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Government
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MMRE16D00722

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Dear Mr Pierce *John*

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Proposed Rule Change – System Security

The South Australian Government proposes amendments to the National Electricity Rules (the Rules) to provide flexibility for the Australian Energy Market Operator (AEMO) to manage security challenges that may emerge as Australia's electricity supply transitions to a carbon constrained future. This proposal would effect a change to components of Chapters 3, 4, 5 and 8 of the Rules, and make other consequential changes as required.

Traditionally, mechanisms in the National Electricity Market (NEM) used to ensure power system security have been very successful. However, Australia's transition to a carbon constrained future is having an impact on arrangements which contribute to the security of the power system.

The transition is resulting in significant investment in intermittent generation such as wind and increasing levels of localised electricity supply changing consumers' needs from the interconnected power system. These changes are having a significant impact on conventional generation in the NEM, with old generation supply being mothballed or withdrawn from the market.

Services that would normally be provided by traditional synchronous generators in the past to balance supply and demand are still required for power system security. However, maintaining these services, or procuring suitable alternative services, to ensure system security is becoming a complex matter, given the high rates of installation of wind and rooftop solar PV and the withdrawal of traditional synchronous generators.

Issues with managing this transition are already emerging in South Australia ahead of other jurisdictions in the NEM, as there has already been a substantial shift from conventional generation to renewable energy production with over 40 per cent of the State's total generation coming from renewable sources in 2014/15.



The South Australian Government has therefore identified the need to assess whether arrangements which contribute to the continued security of the power system remain adequate with this changing generation mix.

AEMO has been working on identifying challenges associated with the transitioning electricity market and will continue to provide planning and analysis to allow for informed decisions to be made to enable the market to respond to the future changes. This Rule change proposal has been generally based on a number of key issues identified by AEMO in its work to date.

The proposal seeks to provide the necessary flexibility in the Rules for AEMO to manage security challenges that may emerge as Australia's electricity supply transitions to a carbon constrained future, and as AEMO's work in this area progresses.

The amendments are presented as a package of individual Rule change proposals, rather than one single Rule change, to enable the Commission to determine the most efficient approach to progress the proposed amendments. This should enable the Commission to advance each component as quickly as possible recognising that some will be more technically difficult than others.

The proposed changes relate to the following areas:

Managing rate of change of frequency

AEMO currently has limited mechanisms available to it to procure additional ancillary services to manage security issues such as rate of change of frequency. To provide AEMO with the necessary flexibility to manage these issues as they arise, it is proposed that a non-market mechanism be incorporated in the Rules to ensure these services can be obtained when required.

Emergency frequency control schemes – for generation deficit events

AEMO has found that in the event of a non-credible separation of one region from the remainder of the NEM, there is an increasing risk that the current automatic under frequency load shedding scheme will be unable to maintain frequency within the frequency operating standards. This risk is partly due to an insufficient amount of load being shed from the power system during low frequency events, due to the impact of rooftop PV embedded in the distribution system. The Rule change proposes flexibility be incorporated in the Rules for an alternative scheme to ensure frequency is maintained as behaviour downstream of the relays becomes more dynamic with increasing levels of distributed generation, and overcome issues associated with the suitability of current technologies that are not designed to adapt to changing system conditions.

Emergency frequency control schemes – for excess generation events

If generation trips during an over frequency event are not well coordinated AEMO considers there is the potential for too much generation plant to trip and an under frequency event to occur, and potentially subsequent load shedding. At present there is no specific emergency control scheme in place to maintain frequency within the frequency operating standards following such an event.

The Rule change proposes that the Commission amend the Rules to explicitly provide a framework for the establishment of flexible emergency frequency control schemes.

Fault levels

AEMO has noted that the NEM has historically been designed to prevent fault levels becoming too high, but as the generation mix changes, challenges will arise with the fault levels being too low. The Rule change proposes that the Commission amend the Rules to ensure they can accommodate issues associated with low fault levels that are becoming relevant in the current market.

Should you have any questions in relation to this proposal, please contact Ms Rebecca Knights, Director – Energy Markets, Energy Markets and Programs Division on (08) 8226 5500.

Yours sincerely



Hon Tom Koutsantonis MP
Minister for Mineral Resources and Energy

12 July 2016

System Security
Package of Rule change requests
July 2016

1. Name and address of rule change proponent

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2. Description of the proposed rules.

The proposed rules seek to provide the necessary flexibility in the National Electricity Rules (the Rules) for the Australian Energy Market Operator (AEMO) to manage security challenges that may emerge as Australia's electricity supply transitions to a carbon constrained future.

The generation mix can evolve rapidly and disruptive events (such as the withdrawal and mothballing of coal-fired and gas-fired generation) can occur with short notice for National Electricity Market (NEM) response by AEMO and other market participants.

There is potential for both security and reliability challenges to emerge rapidly in these circumstances. Whilst a separate rule change has been progressed to extend the Reliability and Emergency Reserve Trader to provide a safety net for reliability issues, mechanisms in the rules which are used by AEMO to address security issues are often prescriptive and may not address or respond to challenges associated with Australia's changing generation mix.

AEMO has recently undertaken work with other market institutions and energy officials through the Power System Implications Technical Advisory Group (PSI – TAG) to develop a clear list of technical challenges of operating the power system in the changing generation mix. PSI-TAG, which met for the first time in early December 2015, included nominated representatives from conventional generators, retailers, transmission and distribution businesses, the Clean Energy Council, the COAG Energy Council's Standing Committee of Officials (SCO), the Australian Energy Regulator (AER), as well as the Commission and AEMO.

Emerging challenges identified by PSI-TAG include:

- Reduced inertia in areas of the grid, which under some circumstances could result in a high rate of change of frequency and the disconnection of some generation.
- Low fault levels on the power system.
- The effectiveness of under frequency load shedding schemes being challenged by high rate of change frequency due to reduced inertia and uptake of distributed energy resources, which can reduce the load available to be shed at the times when distributed generation is generating.

- Potential for power system events resulting in excess generation compared to demand, raising frequency and resulting in protection systems disconnecting generation units.

This proposal is presented as a 'package' of rule changes, and not one single rule change. The Commission should consider the rule changes in the most efficient manner possible, either individually or collectively, so that any amendments can be implemented expediently to help address these emerging issues.

The rule change requests seek to amend Chapters 3, 4, 5 and 8 of the Rules and make other consequential changes as required, so that:

- The regulatory framework supports competitive and efficient provision of ancillary services necessary to manage emerging security challenges such as a high rate of change of frequency;
- The roles and responsibilities for managing system security challenges, including development of a framework for management of particular multiple contingency events by AEMO and NSPs are sufficiently clear; and
- The regulatory framework for the establishment of emergency frequency control schemes, such as automatic load and generation shedding schemes, associated settings and other emergency frequency control schemes are appropriate with the changing generation mix, including increased likelihood of low inertia conditions and further uptake of distributed generation.

3. Background to the proposed rules

AEMO is responsible for ensuring demand on the National Electricity Market (NEM) power system and its instantaneous supply is always in balance. Traditionally, supply was from coal, gas fired and hydro generation plant which can be readily scheduled and dispatched.

A key requirement of a secure power system is that power system frequency remains within limits specified by the Frequency Operating Standards (FOS). This is achieved by balancing electricity generation and demand at all times. The central dispatch process in the NEM is used to procure frequency control ancillary services (FCAS) to meet the FOS during normal operation and following a credible contingency event.

Traditionally, mechanisms used to ensure power system security have been very successful. The Reliability Panel's Annual Market Performance Review in 2014 found that AEMO was only required to issue one direction for security to maintain the power system in a secure operating state over the 2013/14 period. Whilst there were some frequency excursions outside the FOS, these incidents were managed without material impacts on the NEM or its participants.¹

¹ AEMC Reliability Panel, *Annual Market Performance Review 2014*, 16 July 2015, p53.

However Australia is transitioning to a carbon constrained future. The Commonwealth Government has committed Australia to reduce greenhouse gas emissions by 26% to 28% on 2005 levels by 2030. This target represents a 50% to 52% reduction in emissions per capita and a 64% to 65% reduction in the emissions intensity of the economy between 2005 and 2030.

Further, the Renewable Energy Target requires 33,000 GWh of large-scale renewable generation by 2020 and continuing at that level until 2030. This will require substantial additional investment in large scale generation from renewable sources.

Australia's transition to a carbon constrained future has already commenced resulting in significant investment in intermittent generation such as wind and increasing levels of localised electricity supply changing consumers' needs from the interconnected power system.

These changes are having a significant impact on conventional generation in the NEM. The changed energy environment has already resulted in old generation supply being mothballed or withdrawing from the market and being decommissioned. This is already occurring in jurisdictions such as South Australia and New South Wales.

The South Australian Government therefore acknowledges the need to assess whether arrangements which contribute to the continued security of the power system remain adequate with this changing generation mix.

Services that would normally be provided by traditional synchronous generators in the past to balance supply and demand, are still required for power system security. However, maintaining these services, or procuring suitable alternative services, to ensure system security is becoming a complex matter, given the high rates of installation of wind and rooftop solar PV and the withdrawal of traditional synchronous generators.

Issues with managing this transition are already emerging in South Australia ahead of other jurisdictions in the NEM, as there has already been a substantial shift from conventional generation to renewable energy production with over 40 per cent of the State's total generation coming from renewable sources in 2014/15.

AEMO and ElectraNet are leading the analysis of power system impacts of emerging technologies, releasing a report on Renewable Energy Integration into the National Electricity Market. This joint report was initially released in 2014 with an updated version released in February 2016.

The report found that there is a risk to power system security and reliability in South Australia when there is a high proportion of wind and rooftop PV generation and the Heywood Interconnector link to Victoria is disconnected at a time when little local synchronous generation is online. This risk exists because wind and rooftop PV

generation alone do not currently provide the required services to maintain power system security in South Australia during or after a contingency event resulting in separation from the rest of the NEM. While the probability of the disconnection of South Australia from the remainder of the NEM is low, the potential consequence is a state-wide power outage with severe economic and possible health and safety impacts.²

As mentioned above, AEMO has recently undertaken work with other market institutions and energy officials through the PSI – TAG to develop potential solutions for the technical challenges of operating the power system in the changing generation mix. AEMO's program of work going forward will identify feasible solutions to assist maintaining power system security and reliability. While initially focussed on South Australia, as the region most likely to first experience challenges, the program of work has a NEM-wide focus.

4. Nature and scope of the issues the proposed rules will address

A critical challenge for the future is to integrate renewables and other new behind the meter technologies while not compromising the integrity of the power system with regard to security and reliability. AEMO has been working on these issues for a number of years and will continue to provide planning and analysis to allow for informed decisions to be made to enable the market to respond to the future changes.

In the past AEMO could more easily identify a change in load and determine if more or less generation should be dispatched in order to maintain system security. As behind the meter products, such as solar PV, battery storage and energy management systems become more prevalent in the market these types of decisions are becoming increasingly more challenging.

The AEMO-ElectraNet joint report concluded that the high percentage of renewable energy generation in South Australia has placed a greater reliance on the Heywood Interconnector for South Australia's power system security and reliability. Under normal operating conditions, i.e. with no equipment failure, the South Australian power system can continue to operate securely and reliably. However, this stable electricity supply does rely heavily on the transmission network connecting South Australia to Victoria remaining in service and uninterrupted.

The joint report highlights a number of operational measures implemented over the last 18 months to address the short term challenges of operating South Australia's power system securely if it is disconnected from the rest of the NEM. Following its investigations, AEMO has:

- Amended its internal procedures for managing power system security in South Australia when South Australia is at risk of islanding.

² AEMO-ElectraNet, *Update to Renewable Energy Integration in South Australia*, February 2016, p 8.

- Implemented internal procedures to maintain power system security in South Australia post separation for periods that do not include the hot water demand peak period.

The report also explains the need to begin looking at efficient and sustainable solutions with at least a 10 year outlook. As mentioned AEMO formed an industry reference group – the PSI-TAG – to provide input towards a comprehensive issues list with a long term outlook.

The South Australian Government is proposing the Commission consider amendments to the Rules in regards to a number of key issues that have been highlighted through AEMO's work to date and where potential gaps in the regulatory framework and Rules have also been identified.

Given the background provided on these issues above, the South Australian Government is proposing various rule amendments be made. As stated earlier, these amendments are attached as individual rule change proposals to enable the Commission to determine the most efficient approach to progress the proposed amendments. This should enable the Commission to advance each component as quickly as possible recognising that some will be more technically difficult than others. The attached rule change proposals are:

- Attachment A - Managing Rate of Change of Frequency;
- Attachment B – Emergency Frequency Control Schemes – For Generation Deficit Events;
- Attachment C – Emergency Frequency Control Schemes – For Excess Generation Events;
- Attachment D – Low Fault Levels.

Rule Change Request

Managing Rate of Change of Frequency

1. Nature and scope of the issues the proposed rule will address

Changes in the generation mix have significantly increased the risks to system security arising from rapid changes of frequency. Following a separation event, frequency in the separated parts of the power system will rise or fall, depending on the direction of power flow across the separation point immediately prior to separation. The rate of change of frequency (RoCoF) is determined by the contingency size at separation, and the inertia delivered by the online generating units in the respective separated regions of the power system.

If the RoCoF is too high, there is a risk that protection systems sensitive to RoCoF will trip load or generation, or that frequency will rise or fall beyond the bounds of FOS before frequency control schemes are able to act to moderate the disturbance. AEMO report that this additional tripping of generation following separation has the potential to increase the impact of the event, increase the amount of load that is shed and lead to ongoing cascading tripping of generation.

As an example, the joint report states that there is a downward trend in the inertia in South Australia since the start of 2012. This is due to the increase in wind and rooftop PV generation, that contribute little in the way of inertia, and the consequent removal from service of synchronous generation, which is the major provider of inertia. The total inertia available in South Australia has further reduced following closure of Northern Power Station in May 2016.

To limit the RoCoF to acceptable levels, when South Australia is at credible risk of separation, AEMO will invoke network constraint sets to limit flow on the Heywood Interconnector based on the amount of online inertia available in South Australia. This is required so that, in the event of a credible contingency event resulting in separation of South Australia from the rest of the NEM, RoCoF in the islanded South Australian region can be managed and the separated systems maintained in a secure operating state in accordance with Rule 4.2.4.

While the reducing availability of inertia and associated RoCoF are issues currently emerging in South Australia, these are also likely to present themselves more broadly in the NEM as the generation mix continues to change. It is important that right incentives and market frameworks exist to enable AEMO to effectively manage these developing issues.

2. Proposed rule amendment

The Rules do not define the rate of change of frequency which is acceptable under various circumstances. The Rules also do not provide the market or regulatory means to acquire services to maintain the rate of change of frequency within those defined limits.

AEMO currently has limited mechanisms available to it to procure additional ancillary services to manage security issues such as RoCoF. Under the current Rule 3.2.4 AEMO must determine the market's requirements for non-market ancillary services in accordance with Rule 3.11, and use reasonable endeavours to acquire them. Rule 3.11 enables AEMO to instruct a person to provide a non-market ancillary service under an ancillary services agreement and the person must use reasonable endeavours to comply with this instruction. However, the Rules define non-market ancillary services as *system restart ancillary services (SRAS)* and *network support and control ancillary services*, limiting AEMO's ability to procure a broader range of ancillary services that may assist in addressing issues such as RoCoF and low fault levels.

To provide AEMO with the necessary flexibility to manage such issues Chapter 3 of the Rules should be amended to enable AEMO to procure the necessary services via an ancillary service agreement with the prices being determined in accordance with the relevant agreement. This would enable AEMO to obtain a broader range of ancillary services as required providing AEMO with the flexibility to manage emerging security challenges, such as a high RoCoF and low fault levels, through the competitive and efficient procurement of the required ancillary services.

The Commission should also amend the Rules to enable AEMO to develop guidelines for the acquisition of these services, similar to the SRAS guidelines, which may contain technical information, information on the contracting process for AEMO to follow when contacting a potential service provider and guidance to registered participants on the factors that AEMO must take into account when making a decision to follow a particular type of procurement process.

In addition, AEMO has noted that the Rules currently require generating units to remain connected through an event where RoCoF reaches ± 1 Hertz per second. However, there is no system standard in Schedule 5.1a which requires the power system to be operated so that the RoCoF during any contingency event is maintained within this range. A system standard for RoCoF may assist in the management of power system security and clarify responsibilities of AEMO, NSPs and market participants.

It is also therefore proposed that a system standard for RoCoF is established as part of the amendments to the Rules to overcome this issue. Amendments should be made to Rule 8.8 to enable the development of this standard to be undertaken by the Reliability Panel given their current role regarding system security and development

of other system standards. A process for the Reliability Panel to develop and maintain a RoCoF system standard should be prescribed in the Rules.

As mentioned, AEMO has recently undertaken work with other market institutions and energy officials through the PSI – TAG to develop potential solutions for the upcoming technical challenges regarding power system operation. AEMO's program of work going forward will identify feasible solutions to assist maintaining power system security and reliability. While the South Australian Government is proposing the Commission consider amendments to the Rules in regards to a number of key issues, there have been other issues that have been highlighted through AEMO's work to date where potential solutions require further consideration.

3. How the proposed rule will or is likely to contribute to the achievement of the national energy objective

Under section 7 of the National Electricity Law (NEL), the National Energy Objective (NEO) states:

"The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to -

- (a) price, quality, safety, reliability and security of supply of electricity; and
- (b) the reliability, safety and security of the national electricity system."

The aspects of the NEO relevant to this rule change proposal are the promotion of the efficient use of electricity services for the long term interests of consumers with respect to security of the national electricity system.

The proposed rule amendments will, or are likely to, contribute to the achievement of the secure national electricity system where, in light of a changing generation mix, there is a risk that current system standards and mechanisms may not be adequate to respond to power system events.

4. Australian Energy Market Operator's declared network functions

This proposed rule has no impact on rules relating to AEMO's declared network functions.

5. Expected costs, benefit and impacts of the proposed rule

The amendments proposed in this rule change will provide benefits to consumers by helping maintain the security of the power system. By enabling AEMO to obtain a broader range of ancillary services as required, the rule change will provide them with the necessary flexibility to manage emerging security challenges, such as a high RoCoF. Obtaining these ancillary services will assist in preventing high levels of RoCoF from tripping generation following separation events and will therefore reduce the impact of the event and the amount of load that is shed, thereby benefiting

consumers. Obtaining these services via an ancillary service agreement will ensure they are acquired through a competitive and efficient process.

The costs of the rule proposal would include costs to AEMO in establishing the guidelines for the acquisition of services, which would be similar to the SRAS guidelines, as well as any other costs in procuring services via agreements. As these services will only be required on an occasional basis it is not anticipated that the ongoing purchase costs will be high, and therefore the benefits of the proposal are expected to outweigh any costs. Any purchase costs to AEMO will also result in an additional benefit to the party providing the ancillary service.

Further, by including a system standard for RoCoF in the Rules will assist in the management of power system security and clarify responsibilities of AEMO, NSPs and market participants.

The benefit of commencing consideration of this proposed amendment to the Rules in parallel with the work being undertaken by AEMO is it will reduce the time required to implement identified solutions to managing these emerging issues, in particular in regions where the issues are emerging more rapidly. Providing greater flexibility within the Rules should result in more timely application of solutions to address the technical challenges raised.

Further, while some issues associated with the change to the generation mix may be occurring more rapidly in particular jurisdictions, considering potential rule amendments nationally is considered appropriate given the interconnectedness of the system and the ability to manage events that impact on the security of the system in adjacent jurisdictions.

Amending the Rules to address issues associated with the changing generation mix is likely to provide a relatively low-cost option that will benefit consumers with regard to security of the national electricity system. On balance, any potential negative impacts created by amendments to the Rules are likely to be minimal and outweighed by the benefits of maintaining a secure national electricity system.

6. Stakeholder consultation

Officials from the Commission and AEMO, as well as NEM jurisdictional Governments and the Commonwealth Government have been consulted in the development of this rule change proposal. The issues generally discussed in this proposal have been identified by AEMO and ElectraNet in their joint technical reports.