AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

21 February 2017

Level 22
530 Collins Street
Melbourne VIC 3000

**Postal Address:**
GPO Box 2008
Melbourne VIC 3001

T 1300 858724
F 03 9609 8080

Mr John Pierce
Chairman
Australian Energy Market Commission
PO Box A2449
SYDNEY SOUTH
NSW 1235

Dear Mr Pierce

**Australian Energy Market Commission System Security Market Frameworks Review Interim Report**

AEMO welcomes the opportunity to comment on the Australian Energy Market Commission's (AEMC) System Security Market Frameworks Review (Review) Interim Report.

AEMO agrees that the three-part framework proposed by the AEMC is appropriate for considering the issues of managing the grid in response to contingency events, provided system strength is considered in parallel.

AEMO also agrees with the AEMC's assessment that there are two distinct services, inertia and fast-frequency response (FFR), that can be used to address the identified issues. We note that these services are not directly interchangeable, but in some cases procuring one can reduce the need for the other, potentially reducing overall costs. AEMO is currently undertaking technical studies to assess how the quantity of each service procured affects the technical envelope for NEM operation.

AEMO has provided specific feedback below on issues in the attached submission. The AEMC Interim report outlines four potential approaches to procuring inertia or inertia replacement services. Our contention is that any one option has potential weaknesses. The use of contractual or investment solutions to procure inertia has benefits in driving investment but is problematic in how those services would be enabled and co-optimised in real time. We therefore suggest that the AEMC consider a hybrid option for procuring inertia which could drive long-term investment, allow for coordination between inertia procurement and managing system strength, and enable an efficient short-term mix of services.

AEMO is also undertaking broader analysis to underpin the development and implementation of efficient and adaptable solutions for the long-term security of the NEM as part of the Future Power System Security (FPSS) program. AEMO looks forward to engaging further with the AEMC during the Review. If you would like to discuss the contents of this submission further, please do not hesitate to contact Violette Mouchaileh on 03 9609 8551.

Yours sincerely,

Peter Geers

**Executive General Manager, Markets**

cc:

Attachments: AEMO submission on System Security Market Frameworks Review Interim Report



Australian Energy Market Operator Ltd ABN 94 072 010 327 www.aemo.com.au info@aemo.com.au

NEW SOUTH WALES QUEENSLAND SOUTH AUSTRALIA VICTORIA AUSTRALIAN CAPITAL TERRITORY TASMANIA

## Attachment A
## AEMO submission on System Security Market Frameworks Review Interim Report

The Future Power System Security (FPSS) program is a body of work established by AEMO in December 2015 that aims to adapt AEMO's processes, allowing sufficient flexibility so AEMO can continue to maintain security in Australia's power system into the future. The FPSS program is conducting broad analysis to underpin the development and implementation of efficient and adaptable solutions for the long-term security of the NEM. AEMO's process for identifying emerging technical challenges and prioritising focus areas was established in the FPSS program progress report published in August 2016[1]. AEMO is collaborating with the AEMC as part of the FPSS program of work.

AEMO is providing specific feedback on two issues: consideration of a hybrid option for procuring inertia (Section 1), and an identified need for greater coordination between inertia procurement and managing system strength (Section 2).

## 1. PROCUREMENT OPTIONS FOR INERTIA AND FFR

AEMO is currently reviewing the options presented by the AEMC, and considering their potential outcomes for the National Electricity Market (NEM) and how each approach could be implemented by AEMO (if applicable), including the development of new procedures and how existing systems and processes would need to be adapted. Based on AEMO's initial analysis, it appears that all the procurement options raised have advantages and disadvantages – particularly given the need to respond to specific conditions in each NEM region[2]. AEMO recommends that further consideration is given to a "hybrid" option that seeks to effectively combine multiple inertia procurement options outlined in the Interim Report.

Such an approach has potential value because:

- it allows both long term investment signals and short term efficient operation
- it allows flexibility to deliver efficient services in response to changing power system and market conditions
- it provides an opportunity for inertia procurement mechanism to mature over time in response to practical experience

AEMO notes that while, with care, these features could potentially be achieved within the separate options presented by the AEMC to date, a combination of these options may be more likely to deliver the most efficient long-term outcomes.

AEMO has provided further detail on the hybrid approach below.

### 1.1. Layered approach to inertia procurement

There is likely to be value in developing an option that facilitates a "layered" approach to procuring inertia, consisting of a mix of short and long-term procurement strategies and incentives.

---

[1] http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/FPSSP-Reports-and-Analysis

[2] For example, Tasmania is well supplied with synchronous condenser capability, while South Australia has no large-scale synchronous condensers.

Some sources of inertia will require long-term investment signals, such as providers seeking to invest in new sources of inertia (including synchronous generation and synchronous condensers) or existing inertia sources needing to justify investment in maintaining their capacity or entering into new fuel contracts. Providing long-term certainty to such providers may reduce the overall cost of inertia delivery, as well as provide increased confidence that the inertia requirement will be met at all times.

However, the long-term interests of consumers are likely to be best served if there are opportunities for new providers of inertia to enter the market over time, or for the amount of inertia procured to be reduced in response to changing requirements. This also creates incentives in the market for energy providers that can also deliver inertia, such as solar thermal power stations.

The balance between short and long-term procurement would need to be determined through careful market, technical and economic analysis, as well as industry consultation. This could be adjusted over time in response to experiences in the market.

AEMO also notes that the required level of inertia is not directly related to either the installed capacity or the instantaneous demand, meaning that relying on a static technical standard on generators alone is unlikely to deliver the flexibility required to achieve the most efficient outcome. However, mandatory standards that require new entrant generators to be capable of providing services such as FFR may aid the transition to market based solutions in the future.

### 1.2. Flexibility to coordinate inertia with other services

Initial analysis by AEMO suggests that there may be future opportunities to co-optimise the amount of inertia procured with other services or constraints, such as procuring fast frequency response (FFR) or reducing contingency sizes. This would require flexibility in the volume of inertia that is procured at any given time, ideally in response to actual market conditions (for example, five minutes to 24 hours ahead of time). A means of comparing the marginal cost of additional inertia with the cost of other system constraints would also be needed.

This could be achieved through a market mechanism, or through contracts with no or low availability (fixed) payments. However, only a portion of the total inertia requirement is likely to be able to be substituted by other services, due to the technical requirements of grid operation, so procuring at least some inertia through long-term contracts may be most efficient in this regard. Some longer-term contracts might also provide more opportunities for procuring inertia in specific locations (e.g., to assist with system strength, or to address regions at risk of islanding).

### 1.3. Procurement mechanisms are combined under the current Ancillary Services framework

The current Ancillary Services framework has evolved to utilise a combination of procurement mechanisms. AEMO considers the framework for procuring new services should also allow for a combination of approaches.

To illustrate this point, the following mechanisms are combined under the current ancillary services framework:

- *Generator obligations:* The generator automatic access standard for frequency control (clause 5.2.5.11) requires automatic response to frequency sufficiently rapidly for a generator to be in a position to offer measurable amounts of services to the spot market for market ancillary services.
- *AEMO contracting:* AEMO is a "provider of last resort" for network support and control ancillary services, where the network service provider has not fully met the need and the resulting gap must be met to maintain power system security.
- *TNSP provision:* TNSPs can procure network support and control ancillary services that maximise the present value of net economic benefit to all those who produce, consume or transport electricity in the market (clause 3.11.6).

- *Five-minute dispatch:* The central dispatch process is used for the dispatch and pricing of energy and market ancillary services in the NEM. AEMO may also dispatch services (such as those procured under network support agreements) through the use of constraint equations in the central dispatch process.

### 1.4. Opportunity for market to develop over time

In the near-term, for both inertia and FFR, AEMO sees value in the NEM regulatory framework facilitating trials of emerging technologies, as well as procurement strategies that provide opportunities for as many potential providers as possible. The experience from real-world case studies could then feed into a subsequent review and potentially inform more structured or dynamic procurement options. This would help refine the approach to the enablement, delivery and measurement of the services.

AEMO notes that this is the approach that was taken to the development of the existing FCAS markets: services were originally procured by contracts, before transitioning to a market as a way of reducing costs once the required services and provider capabilities were sufficiently well defined.

### 1.5. Example hybrid options for inertia

Many different hybrid options could be developed, and although a number of options are proposed below, AEMO does not recommend any single approach at this time.

One hybrid option could involve using the NSCAS framework to identify an inertia gap, with a market approach being used to "top-up" the inertia in response to real-time conditions to deliver market benefits, if required. This would allow for longer-term contracts with the TNSP to provide investment certainty for some specified level of system inertia, while the level of additional inertia purchased through the market could be co-optimised with other services (such as procuring FFR or reducing the size of limiting contingency events).

In this context, the market could refer to a 5-minute market (similar to the existing FCAS markets) or a longer duration day-ahead market. AEMO notes that while market participants currently manage their own unit commitment for the energy and FCAS markets, in the near term a day-ahead market may provide greater certainty that the inertia required for power system security would be available when required (particularly in regions with few participants, or if fuel contracts must be sourced), and procured at an efficient price. Further thinking is required to explore these questions in more detail.

In an alternative hybrid option, multiple contracting options could be implemented, so as to deliver inertia contracts with a variety of lengths and financial structures. This could again involve the NSCAS framework for a baseline level of inertia, combined with an option that allows AEMO to procure contracts for inertia that deliver market benefits (which is currently not allowed under the NSCAS framework). The baseline inertia contracts could involve longer durations and primarily fixed payments, while the flexible inertia options could involve primarily payments for delivery and be reconsidered on a regular basis. In practice, the day-to-day dispatch of AEMO contracted inertia could look very similar to the market option.

A permissive approach, where providers submit the terms of what they can deliver, would create more opportunities for varied market participants, but would also make assessing different and varied contracts more challenging.

### 1.6. Fast-frequency response

The above analysis focuses primarily on inertia procurement.

AEMO has recently commissioned detailed analysis by consultants GE on the role of fast-frequency response in efficient and secure market operation. There is little global experience in procuring or operating FFR, and careful consideration of the specific requirements of the NEM will also be required. Therefore, AEMO would caution against immediately committing to prescriptive or long-term procurement options for FFR. It would be more preferable to start out with a series of trials, which could establish the technical capabilities and benefits of FFR delivery. This could be a transitioned to a more structured market or tendering process over time.

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

## 2. CONSIDERATION OF SYSTEM STRENGTH

As part of AEMO's Future Power System Security (FPSS) program, system strength has been identified as a high priority technical challenge that requires further investigation and analysis. AEMO is currently undertaking a program of work to quantify the magnitude of potential system strength challenges and their solutions.

As noted in the AEMC's Interim Report, there is a strong linkage between solutions to inertia and system strength challenges. Therefore, when assessing the different potential options for managing inertia challenges, it is important to also consider the impact on system strength. However, any determination regarding inertia need not fully address system strength issues, so long as any inertia determination isn't inconsistent with any future system strength framework(s).

This would mean that a draft determination on system strength could come after a determination on inertia and FFR, if there was deemed merit in further analysis prior to the determination.

While the AEMC's Interim Report did not provide an extensive discussion regarding regulatory frameworks required to address emerging system strength challenges, AEMO is aware that the AEMC is beginning to consider these questions in parallel with its work on inertia and FFR.

The commentary provided below provides AEMO's preliminary views on the regulatory requirements for managing system strength challenges. Critically, we note that AEMO's thinking is still evolving on these issues, particularly as AEMO undertakes more technical studies of the various requirements.

### 2.1. Context

System strength is an inherent characteristic of any power system – it is an important factor contributing to the stability of a power system under all reasonably possible operating conditions, and can materially impact the way a power system operates.

System strength is usually measured by the available fault current at a given location or by the short circuit ratio. Higher fault current levels are typically found in a stronger power system, while lower fault current levels are representative of a weaker power system. A high fault level, or high currents following a fault, results from generation on the grid responding strongly to the drop in voltage at the fault – trying to restore the situation. Similarly a high short circuit ratio at a point in the grid is a measure of the strength of the response to any faults in that area. Further, a low X/R ratio (ratio of system inductive to resistive impedance) would also have some impact in degrading system strength.

Fault currents vary around the grid both by location and by voltage level. For example, the fault currents are higher in areas close to synchronous generation.

Operation of large high voltage power systems at low fault levels can degrade power system performance, or threaten power system security due to factors such as:

- Manufacturers' design limits on power electronic converter (PEC) interfaced devices such as wind turbines and static Var compensators. Operation of these devices outside their minimum design limits could give rise to generating systems' instability and consequent disconnection from the grid.
- Protections systems which rely on measurement of current (excluding differential protection) or current and voltage during a fault to achieve two basic requirements – selectivity (that is, to operate only for conditions for which the system has been installed) and sensitivity (that is, to be sufficiently sensitive to faults on the equipment it is protecting).
- Inability to control voltage during normal system and market operations such as switching of transmission lines or transformers, switching reactive plant (capacitors and reactors), transformer tap changing, and routine variations in load or generation.

System strength reduces with increasing amounts of PEC connected generation, and also with the displacement of synchronous generation which contribute more to the fault current. Both these drivers can lead to a system wide weak grid[3]. These two drivers for reduced system strength can occur simultaneously or on their own, meaning that the regulatory framework needs to address both drivers and provide clear obligations on appropriate parties to address both issues.

## 2.2. Regulatory requirements

Based on its work to-date, AEMO currently sees a need for two key obligations in parallel to address the underlying drivers for system strength issues:

1. An obligation on an appropriate party (or parties) to maintain some minimum level of system strength; and
2. Obligations on connecting parties, potentially including some combination of:
    a. Not causing any existing Network Users to breach their performance standards as a result of a connecting party driving down the local system strength, and
    b. Requiring connecting parties to operate correctly at short circuit ratios down to a certain level.

The first obligation would ensure that some agreed minimum system strength would be maintained regardless of generator dispatch patterns and the number of synchronous units online, while the second obligation would seek to ensure a fair allocation of responsibility to parties who impact system strength. These two obligations are explored further below.

### 2.2.1. Maintaining a minimum level of system strength

As noted above, adequate system strength is a necessary for secure operation of a power system. Accordingly, it seems reasonable to argue that there is a fundamental amount of system strength which is an essential service, required by all participants, all the time.

While synchronous generation has historically inherently provided system strength, as we transition towards a system with more asynchronous generation, system strength could reasonably be seen as a network service.

This holds for a scenario where a region reaches zero operational demand (as all demand is met by embedded generation), and no large generation is dispatched. Under such a scenario, a certain amount of system strength would still be required on the network.

If viewed as a network service, an obligation could be placed on NSPs to maintain some minimum level of system strength.

### 2.2.2. Obligations on connecting parties

Because system strength issues can also be exacerbated by the connection of multiple PEC connected generating units in close proximity (even if the background system strength remains constant), there is a need to ensure efficient allocation of responsibility between relevant parties.

The minimum access standard could be amended to require connecting parties not to cause any existing network users to not meet their performance standards as a result of the connecting party driving down the local short circuit ratio.

This could be achieved either through the connecting generator installing additional plant to provide local fault current, or contracting with a third party to provide the service centrally.

This places responsibility on the party causing the problem, but provides the potential for the most efficient solution if the connecting generator and a third party provider can agree on commercial terms for a central solution.

---

[3] Local weak grids can also occur, generally in areas where the connection point is in a remote part of the network.

In addition, or as an alternative, the generator performance standards could be reviewed to improve the overall resilience of the future power system to operate in weaker systems. This would lead to modifications of converter control systems from new PEC connected plant.

This could be achieved through a mechanism in the Rules that requires PECs to sustain short circuit ratios down to a certain level.

Such an obligation would improve the overall resilience of the future power system to operate in weaker systems, however it may result in increased costs for new generation as the converter designs would not be standard off the shelf designs (at least initially). Accordingly, such an obligation would need to be tested for efficiency against maintaining higher short circuit ratios across the system, and efficient cost allocation across parties.

## 2.3. General comments

In addition to the proposals above, AEMO also makes the following observations:

- For whatever frameworks are proposed, there would be value in having clear guidelines or expectations set out in the Rules and Rule-based documents (e.g. the Power System Stability Guidelines, Frequency Operating Standards, etc.) that clearly define the responsibilities of relevant parties and how they impact on each other.
- Any framework should ideally allow the most efficient technical solution to be adopted based on existing network planning processes (e.g. comparison of least-cost options including procurement of services from generators, installation of new plant, network augmentation, etc.)
- Ideally there should be an incentive in any inertia solution to also consider how system strength could be addressed (and vice versa). This is important when considering that some solutions (e.g. synchronous condensers) may need to be designed specially to address both issues rather than inherently providing both services from an off the shelf product. The lack of such an incentive risks missing out on significant opportunities for efficiency.
- Any system strength solution needs to have a locational signal due to the geographic nature of system strength issues. Similarly, any inertia procurement option would need to incorporate some form of locational signal if it were to provide a useful additional benefit for the management of system strength issues.