

The Hon Tom Koutsantonis MP
Member for West Torrens



Government
of South Australia

MMRE16D00722

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Mr John Pierce
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The Australian Energy Market Commission
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Dear Mr Pierce

A handwritten signature in dark ink, appearing to read "John", written over the typed name "Dear Mr Pierce".

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are having a significant impact on conventional generation in the NEM, with old generation supply being mothballed or withdrawn from the market.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

Emergency frequency control schemes – for generation deficit events

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

Changes in the generation mix have changed the dynamic response of the power system to contingencies. The central dispatch process in the NEM is used to procure FCAS to meet the FOS during normal operation and following a credible contingency event. However, for non-credible contingency events that usually have more severe outcomes, the Rules require automatic under frequency load shedding (AUFLS) to prevent the frequency from breaching a wider FOS. The AUFLS scheme is designed to minimise disruption of a major disturbance on the power system, such as cascading tripping of generating units, which could otherwise lead to a total blackout of the system.

In 2015, AEMO completed a NEM-wide study to determine if the current settings for AUFLS schemes were still appropriate to maintain power system security and reliability. A further review was then undertaken to investigate the impact of further growth in rooftop PV and generator withdrawals on the effectiveness of the AUFLS scheme in South Australia. The studies have found that:

- In the event of a non-credible separation of South Australia from the remainder of the NEM, there is an appreciable and increasing risk that the current AUFLS scheme in South Australia will be unable to maintain frequency within the FOS.
- It is reported that this risk exists when there is low operational consumption, low power system inertia (less than 4–5 synchronous generating units operating in South Australia), a material flow of power across the Heywood Interconnector into South Australia and high rooftop PV generation.
- 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 parts of the distribution system.
- As synchronous generation continues to withdraw or be operationally de-committed from the market, there is an increasing risk of high RoCoF following extreme events and especially in the case of separation³.

AEMO are suggesting that the current load shedding scheme in its current form is not likely to be sufficient at higher RoCoF levels, and given the impact of PV and therefore the related behaviour downstream of the relays. An alternative scheme is expected to be required to ensure frequency is maintained as high RoCoF exposure

³ AEMO-ElectraNet, *Update to Renewable Energy Integration in South Australia*, February 2016, p 3,25.

increases, and the behaviour downstream of the relays becomes more and more dynamic with increasing levels of distributed generation.

These amendments to the Rules would allow AEMO and NSPs to develop control schemes able to deliver broader emergency frequency response services that are better able to manage the increasingly dynamic behaviour of the power system. Such schemes could operate automatically on the basis of changes in system frequency, or directly in response to specific system events such as the disconnection of critical network elements (e.g. both circuits of the Heywood Interconnector). The additional ability to respond to system events rather than a change in frequency is likely to be required to maintain FOS under high RoCoF conditions that may suppress system frequency faster than relays are able to respond.

2. Proposed rule amendment

AEMO analysis highlights that the limited provisions in the Rules for the provision of under-frequency load shedding are likely to become increasingly inadequate to manage the frequency of the power system during extreme events and, in particular, in separation events. The Rules and the frequency operating standards inadequately define the requirements and do not provide an appropriate framework to ensure that efficient and effective mechanisms are available to meet those requirements.

The Commission should consider whether an amended AUFLS or alternative emergency frequency control scheme could be accommodated under the current Rules contained through Chapters 4 and 5 (specifically clauses 4.3.2, 4.8.9, S5.1.8 and S5.1.10.1), or make amendments to allow flexibility for this to occur, following further AEMO consideration of potential future schemes.

The Commission should make amendments to the Rules to overcome issues associated with the suitability of current technologies to ensure efficient and effective schemes are in place to manage the frequency following extreme events. As current schemes may disconnect sources of distributed generation, as well as load, and may not be able to act quickly enough to maintain FOS under high RoCoF, they may not be the most effective ways to deliver the required level of load reduction and frequency control, as described above. However, as current technologies that shed load use pre-set relays and are not designed to adapt to changing system conditions, they are therefore unlikely to shed sufficient load to adequately manage system frequency with ever increasing levels of embedded generation.

As there are currently no incentives for network operators to invest in updated technology it is proposed that the Rules be amended to include a framework to require these investments to be made as necessary. Network service providers should be required to monitor the efficacy of emergency frequency control schemes as the character of generation and load on the system continues to change. This will require assessing the need to invest in updated relay technologies that will enable more adaptable load shedding. AEMO and the Jurisdictional System Security

Coordinator, in consultation, should be able to direct network service providers to undertake these investments, in accordance with their role in maintaining power system security, if NSPs have not done so within a sufficient timeframe of the need being identified.

These responsibilities should be well defined within the framework established by the Rules. Amendments to the Rules are likely to be required regarding network planning, as well as around operation of load shedding and emergency frequency control schemes. This may also require amendments to Schedule 5.1 regarding Network Performance Requirements by Network Service Providers, and clauses 5.12 and 5.13 regarding planning and reporting obligations for Network Service Providers. Rules under Chapter 6 and 6A should also be reviewed to ensure the AER approve these types of investment, assuming they are justified by the NSP or if it is directed to undertake the expenditure by AEMO or the Jurisdictional System Security Coordinator.

In addition to the above, concerns have also been raised regarding clause 4.3.5 of the Rules which refers to the ability of market customers who have expected peak demand at connection points in excess of 10MW to provide automatic interruptible load above 60% of their expected demand (or some other amount determined by the Reliability Panel). This clause does not reflect the practical implementation of current load shedding arrangements which are determined and managed by AEMO, the Jurisdictional System Security Coordinator and the NSP. It is unclear how this clause is relevant given current load shedding arrangements and should therefore be amended to reflect current practices.

A further matter for the Commission's consideration is in regard to the definition of multiple contingency events. These events are poorly described in the Rules. The Rules should be clarified to ensure frequency is controlled following islanding or major disruptions under certain multiple contingencies.

The frequency operating standards currently state that *"as a result of any multiple contingency event, system frequency should not exceed the extreme frequency excursion tolerance limits and should not exceed the applicable generation and load change band for more than two minutes while there is no contingency event or exceed the applicable normal operating frequency band for more than ten minutes while there is no contingency event."*

It is not possible to maintain FOS for *any possible multiple contingency event* (the simultaneous trip of all generation in a NEM region, for example). As such, the Commission should add flexible provisions to the Rules that would allow an independent body, such as the Reliability Panel, to nominate specific system events, such as the non-credible loss of interconnectors under particular conditions, for which FOS should be maintained. The objective of these provisions is to provide clarity as to which multiple contingency events should be managed and define

acceptable levels of consequence in mitigating the most severe outcomes of the specific events.

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 -

- (c) price, quality, safety, reliability and security of supply of electricity; and
- (d) 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

This rule change proposal will provide benefits to the market and consumers by enabling broader emergency frequency response services to be established that are better able to manage the increasingly dynamic behaviour of the demand side. As current schemes may disconnect sources of distributed generation, as well as load, and may not be able to act quickly enough to maintain FOS under high RoCoF, they may not be the most effective ways to deliver the required level of load reduction and

frequency control. The proposal will enable an amended or alternative scheme to be accommodated under the Rules.

The proposal will also overcome issues associated with the suitability of current technologies to ensure load shedding schemes are efficient and do not disconnect sources of distributed generation. The framework to require network operators to invest in updated relay technologies proposed by this rule change will benefit consumers by enabling more adaptable load shedding to be undertaken. These investment costs would need to be justified by the NSP and approved by the AER.

This rule change proposal does not propose that any specific event or group of events should be included in the framework, rather, it merely proposes the establishment of a framework to support such a process.

The addition of flexible provisions to the Rules that would allow an independent body, such as the Reliability Panel, to nominate specific system events for which FOS should be maintained acts to advance the NEO and provides benefits to consumers by increasing the security of the power system where it is determined to be of benefit.

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.