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7 February 2025

Anna Collyer
Chair
Australian Energy Market Commission
Sydney NSW 2000

Reference: ERC0339

Dear Ms Collyer,

Directions Paper – Efficient Provision of Inertia

AEMO welcomes the opportunity to comment on the Directions Paper (Paper) for the Rule Change consideration of the Efficient Provision of Inertia. The Paper presents a mid-way stage in the consideration of the Rule Change proposal for an inertia spot market valuation mechanism and a preferred way forward to be set out at the Draft Determination stage in mid-2025.

AEMO must consider how the energy transition affects numerous system security services and discusses this at length in its publications[1]. Like other services, the provision of inertia will change with the decline of traditional synchronous generation, growth of Inverter-Based Resources (IBR) and installation of synchronous condensers and it is critical that its supply is efficiently sourced ahead of major coal retirement.

Recent changes to the security framework resulting from the Improving Security Frameworks (ISF) provide clear signals about the roles and responsibilities for delivering inertia services, including mechanisms to bundle its provision with system strength. AEMO concurs with Houston Kemp's analysis of the costs of various sources of inertia, particularly the very low incremental cost of increasing the inertia of a synchronous condenser that has already been justified to supply a more urgent service[2].

The ISF, along with Network Support and Control Ancillary Services (NSCAS) arrangements, also permit acquisition of inertia services through contracting with market participants where that is efficient or timely. AEMO supports the Paper's recommendation that these mechanisms be used to procure the minimum level of secure inertia. Industry is currently focused on implementing the ISF rule to enable the procurement of the minimum secure inertia levels and other non-market services.

With respect to the Paper's contemplation of a spot market mechanism to purchase *additional* inertia above the minimum secure level to achieve a more efficient total cost of dispatch, AEMO notes, in principle, it may be a possible option. The attached submission provides views on the Houston Kemp's assessed costs and benefits for this hypothetical market.

However, for the following reasons, AEMO does not consider now is the right time to progress with a decision to implement an inertia market.

- Forecast changes in inertia supply and demand are less rapid than other services.
- Without discounting its importance, and noting existing pathways to deliver large volumes of inertia through ISF and NSCAS, AEMO has a lower level of concern regarding the maintenance of sufficient inertia through the energy transition than it does for other services.

[1] See https://aemo.com.au/initiatives/major-programs/engineering-roadmap

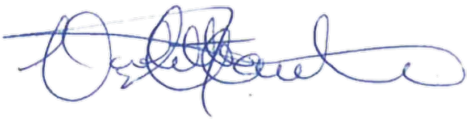
[2] This could be either a new synchronous condenser or repurposed generator.

- The industry needs clear time to imbed the existing ISF rule and start procuring the associated services.
- While the Paper anticipates relatively low tangible costs from building an additional ancillary service of the broad form presented by the original Rule Change, there are opportunity costs associated with inserting an additional reform into the industry's reform priorities at this time.
- With respect to the Houston Kemp's assessed benefits of a spot market mechanism, AEMO considers it is premature to count benefits associated with avoiding constraints on maximum contingency sizes, which contributes roughly one third of the benefits.
- Houston Kemp has found only a marginal positive net margin within a very large range of uncertainty. The case for change would need to be considerably clearer to commit to a non-urgent reform.

AEMO considers this reform is better suited to defer now and revisit in several years when the market and participants are better informed. Developments during the current process have already, and will continue to, improve the understanding of the role, design and potential benefits of a market. The additional time will provide opportunities to improve the essential technical understandings about non-traditional inertia in operational timeframes, which are necessary to inform both the development of and to support any potential market where a need emerges. Even if the current process concludes against short-term implementation in mid-2025, its findings will be available for reconsideration at a time when the technical understandings of non-traditional sources have improved and the benefits of procuring additional inertia have become clearer.

Should you wish to discuss any aspect of our submission, please contact Hannah Heath, Group Manager, Strategic Market Reform (Hannah.Heath@aemo.com.au).

Yours sincerely,



Violette Mouchaileh
Executive General Manager, Reform Delivery

ATTACHMENT – Detailed submission

PART 1 – Response to Paper questions

Question 1: Future credible contingency size in the NEM

Do stakeholders expect that the NEM will have smaller or larger credible contingencies in the future? What will drive trends in contingency sizes?

The Paper's summary of the likely demand for inertia over the medium-long term is consistent with AEMO's current understanding that existing inertia requirements seem likely to be stable until the mid-2030s, and then gradually decline as large conventional generators retire, reducing the maximum credible contingency size. Those retirements might also permit the Reliability Panel to relax maximum Rates of Change of Frequency (RoCoF), which would result in a step decline.

In that same timeframe, the Paper then speculates step increases in demand for inertia with the introduction of larger contingencies from new network topologies around Renewable Energy Zones (REZs) and offshore wind farms. Such future topologies are naturally highly speculative, and as the Paper notes, large contingencies may be rectified by protection schemes. Given this, it seems unlikely that a new topology could give rise to a very large credible contingency size that would not also have a corresponding contingency size rectification.

A new topology that results in a very large credible contingency size would have many adverse impacts on the secure power system envelope, of which the resulting increase in inertia requirements would be a relatively minor concern[3]. Therefore, for the purposes of this analysis, it is prudent to assume rectification of a very large contingency size

Additionally, for a less extreme increase in contingency size, AEMO's existing minimum inertia requirements publication would readily react by increasing the requirements on TNSPs to deliver inertia.

In light of this, AEMO does not consider there is a benefit from procuring additional inertia – by permitting tolerance of larger contingency sizes, this comprising approximately a third of the benefits currently captured in Houston Kemp's findings. In the former (large increase) case, a rectification should be assumed. In the latter (moderate increase), the specification of an increase in minimum inertia to be delivered by existing procurement processes would raise the *minimum* inertia demand as presented in the Paper's figure 4.7. This higher base should mean that the *additional* requirement to meet the moderately higher demand should conceptually be about the same.

Question 2: Future estimates of synchronous condensers

Do stakeholders expect that synchronous condensers for system strength are likely to provide most of the NEM's minimum inertia needs? What would influence the uptake of synchronous condensers in the NEM?

AEMO supports Houston-Kemp's findings that synchronous condensers[4] for system strength offer a practical and cost-effective source of inertia to replace most of the NEM's traditional sources in at least the medium term and an example of where a single resource can provide multiple essential system services. The regulatory framework arrangements implemented through the System Strength Rule 2021[5] and more recently, the ISF rule 2024, provide the primary pathway for delivering new Essential System Services (ESS), with the deployment of higher inertia synchronous condensers an expected outcome with the framework bundling system strength and inertia incentives together. The low incremental cost of flywheel installation to increase the weight of a synchronous condenser at time of construction

[3] Additional challenges caused by a very large credible contingency size would include voltage stability management, higher FCAS procurement, higher Lack of Reserve (LoR) minimum margins and reduced network limits to manage post-contingent overload, voltage and transient stability limits.
[4] Synchronous condensers in this context includes repurposed generators.
[5] National Electricity Amendment (Efficient management of system strength on the power system) Rule 2021

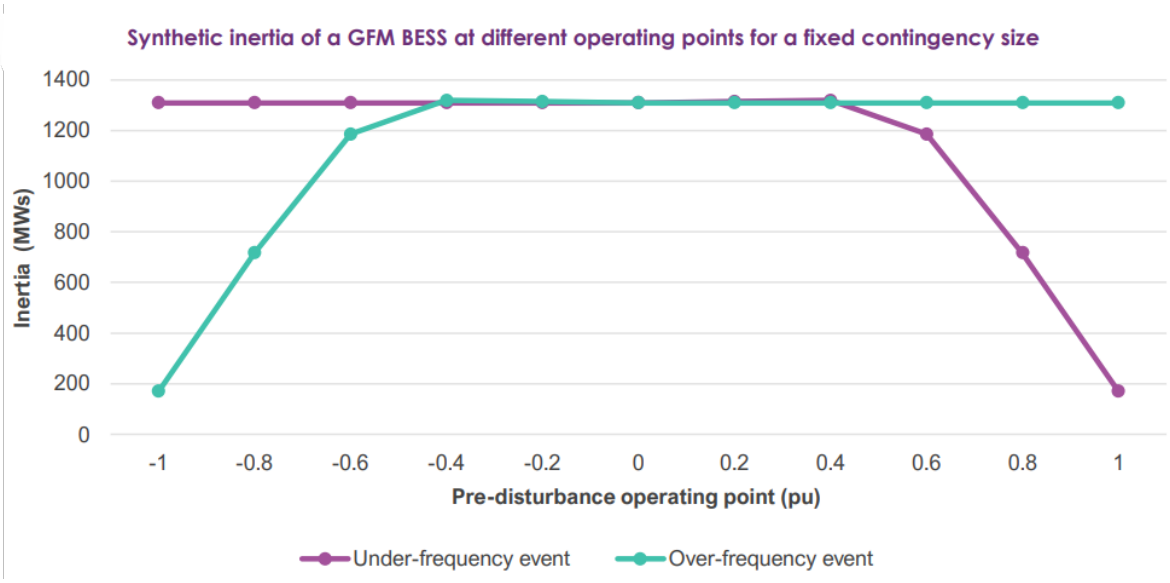
offers a low-regrets option. AEMO supports frameworks that encourage bundling technologies to contribute to the cost efficient and timely delivery of system services.

The Paper's observations regarding synchronous condensers are welcome as they help consolidate industry focus on delivering the ISF rule.

Question 3: Future role of grid-forming inverters

What do stakeholders consider to be the potential role of grid-forming inverters in future inertia provision? We would be interested in thoughts on technical and economic challenges, opportunities for co-optimisation with other system services, and the conditions necessary for scaling their deployment effectively.

Synthetic inertia has the potential to provide a major cost-effective source of inertia in the medium- to long-term. In September 2024, AEMO published a technical note[6] that presents a methodology to quantify the synthetic inertia of a Grid Forming (GFM) Battery Energy Storage System (BESS). The note shows that GFM BESS could theoretically produce large quantities of inertia, although it is dependent on the operating condition of the BESS prior to the disturbance, as demonstrated by the figure below.



The interaction between energy operation and synthetic inertia provision is part of the theoretical attraction to market co-optimisation. However, further analysis is required to inform the optimal options for co-optimisation service procurement in an operational timeframe. AEMO's work to date[7] has focused on analysis and estimations in a planning timeframe. Approaches to predict and measure synthetic inertia in an operational timeframe are still under development. Further work can also explore the relationships between provision of other services and synthetic inertia that can also inform co-optimisation options. This evolving and progressive development of understanding means it would be better to revisit the case for operational procurement in several years when greater confidence emerges in the potential to practically perform the role that Houston Kemp envisages.

In the interim, as understanding improves around how these emerging sources can provide synthetic inertia, the existing frameworks may enable procurement for inertia services. For example, a TNSP inertia contract could oblige a BESS to operate within a certain range when required for inertia services.

[6] See: https://aemo.com.au/-/media/files/initiatives/engineering-framework/2024/quantifying-synthetic-inertia-from-gfm-bess.pdf
[7] Ibid.

Question 4: Future inertia supply and costs

Do stakeholders have any further information about the fixed and variable cost estimates of future inertia supply?

Continuing from the discussion under Question 2 on synchronous condenser costs, AEMO generally supports Houston Kemp's assessments of the costs of future inertia supply.

Question 5: Procurement mechanism to meet minimum inertia levels

Do stakeholders agree that long-term procurement models are currently most suitable to meet minimum levels — given the high cost to the system if minimum inertia requirements are not met?

AEMO supports the Paper's finding that structured procurement, in the planning timeframe, is currently the preferred way to procure minimum secure inertia. The finding improves network planning certainty and provides the opportunity to achieve efficiencies by delivering both system strength and inertia through installation of synchronous condensers. The timeframes of declining inertia presented by Houston Kemp should permit these efficient solutions to be explored and delivered through the network planning process.

When considering frameworks for market procurement of *additional* inertia for dispatch efficiency, AEMO agrees, in principle, with the finding that dispatch of additional inertia above the minimum secure level could, in some situations, result in a lower total cost of dispatch. AEMO supports the broad approach that the Paper and Houston Kemp have taken, in that it presents these dispatch savings as the *benefit* of operational procurement, and the cost of building and operating the market system as a *cost*.

Question 6: Other potential benefits from operational procurement

Are there other potential benefits from operational procurement that stakeholders consider we should include in our analysis? If so, can stakeholders provide further information about how these could be modelled and / or the quantum of such benefits?

For the reasons set out under Question 1, AEMO considers the Houston Kemp benefits analysis should exclude the perceived benefits from procuring additional inertia.

Additionally, the benefits analysis included as a small component the avoided cost of hypothetical future directions to inertia supplying plant, using South Australian system strength directions as a benchmark. It is not clear that this inclusion is consistent with the proposal that the market be used only for "additional" inertia to achieve dispatch efficiency. A direction can only be used to maintain power system security, and the Paper proposes that the minimum level of inertia required for security is to be supplied by other regimes. Thus, it is not clear why the market would avoid these directions, were they required.

In any case, it is intended that the ISF rule change will deliver this minimum level for security through contractual arrangements and thus reliance on directions is expected to decline.

Question 7: Implementation considerations

Do stakeholders have suggestions on implementation considerations that should be taken into account? For example, how we can mitigate regulatory uncertainty?

AEMO notes the implementation considerations for the next stage of the project outlined in the Paper and provides the following comments.

Merging with 1 second market

Section 8.2.2 discusses a potentially low-cost implementation via an adaptation to the existing 1-second FCAS market by having it simultaneously procure inertia and 1-second FCAS. It is true that the volume of 1-second FCAS that AEMO presently recruits adjusts depending on the amount of inertia that AEMO assesses as being on-line, but this does not mean that the two phenomena are substitutable. To explain, it is worth imagining inertia as "0-second FCAS", an immediate response to arrest RoCoF, but one that disappears as soon as frequency stabilises, being then replaced by 1-second FCAS that must be sustained until either the frequency returns to normal levels or 6-second FCAS response emerges. Despite overlaps and interdependencies, the power system nevertheless requires some supply from all the response timeframes simultaneously.

The FCAS markets are common-clearing priced, which assumes that all registered suppliers to a particular market are fungible so that selection can occur on competitive bid. Issues would arise if it was attempted to procure both inertia and 1-second response in the one FCAS market. Whilst it may be possible to incorporate maximum and minimum purchase constraints on each response, the resulting clearing price would then be inconsistent with the marginal value of at least one of the responses.

Bidding systems

From a design perspective, a least cost approach could be to attempt to replicate the existing FCAS contingency markets constructs to the extent it is reasonable. While AEMO agrees with the Paper that 10 price-quantity pairs may seem unnecessary, an alternative approach may end up being a more costly design.

One of the design options put forward in the original Rule Change suggested re-allocating dispatch Energy Band one to an inertia bid to save systems cost. However, that appears a false economy as it would disturb the design of the energy market in a way likely to be more expensive than building new data fields. Additionally, it would reduce energy market flexibility (9 energy bid bands rather than 10), which participants would likely have concerns with and result in an inconsistent number of bid bands with FCAS markets.

Non-linearities and measurements

In section 8.3.3 the Paper discusses changes to NEMDE to account for non-linear characteristics of the demand for inertia. As the NEMDE is a linear program, any non-linearities must be simplified into piece-wise linear equations, a process that necessitates a loss of accuracy. The Paper is correct in noting that the non-linearities for inertia are much more significant than those that have been simplified for the existing contingency FCAS markets.

The Paper notes the need to calculate these non-linearities and to develop new real-time monitoring as reasons why the development of an inertia market may be more expensive than the 1 second FCAS market. AEMO agrees but notes that even if no market is developed, in time these developments will likely be required in any case to understand the new technologies and to help schedule ISF assets. This is relevant to consideration of implementation timeframes that is discussed in Part 2 of this submission.

Staging

Section 8.4 discusses implementation timing and staging and discusses phasing in an inertia market with different stages and long lead times. AEMO has a range of reflections on this matter that are mentioned in Part 2.

PART 2 – Other detailed comments

In context of the broader reform agenda, the medium-term outlook for minimum secure levels of inertia provision, the developing knowledge of how the emerging sources of synthetic inertia will work in operational timeframes, and the only marginal benefits case presented by Houston Kemp, AEMO considers now is not the right time to progress with a decision to implement an additional inertia market. Any future work can build on the work progressed through this consultation, which provides useful design pathways that leverage off existing market systems.

1. Inertia as a system priority

As reflected in the Houston Kemp report, the supply of conventional inertia is expected to decline only progressively, which leads their analysis to show the benefits of a spot market for additional inertia grow over time.

AEMO's NEM Engineering Roadmap[8] and Transition Plan for System Security[9] publications, amongst others monitor the power system transition with respect to changes in the supply and demand of various Essential System Services (ESS), including inertia. AEMO is also committed to the Engineering Roadmap's FY2025 Priority Action[10] number 22 that requires reviewing the frequency control landscape. At the present time, the most onerous ESS concern relates to System Strength. This more pressing need to resolve system strength concerns is expected to provide inertia as a low-cost by-product, both through the addition of flywheels to synchronous condensers and through ISF agreements with conventional plant and GFM BESS.

2. **Industry Reform Priorities**

While the analysis indicates the proposed market creates moderate tangible system costs for industry, development of a new market creates intangible costs in terms of expert attention and understanding. The industry is presently allocating expertise to its engagement to implement the ISF Rule and engage in urgent market reform processes targeting issues that must be resolved in the lead up to coal generation retirement. While it is not possible to quantify this diversion of attention into a numerical cost estimate, it should be considered qualitatively, particularly with respect to questions of the required cost-benefit margin and the timing of implementation.

3. **Costs decrease with implementation timing**

Houston Kemp extrapolated from the costs of developing the 1 second FCAS market a range of industry costs (allowing for some assumed greater complexity). This approach is not unreasonable in respect of new bidding systems and modifications to dispatch and settlement systems.

However, it may under-estimate other costs, depending on implementation timeframes. This relates to the progressive development of the management of synthetic inertia discussed in response to Question 3 above and the real time measurements and calculations of linearities in response to Question 7. In time, these matters need to be addressed, regardless of the purchasing regime. However, if a market were to be introduced with a short lead-time, it would necessarily bring them forward, diverting resources from more urgent work and introducing potentially large costs that are very difficult to quantify.

4. Cost-Benefit Margin

Notwithstanding AEMO's view above that the Houston Kemp work has potentially over-estimated benefits in some areas and under-estimated the costs of a near-term implementation, Houston Kemp has calculated a relatively small

[8] See https://aemo.com.au/initiatives/major-programs/engineering-roadmap
[9] aemo-2024-transition-plan-for-system-security.pdf
[10] See nem-engineering-roadmap-fy2025-priority-actions.pdf

positive margin that includes a relatively large range of uncertainty. AEMO considers that the positive margin should be greater before committing the reform to the industry's list of priorities. This view is informed by:

- The limited role envisaged for a new market, in that its objective will be to marginally lower the cost of dispatch. As system security and investment in inertia sources will be ensured through the existing regime, the opportunity cost of not having the market in place quickly is limited.
- That the changing structure of inertia supply is occurring gradually, and that there are more immediate ESS concerns.
- That further progress is required to understand and measure new technologies' provision of inertia, and the power system need for inertia. A near-term implementation of a spot market would oblige this to be accelerated.
- That the industry is introducing another procurement regime at this time, and depending on its success, may have significant implications to the value of an inertia spot market.
- That the benefits emerge in the later years of Houston Kemp's analysis, when they are more speculative.
- That the industry has a crowded near-term industry reform agenda, which presently does not include an inertia spot market. In AEMO's view, other reforms should take priority in the short to medium term.

5. Revisiting the decision

Section 8.3 of the Paper engages with AEMO's view of the disadvantages of introducing an inertia spot market in the short-term by discussing potentially extended and staged implementation. This discussion of delayed implementation however seems to rest on a go/no-go decision being made in 2025, even if the market itself is not developed for some years. AEMO does not consider that a commitment to implement an inertia market need be made now.

The urgency is not great, as the benefits are delayed and speculative. The costs are also highly uncertain. This suggests that it would be better to defer a decision and revisit later in the decade as greater clarity emerges on the potential need for an inertia market.

As discussed previously, AEMO feels the Rule Change process has developed a conceptually strong framework for the role and design of a hypothetical spot market, particularly its function in procuring additional inertia for the purpose of lowering the total cost of dispatch. This has substantially progressed the model which provides a good start for future work.

Notwithstanding some of AEMO's concerns on two forms of modelled benefit, the broad approach to cost-benefit assessment that Houston Kemp has developed is also strong and can be used as a launch point.

The rule change has also laid out a relatively moderate system design by broadly replicating existing FCAS markets. This gives some confidence that a very long lead-time is unnecessary, hence deferring a decision to implement a market should not be problematic.