Level 22
530 Collins Street
Melbourne VIC 3000

Postal Address:
GPO Box 2008
Melbourne VIC 3001

T 1300 858724
F 03 9609 8080

17 June 2021

Ms Anna Collyer
Chair
Australian Energy Market Commission
Sydney South NSW 1235

By online submission
AEMC Code: ERC0300

Dear Ms Collyer

Draft Determination – Efficient management of system strength

AEMO welcomes the opportunity to provide feedback on the draft determination and draft preferable rule for implementing a new system strength framework, published on 22 April 2021.

Action to maintain security is needed as the transition of the power system accelerates
AEMO considers that the National Electricity Market (NEM) is at the international forefront of managing issues associated with low system strength, and industry is adapting to operating in these low system strength conditions. In 2020 the NEM saw 109 days with more than 40% penetration of wind and solar generation in the NEM and minimum synchronous generation levels decreased from 13.75GW in 2018 to 10.8GW in 2020.

AEMO's Engineering Framework will outline the requirements and commissioning tests needed to support operation of the power system as these changes occur. AEMO considers the NEM must be redesigned and prepared, within the next 5 years and possibly much sooner, to operate with little to no synchronous generation online and at times 100% instantaneous inverter-based generation. As part of this redesign, it is imperative that opportunities to improve system strength be realised to provide the sought-after gains in security, efficiency and resiliency for consumers, participants, and investors.

AEMO supports the direction and intent of the draft determination
AEMO acknowledges the value of an integrated framework for system strength, incorporating the previous 'do no harm' framework for generator connections and 'minimum and shortfall' framework for transmission networks.

AEMO understands that the intent for the proposed amendment is to enable a more rapid connection of large numbers of new developments whilst achieving economies of scale solutions by TNSPs, utilising AEMO forecasts in alignment with AEMO's Integrated System Plan (ISP). AEMO understands key elements of the AEMC's approach to be:

- provide a proactive framework so necessary services are available at scale, in a timely manner;
- address coordination concerns about the existing 'do no harm' framework for generator connections;
- transfer responsibilities for provision of system strength services to Transmission Network Service Providers (TNSPs) by making system strength a prescribed transmission service; and
- encourage generators to connect in locations where system strength is well supplied by the TNSP.

AEMO agrees with the AEMC that effective economies of scale can be realised through carefully planned infrastructure strategies to support large scale clusters of inverter-based resource (IBR) and renewable energy zones (REZ) as defined by the ISP. AEMO welcomes the roles of independent forecasting and setting the planning standard aligned with its ISP.

AEMO has identified some potential enhancements of the draft determination
To capture the identified efficiencies and economies of scale, AEMO has identified three potential enhancement and clarification areas for the draft determination.

Firstly, AEMO notes that to be effective in realising timely and efficient infrastructure and services to support new connections, it is crucial that the associated regulatory framework be able to deliver timely decision-making. AEMO considers that the current regulatory regime remains lengthy and can result in delays and risks to TNSPs that will likely make it difficult for them to invest in a manner to keep pace with the developments in the system. AEMO recommends the final determination consider a streamlined regulatory approval process for the prescribed transmission services, including explicit consideration of how best to ensure transparent, timely and flexible arrangements to facilitate non-network options including grid-forming inverter services and synchronous generation dispatch.

Secondly, AEMO supports the options the ESB is considering for operational procurement, namely the Unit Commitment for Security (UCS) and System Security Mechanism (SSM), and looks forward to continuing to work with the AEMC on those associated potential amendments.

Finally, AEMO recommends explicit joint planning arrangements to allow learning-by-doing, reflect system needs over time, and support an orderly energy transition. Joint planning arrangements should be used from start to finish to ensure that solutions match projected network requirements as well as operational needs. For this reason, AEMO recommends that the joint planning provisions for the amended framework be explicit and include provision of data and models to AEMO.

The attachments to this letter provide further details and a high-level indication of AEMO's intended approach for applying the new framework.

Should you wish to discuss any of the matters raised in this submission, please contact Kevin Ly, Group Manager Regulation on kevin.ly@aemo.com.au.

Yours sincerely

Tony Chappel
Chief External Affairs Officer

Attachment A – Detailed AEMO feedback
Attachment B – Indicative Implementation Plan

ATTACHMENT A: DETAILED AEMO FEEDBACK

1. Forecasting – National Electricity Rules (NER) 5.20.6

AEMO welcomes the changes to NER 5.20.6 (System strength requirements methodologies). They will enable AEMO to apply the most up-to-date and relevant forecasts to develop the system strength requirements, including forecasts aligned with the ISP. The ISP is at present provided every two years. If development has proceeded faster than envisaged by scenarios in the ISP or other changes to system generation occur faster than expected, then system strength assessment updates may need to apply the most recent connection trends or specific ISP scenario with revised forecasts, given that the proposed changes require deterministic assessments of MVA or Inverter Based Resources (IBR) at each node. However, the re-alignment of assessment of system strength with the next ISP will ensure that solutions remain consistent with the overall optimal development path of the ISP, and the broader investment and operational directions of the entire NEM. AEMO considers that the proposed approach provides the right degree of accountability and responsiveness to changing system requirements.

The premise of the Draft Determination is outlined in section 3.4.3 where the AEMC considers there to be a negative asymmetry in cost and risk from under-provision of system strength. AEMO supports the analysis presented in Box 3 of the Draft Determination that demonstrates how it may be cheaper to build more synchronous condensers (or technological equivalents) than too few but recognises the analysis may not assess the risks of doing so.

2. Standard – NER 5.20C.1 and NER S5.1.14

The new system strength standard is based on assessments by AEMO of minimum MVA fault levels and a voltage waveform stability requirement (linked to IBR development forecasts). These are described as the minimum and efficient levels.

The matters covered by NER 5.20C.1 and NER S5.1.14 are an evolving technological area, and as such the AEMC has prioritised flexibility for the TNSPs rather than prescriptive compliance, for example creating the voltage waveform stability element of the standard and using a reasonable endeavours obligation.

Combined these elements may create some ambiguity as to how the TNSP should comply, particularly with regards to supporting the efficient level. This statement is not to reject the use of voltage waveform stability standard. Instead AEMO recommends the AEMC consider extending the joint planning provisions and further identifying AER's role in specifying how System Strength Service Providers (SSSPs) should comply with the standard, particularly regarding non-network options. With regards to responsibilities, AEMO's involvement may be to provide input on the operability of the solutions and the AER may consider the efficiency of the investment.

The Draft Determination is confusing with respect to the policy intent for the preparation of the minimum fault level arrangements and how they will interact with the 'general stability'. For example, the Draft Determination[1] discusses how AEMO will cooperate with the TNSP on both the minimum and efficient levels. It also suggests some limits on the network investments or

[1] Section B.6.4, p82 - AEMC, Efficient management of system strength on the power system, Draft rule determination, 29 April 2021

procurement, with regards to the minimum level and general stability, suggesting the latter is expected to be supported by operation of synchronous generators, at least initially.

Figure B.1[2] considers that joint planning with AEMO will occur where obligations and solutions for services overlap with general power system stability. The new joint planning rules 5.14.3 and 5.14.4(d) are not explicit about this point, and neither is the specification of the minimum standard S5.1a.9. For example, the new 5.14.4(d) appears to require AEMO's input only in the case when the TNSP is planning to use a non-network option. Further, Figure B.3[3] of the Draft Determination highlights the standard in blue and then includes a section in orange, related to "general stability".

Contrary to the Draft Determination, the draft amendment itself does not specify such distinctions, so it is unclear how AEMO could, or if it is expected to, express the standards to reflect the intent in Figure B.3. AEMO expects that since the SSSP is expected to procure the 'full amount' of system strength to meet the standard, this will include the amount that forms the 'stability portion' and there is no obligation on the SSSP to procure this amount through any particular solution, nor to meet any other obligation than the minimum fault current level.

Regarding the setting of the values for each portion of the standard, AEMO emphasises that the current minimum fault level requirements for some regions of the NEM have been evaluated under the 'stage 1' assessment of the System Strength Requirements Methodology. Further detailed work will be needed before the requirements can be declared for protection setting requirements and voltage stability needs under the new definition of the minimum standard.

It may be impractical to immediately identify a technical minimum for all nodes across the system and that a transition approach will be required. AEMO is currently preparing a work plan for the transition to the revised system strength framework. MVA is a metric that largely represents the contribution from existing synchronous machines, meaning the engineering challenge is to transition from relying on these synchronous generators, and not simply replacing the MVA from them. Nevertheless, subject to applying joint planning arrangements, AEMO endorses the draft amendment which empowers TNSPs to provide system strength for the "full" amount. Further consideration is needed on procurement, as discussed in section 3 of this submission.

The amendment is silent on maintaining system strength during network outages. Given this consultation determines the medium to long term arrangements for meeting system strength, it is important to consider an arrangement to meet system strength requirements during network outages. AEMO is responsible for maintaining system strength under intact network as well as during outage conditions. This requires restoring system security within 30 minutes (meeting system strength is an aspect of system security) following an unplanned outage (N-1-1). The recent experience with critical network outages highlighted the need for a robust arrangement for meeting system strength, at the least for outages of critical network elements.

AEMO further recommends more detailed consideration be given to the requirements under S5.1a.9:

[2] Section B, p68 - AEMC, Efficient management of system strength on the power system, Draft rule determination, 29 April 2021
[3] Section B.6.4, p83-84 - AEMC, Efficient management of system strength on the power system, Draft rule determination, 29 April 2021

- The standard refers to "small signals" without defining what these are, potentially leading to ambiguity and different interpretations of the rule.
- The standard introduces a requirement to meet the standard for protected events, which may imply a need for additional measures under S5.1a.9 to be assessed as part of protected event proposals.
- The new standard establishes a need for plant to remain connected, but not other performance criteria established under S5.2.5 (discussed further in section 5 of this submission).

3. Procurement

The draft amendment requires the TNSP to comply with the standard(s), by identifying the least costly option that provides the benefit expressed by the standard. The drafting appears to require the TNSP, as the System Strength Service Provider (SSSP), to immediately meet the standard when it applies in late 2025.

For example, clause 11.3 of the amending rule specifies any existing fault level nodes are deemed to be system strength nodes under the new framework. Whilst AEMO would have the power to also declare other nodes and to change the MVA amount at each node, absent this, the effect of clause 11.3 is equivalent to declaring a shortfall for the full MVA at all the existing nodes under the current framework. A reading of 5.20C1 indicates AEMO has no discretion in declaring nodes and requirements at each node must be represent the full system requirements in terms of minimum MVA and IBR forecast. This is supported in the Draft Determination[4], which states:

"The proposed standard would result in SSS Providers procuring the whole amount of system strength required to meet the requirements of the standard. That is, a SSS Provider must coordinate the procurement of a portfolio of solutions to satisfy the standard, and it cannot rely on any system strength services that may be coincidentally provided by generators as a result of them being dispatched in the energy markets in the operational timeframe"

AEMO understands this to mean that the SSSP must procure the useful contribution of the entire fleet of synchronous machines or look to invest in synchronous condensers across all nodes. AEMO accepts judiciously placed synchronous condensers (or technological equivalents) may be an effective way to supplant the MVA contribution from some synchronous generators and also welcomes procuring system strength before it becomes scarce.

However, there is much uncertainty as to the future operational behaviour of the existing synchronous generating fleet, and hence the level of fault level contribution from these resources. Therefore, it is difficult to accurately forecast shortfalls under the 2017 Rule. There is also much uncertainty on the ability and commerciality of service provision by new technologies. As drafted, this uncertainty does not go away, but simply needs to be priced through contracts with the SSSP and assessed against network options.

While AEMO endorses the approach of TNSPs procuring the "full amount", rather than a shortfall, it would be beneficial if more clarity is provided on how the procurement arrangements should

[4] Section B6 p73-74 - AEMC, Efficient management of system strength on the power system, Draft rule determination, 29 April 2021

work in practice. The Draft Determination focuses on how network options provided by the SSSP may "countervail" the potential market power of synchronous generators, by in effect, placing a cap on the offers by non-network solutions. The intention behind the draft amendment seems to be to avoid any "squeeze" where few existing synchronous generators can charge much for their services. AEMO agrees any "squeeze" should be avoided in the frameworks, (particularly in the early years where TNSPs may struggle to initially meet requirements under this framework), but similarly, the framework should provide for existing and new technology to compete.

AEMO notes that significant modelling and analysis would be required to demonstrate the technical feasibility of replacing system strength presently provided by synchronous generators, and lead-times associated with equipment (synchronous condensers) may be extended given significant TNSP procurement activities. This may lead to SSSPs needing to contract with synchronous generators as the primary solution, at least in the short term.

AEMO notes that currently in the market, TNSPs have sometimes demonstrated a preference to rely on AEMO rather than investing to resolve the identified need. AEMO requests that the AEMC consider how the TNSP should comply to ensure reliance on AEMO directions are minimised.

Prior to the Final Determination, the AEMC may consider how the AER can assess investments are prudent and efficient[5], including the consideration of non-network options.

4. Operations

AEMO faces obligations to ensure the minimum three phase fault level for system security is maintained in operational timeframes under clauses 4.2.6(g), 4.4.5(a) and 4.6.1(b) of the NER, which have been amended under the draft rule to reflect the change from fault level nodes to system strength nodes. The clause 4.4.5 gives AEMO the role to enable system strength services using the same drafting as the 2017 Rule, yet only to maintain the minimum MVA level.

AEMO is supportive of these obligations but recognises these clauses limit AEMO's ability to use directions for system strength above this minimum MVA level. This means the SSSP will be responsible for "dispatching" services to meet the IBR forecast obligation. This is confusing because the S5.1.14 is a planning obligation on the SSSP, whereas AEMO is responsible for operations.

For non-network solutions to be useful in operations, AEMO considers further work is required to consider their scheduling, as well as how this may be complemented by operational procurement to manage variances between the planning and operations. AEMO supports the work the AEMC and ESB are completing in considering a potential UCS[6] and SSM[7] as operational mechanisms to support this long-term framework and improve the procurement arrangements.

AEMO considers that if only a sub-set of the existing synchronous generation fleet is contracted by TNSPs, this may limit the options available in real-time operations to manage the operational need for system strength. Operational conditions may differ to those considered in system strength planning scenarios – it is not possible to consider all scenarios in the planning timeframe,

[5] It will be important for the AER to ensure non-network options and the potential for new technology are considered.
[6] Understood to be through Delta Electricity's Rule Change Proposal Capacity Commitment Mechanism
[7] Understand to be through Hydro Tasmania's Rule Change Proposal Synchronous Services Markets

and simplifying or averaging assumptions must be made to determine a single parameter for a planning standard, which may result in a difference to the dynamic assessment in operations. It is also possible that there may be a regulatory, contractual, or build lag between the solution planned for by the SSSP and that which is available in the operational time. In such circumstances, AEMO may need to continue to rely on interventions through 4.8.9 directions to meet the operational requirements of the system. As such, AEMO considers that an operational procurement mechanism such as an SSM could help to manage these challenges and looks forward to continued engagement with the AEMC and industry to develop such a mechanism.

5. Connection, performance standards and charging

The draft amendment imposes a new performance standard and a charging regime for system strength.

It is AEMO's understanding that most IBR connecting will aim to operate stably well below a SCR of 3 and should be encouraged to do so by the new framework's charging regime. Similarly, AEMO understands that over time most IBR connecting to the network should be able to out-perform the minimum voltage phase change requirement proposed for the draft rule. The AEMC may wish to consider whether minimum thresholds may be specified outside of the rules, for example in the guidelines or methodology, in order to accommodate technological improvements over time.

The Draft Determination, 5.3.4B(a2) allows a generator to pay the System Strength Mitigation Requirement (SSMR), after undertaking a Preliminary Impact Assessment (PIA) at the connection enquiry stage. The drafting allows a Full Impact Assessment (FIA) by the TNSP to be avoided should the generator elect to pay the SSMR when it submits the application to connect.

AEMO is unsure of the utility to this option because:

1. wide area PSCAD modelling will be required, not just to assess the "general system strength impact" or MVA, but also to assess control interactions;
2. the PSCAD modelling must assess the stability of both the inverter and the remediation solution, irrespective of whether the solution is from prescribed transmission services or a private synchronous condenser; and
3. proposed clause 5.3.4B(b1) is unfair because it requires a decision on whether to select the network service before an FIA, therefore before the cost of self-remediating is known.

Additionally, by allowing generators to avoid a FIA, (by electing to pay the SSMR at the connection application stage), this also removes the obligation on the TNSP to conduct wide-area PSCAD modelling, possibly leaving AEMO solely responsible for assessing performance. AEMO considers the SSSP should remain responsible for ensuring stable operation of their network.

Under these circumstances AEMO considers 5.3.4B and the FIA to apply and the generator not to connect until remediation is provided by either the SSSP or the connection applicant. Of course, should there be some available hosting capacity from the SSSP, the applicant should be able to partially connect, with these limitations negotiated at the connection application stage.

AEMO also notes the Standard - S5.1.14 (a)(2)(ii) specifies the TNSP should plan their system to be able to maintain stable voltage waveforms such that following a credible contingency, IBR should remain synchronised. This is less onerous than the present requirements under 5.3.4A. It may be sensible to consider aligning these standards, because this will then provide an equivalence for a generator connecting to decide whether to pay the SSMR charge or remediate the system strength requirement under the "do no harm" framework.

The clause S5.2.5.16 is specific to voltage phase angle shift protection settings and does not include other protection settings. On similar grounds, other protection systems in a generating system could require inclusion in Minimum Access Standards under S5.2. Protection systems and protection settings are documented in protection design reports, and so it is inconsistent to document them in the Generator Performance Standards.

AEMO also notes the draft amendment does not establish a need for system strength services to establish performance standards. Synchronous condenser performance standards have to-date been established on an ad-hoc basis leveraging the existing performance standards requirements and template. AEMOs view is that there would be benefit establishing performance standards as part of the NER to ensure there is an appropriate regime in place for performance standards and compliance monitoring for system strength services.

Finally, AEMO requests consideration of the following comments on the draft glossary amendments:

- Please consider replacing "rated output" with "rated active power" to be consistent with S5.2.5.15;
- It may be preferable to use a more generic term such as "power-electronics connected loads" rather than "inverter-based loads", as the connection will be via a converter rather than an inverter.
- AEMO considers that inverter-based resources units that falls under definition of generating system should calculate short circuit ratio based on *rated active power*, whereas power electronics-connected loads can use the *maximum demand* for the short circuit ratio calculation.

ATTACHMENT B: INDICATIVE IMPLEMENTATION PLAN

AEMO provides the following provisional approach and timeline it may use to implement the NER amendment as described in the draft determination. This includes an intended approach to projecting future demand for system strength and an approach to declaring nodes.

Intended approach to projecting future demand for system strength

Although the AEMC draft determination suggests that AEMO would no longer be required to consider typical dispatch patterns when forecasting likely minimum fault levels, AEMO has reviewed how projections may be conducted and does consider it prudent to include the results of market modelling, consideration of typical dispatch patterns and market intelligence in order to project future demand for system strength. Setting system strength nodes and their requirements must include projections for IBR development and dispatch, but preparation of these projections would be usefully informed by an assessment of where synchronous generation dispatch may or may not be expected, and when, given the market interplay between these differing generation sources.

AEMO intends to use the results of analysis for the Integrated System Plan, and leverage the most recent understanding of generator dispatch patterns and connection forecasts for new generators and equipment.

For the first System Strength Report to be prepared under the revised framework, for release in August 2022, AEMO expects to leverage the draft Integrated System Plan modelling work to be conducted in Q3 and Q4 of 2021. AEMO is still considering whether generators which become newly committed in Q1 or Q2 2022 will be able to be included in the modelling for the System Strength Report, but this seems unlikely given the lead-time required to complete modelling.

AEMO will ensure that the updated System Strength Requirements Methodology and System Strength Impact Assessment Guidelines include cut-off timeframes for when committed status generators will and will not be included in the modelling informing system strength node and requirements declarations.

Intended approach to reviewing minimum fault levels and system strength nodes

The draft system strength framework requires that AEMO project minimum fault level requirements for each system strength node for each year of the coming decade. This approach will provide TNSPs and market participants with an understanding of AEMO's intentions for the setting of system strength nodes and their requirements, and AEMO considers that this approach will be of benefit to the industry.

However, this approach will necessitate a degree of high-level modelling rather than the more precise approach taken to the present establishment of current or near-term requirements. This is because precise electromagnetic transient modelling applied to set precise requirements is time-consuming to prepare and does require precise models of generators, inverters and synchronous condensers. In order to project system strength requirements in to the future, AEMO will need to use imprecise modelling techniques – this is likely to be through applying generic assumptions about future generators, inverters and synchronous condensers through

steady state system analysis (PSS/E) for the further-out years of the decade, rather than electromagnetic transient studies (PSCAD) presently used for near-term requirements. As the need date for a node moves closer, AEMO will update its annual System Strength Report with more specific requirements set using EMT analysis. This approach change will be explored and documented through the consultation on updates to AEMO's System Strength Requirements Methodology.

AEMO timeline for implementation

The draft determination requires that AEMO make the revised system strength requirements methodology and publish the first system strength report under the evolved framework by 30 September 2022. There is, however, some ambiguity on this matter as some parts of the draft determination also envisage a publication of both documents by the end of August 2022. It is AEMO's understanding that for 2022, AEMO will publish the first system strength report and methodology by 30 September 2022. Then subsequent publications will be published prior to 31 August as stated by the draft rules. AEMO proposes to begin initial consultations with TNSPs and others within three months of the release of the final rule determination, including publication of a directions paper and a call for any comments, ahead of the initiation of the formal consultation process. The formal consultation process on the requirements methodology would need to begin in early 2022 for a finalised methodology by end of September 2022.