery Fund

Recognising the full value of storage assets

It is clear from the over 2x multiple in NEM storage deployments (relative to AEMO's 2020 ISP Step Change results for 2040) that the role of all forms of storage across all durations is becoming increasingly critical, ultimately reaching 60GW of storage capacity by 2050. This is particularly noticeably in the explosion of behind the meter assets (both coordinated and distributed), which AEMO forecast to 6x between now and 2040 (relative to 2020 ISP figures):

Figure 1: Behind the meter deployments forecasts have expanded and accelerated relative to 2020 ISP



These projections for DER are a welcome vision of the future, and if achieved would underpin a lower cost, more sustainable NEM. However, significant market and policy reforms are still required in support, many of which are at various stages of design, consultation or implementation – including establishing a clear governance framework for technical standards, developing and implementing dynamic network tariffs that recognise and reward the value of DER and VPPs (including smart charging electric vehicles) which collectively can provide a significant controllable load 'fleet' that can help mitigate minimum operational demand risks and provide critical power system balancing functions.

For shorter duration grid-scale battery storage however (where deployments have reduced relative to 2020 numbers), it remains unclear as to whether AEMO is appropriately considering the full value stack of services that will likely be provided. To ensure this full stack is incorporated, Tesla recommends enhancing the ISP modelling approach to consider the full value potential of storage beyond simply energy time-shifting applications. In particular, AEMO's modelling can incorporate the additional capabilities and flexibilities beyond energy generation provided by both stand-alone battery storage (e.g. ancillary services, inertia contributions and system security benefits) as well as hybrid battery assets when paired with renewables (e.g. reduced curtailment, improved marginal loss factors, reduced causer pays liabilities).

This will more accurately reflect the role and value of battery storage and better map to actual and expected market behaviour relative to other generation and storage plant, without relying on sensitive forecast capital cost comparisons based on energy related costs ($/kW or $/kWh) - which should be used with caution for informing optimal investment decisions. In other words, without incorporating the additional value streams provided by ancillary, network and system services beyond simply energy time-shifting, the value of batteries remains significantly understated and does not accurately reflect the NEM's investment reality – and will lead to a disconnect between AEMO's resource adequacy forecasts, and the likely deployment outcomes based on market and policy settings.

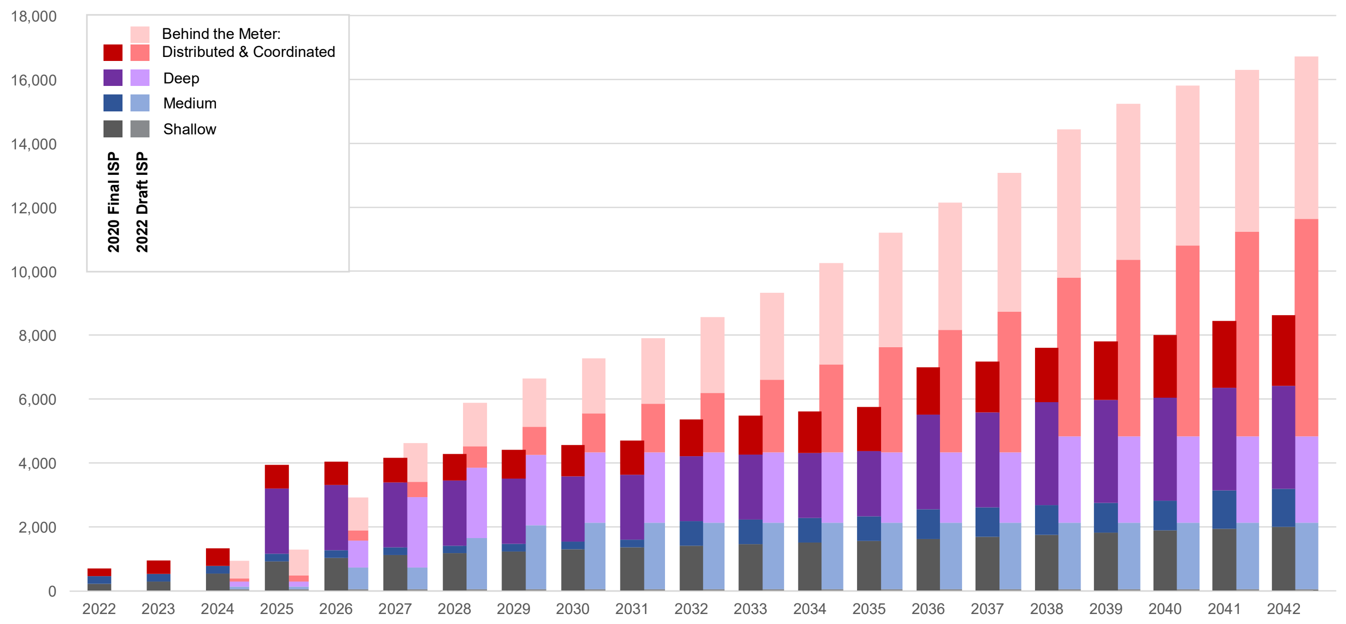
Today's commercial assessments are also increasingly considering storage as a 'firming asset' with renewable generation (i.e. solar/wind and storage). This provides a more holistic benefit to replacing retiring thermal plant, rather than simply viewing storage as a form of stand-alone peaking generation. For new hybrid projects, this means the direct benefit of providing a higher return in revenue from the renewable generator, as well as several secondary benefits such as the ability to sell the 'firmed renewable' energy in blocks back to the market, and the ability to mitigate dispatch imbalances and associated charges (i.e. causer pays factors). AEMO's current approach to ISP modelling appears to neglect (or at least downplay) the contribution of these values, despite increasing interest in exploring market mechanisms that will recognise them in practice.

Accordingly, to ensure a credible model of future generation and storage capacity, AEMO must find a way to incorporate the full range of potential ancillary, network and system service benefits of battery storage, beyond solely energy generation. One alternative approach could include reducing the upfront capital cost of battery storage deployments by a 'factor' to reflect that some portion of the asset will be paid for and used by network utilities for network services (e.g. in lieu of deploying synchronous condensers), whilst the remaining capacity can still be market facing and provide energy and frequency services. For example, even if sycons are used as the proxy cost for system strength, it is clear grid-forming batteries can provide much of this service going forward – so whilst the ISP optimises build costs driven by resource adequacy requirements, the model could still 'discount' the cost of batteries noting their broader applications beyond energy.

Taking this approach will also (helpfully) dampen the influence of state government policies that can be seen to drive big sensitivities in the mix of deployments. For example, NSW's Electricity Infrastructure Roadmap with targets to deploy 2GW of (at least) 8-hour[4] storage assets (limited to energy-only considerations) clearly acts as a forcing function on ISP modelling, pushing the state away from the previous 2020 ISP least-cost system that showed mainly shallow (~2GW) and medium storage (~1GW) deployments are required by 2040 to complement the build out of Snowy 2.0's 'deep' storage. Following the Roadmap's legislation, the 2022 Draft ISP figures now include only 50MW of shallow storage by 2040 (effectively replaced by some medium and a large expansion of behind the meter storage uptake):

[4] NSW policy also remains ambiguous as to whether partitioned storage assets (e.g. a 200MW / 400MWh system de-rated to 50MW with 8-hour storage) will be eligible

Figure 2: NSW Storage by Type: Final 2020 ISP vs Draft 2022 ISP Capacity – Step Change Scenario
MW



More generally, longer duration requirements should not be restrictive for different technology types. Batteries are modular and complementary, such that two independent 2-hour systems may be deployed and concatenated to provide up to 4 hours of duration, or two 4-hour battery systems are able to provide up to 8 hours of depth for intraday energy shifting etc – in much the same way that behind the meter batteries can be aggregated and considered as a fleet when part of a VPP. AEMO must recognise that even if this deployment approach does not satisfy a least-cost system wide optimisation pathway, it is still a likely outcome based on project by project investment decision factors that will be considering market returns, the ability to use co-located assets as a hedge (e.g. for MLF or causer pays reductions), optionality and deployment flexibility benefits, or be influenced by other direct policy interventions. Moreover, in practice this approach may in fact align with a least-cost system optimisation outcome, given the rapid decline in solar, wind and battery costs and relatively static (or likely increasing) costs for gas and pumped hydro and enabling network infrastructure, and as AEMO articulate in the draft ISP: *“based on future technology cost estimates, installing sufficient VRE to meet the energy needs of winter and accepting some curtailment in summer is likely to be a more efficient outcome than the alternative of building less utility-scale solar but more seasonal storage”.*

Conversely, assuming streamlined deployment of GW scale pumped-hydro schemes alongside requisite transmission upgrades belies the uncertainty and social licence challenges already visible for hydro projects currently progressing. We support AEMO highlighting the risks here, noting: *“In some cases, this may lead to alternative developments that reduce the need for new transmission, including batteries…”*

Similarly, we support AEMO’s conclusions captured in the Draft 2022 ISP that: *“the most pressing need in the next decade (beyond what is already committed) is for batteries, hydro or viable alternative storage of up to eight hours’ depth to manage daily variations in the fast-growing solar and wind output”.*

For future developments, it is expected that the value of the firming and system security services will only increase as more thermal generators retire and the penetration of variable renewable energy (VRE) increases. Market changes will be made to incentivise and reward all fast acting and flexible frequency, voltage and inertial responses that battery storage can offer. Over time, these non-energy services should increase their proportion of the value stack, particularly as non-traditional network support services and grid infrastructure deferrals are able to be monetised, and as regulatory reforms unlock more appropriate markets to value the services being provided.

Tesla remains committed to support AEMO exploring how grid forming storage can be best integrated in the NEM – e.g. cost analysis, grid modelling studies, market benefit modelling, and ensuring all system services that fast-response storage is already providing is captured as part of forecast developments. This will also strengthen the link between the ISP and other reform work already underway.

Battery storage – the new clean peaker

The 2022 Draft ISP appears to include outdated assumptions still driving 9GW of new peaking gas capacity. We disagree with this result. As demonstrated by the CEC's white paper that undertook a deep-dive economic comparison[5], battery storage has improved its capability and cost-effectiveness to become the preeminent peaking plant solution for energy grids across the world. The key barrier for batteries previously was capital cost, but rapid and continuing cost efficiencies driven by product innovations and manufacturing at scale has significantly reduced this barrier.

The NEM is now primed for a rapid transition to battery storage systems as a replacement for gas peakers as battery technology has advanced to the point where it can provide faster response for a much lower cost. Battery solutions can serve the same role traditionally performed by gas peakers by discharging when demand (and correspondingly prices) approach peak levels and sustaining output to cover the typical daily peak duration. Given it is no longer economically rational (or necessary) for proponents, investors or governments to build gas peaking plants in Australia, aside from a small selection of subsidised plants currently proposed (~700MW), there is unlikely to be further commercial opportunities to deploy gas peakers anywhere in the NEM, and to include 9GW in the ISP would unnecessarily embed a clear disconnect between AEMO's ISP modelling results and a credible deployment outcome.

[5] CEC Battery Storage – the new clean peaker