Australian Energy Market Commission

DRAFT RULE DETERMINATION

National Electricity Amendment (Managing the rate of change of power system frequency) Rule 2017

Rule Proponent

South Australian Minister for Mineral Resources and Energy

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About the AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the COAG Energy Council.

Executive Summary

The Australian Energy Market Commission (AEMC or Commission) has made a draft rule, which is a more preferable rule, to place an obligation on Transmission Network Service Providers (TNSPs) to procure minimum required levels of inertia or alternative frequency control services.

The widespread deployment of non-synchronous generating technologies, such as wind farms and solar panels, is having impacts on the operation of the power system. These technologies, have low or no physical inertia, and are therefore currently limited in their ability to dampen rapid changes in power system frequency, which is needed in order to maintain a secure power system.

The Commission considers that a secure power system demands the availability of minimum levels of inertia at all times and an obligation on TNSPs to provide this service will establish confidence that system security can be maintained in all regions of the National Electricity Market (NEM).

The rule change request

The more preferable draft rule has been made with respect to a rule change request received from the South Australian Government and accompanies the Commission's final report on the *System security market frameworks review*. The South Australian Government considers that less synchronous generation in the NEM is leading to a lack of system inertia. This is increasing the susceptibility of the system to rapid changes in frequency that arise as a result of system disturbances.

Historically, most generation in the NEM has been synchronous and, as such, the inertia provided by these generators has not been separately valued. As the generation mix shifts to smaller and more non-synchronous generation however, inertia is not provided as a matter of course giving rise to increasing challenges for the Australian Energy Market Operator (AEMO) in maintaining the power system in a secure operating state.

The shift to newer types of generation has been more pronounced in some regions of the NEM than others. South Australia, in particular, has experienced a substantially faster change than other regions as an increasing volume of non-synchronous generation is integrated. Flows on the interconnector with Victoria allow power system security to be maintained in normal circumstances because of inertia provided by generators in other parts of the NEM. Where there is an outage of this interconnector, the risks to system security in South Australia increase significantly because it must rely on inertia provided by generators within the region. This makes it harder to arrest the frequency change and restore the frequency to normal operating levels. As the generation mix changes in a similar way across the NEM these risks may become more widespread.

The South Australian Government's rule change request proposes that AEMO should be provided with powers to determine the services necessary to manage sudden

changes in frequency and procure these services through an efficient and competitive process to maintain power system security.

The Commission has made a more preferable draft rule with respect to the South Australian Government's rule change request. The Commission has concluded that, for the following reasons, the best mechanism to meet the minimum inertia requirements associated with maintaining system security would be through provision of inertia services by TNSPs.

- The existing economic regulatory framework will provide a means for the TNSP to assess the least-cost approach to meeting the obligation with oversight and approval by the Australian Energy Regulator (AER).
- TNSPs are best placed to provide the required levels of inertia within each sub-network and to coordinate the location of inertia with other network support services, including obligations related to minimum system strength.

Minimum required levels of inertia

Under the National Electricity Rules (NER), AEMO must operate the power system such that, to the extent practicable, it is and will remain in a secure operating state.[1] In terms of frequency control, this means that system frequency must stay within the bounds specified in the Frequency Operating Standards (FOS) following the occurrence of a credible contingency[2] or protected event.[3]

Prior to the occurrence of such a contingency event, there are two actions that could be taken to minimise the resulting initial frequency change:

- constrain the power system to minimise the impact of the contingency; and/or
- increase the level of inertia in the system to resist the initial frequency change.

However, short of constraining all generation and network flows - and therefore demand - to zero, there is a minimum level of inertia required even to operate the system in a heavily constrained manner. Such a level would provide:

- time for frequency control ancillary services to respond and recover the frequency to normal operating levels;
- time for emergency frequency control schemes to operate effectively; and
- a higher probability of generators remaining online following the occurrence of the contingency event.

1 Clause 4.2.6(a) of the NER.

2 A credible contingency is an event which AEMO considers to be reasonably possible. Generally, such events would involve the loss of one generating unit or network element.

3 A protected event is a non-credible contingency that, following a declaration by the Reliability Panel, must be managed in a similar manner to credible contingencies.

With increasingly less synchronous generation in the NEM, this draft rule establishes an obligation on TNSPs to provide confidence that this minimum level of inertia will be available when needed to maintain a secure operating system.

The draft rule

The more preferable draft rule made by the Commission is attached to and published with this draft rule determination. The key features of the more preferable draft rule are as follows.

- An obligation on AEMO to determine sub-networks in the NEM that are required to be able to operate independently as an island and, for each sub-network, to assess whether a shortfall in inertia exists or is likely to exist in the future.
- Where an inertia shortfall exists in a sub-network, an obligation on the relevant TNSPs to make continuously available minimum required levels of inertia, determined by AEMO through a prescribed process.
- An ability for TNSPs to contract with third-party providers of alternative frequency control services, including fast frequency response (FFR) services, as a means of meeting a proportion of the obligation to provide the minimum required levels of inertia, with approval from AEMO.
- An ability for AEMO to enable the inertia network services provided by TNSPs and third-party providers under specific circumstances in order to maintain the power system in a secure operating state.[4]

The Commission considers that the draft more preferable rule will contribute to the achievement of the national electricity objective (NEO) for the following reasons.

- The existing economic regulatory framework will provide a means for the TNSP to assess the least-cost approach to meeting the obligation with oversight and approval by the AER.[5] The draft rule will allow the TNSP to meet the obligation in the short-term by contracting with existing third-party providers of inertia, while concurrently assessing the most efficient means of meeting the obligation over the long term.
- The periodic review of the level of the obligation on TNSPs to provide inertia network services, and the requirement for the TNSP to identify and procure the least cost option or combination of options to meet its inertia obligation,[6] will

4 An inertia network service is enabled when AEMO has selected the relevant inertia network service and it is providing inertia to an inertia sub-network.

5 AEMO is responsible for planning, authorising and directing augmentation of the declared shared network in Victoria. AEMO Different arrangements for the provision of shared transmission services, including inertia network services, will apply to AEMO in its role as the Inertia Service Provider for Victoria.

6 Draft Rule clause 5.20B.4(f).

assist in making sure that further investments are efficient and reflective of changing market conditions.

- The obligation on TNSPs to provide inertia network services will only apply to sub-networks where AEMO has identified that an inertia shortfall exists. This will promote efficient investment and use of services by:
  - maintaining system security where it is needed while not imposing undue market or compliance costs on other areas; and
  - providing for future shortfalls in inertia to be identified in a timely manner.
- Placing the obligation on TNSPs to provide inertia network services will provide a greater ability to coordinate the provision of inertia network services with other network support requirements for the relevant sub-network, such as system strength. This should result in a more efficient outcome for consumers in the long term by avoiding the potential duplication of investment.
- The ability for the TNSP to make available inertia network services through contracts with third-party providers of services other than the provision of inertia will promote efficiency in investments by expanding the range of options available to manage the secure operation of the system.

Submissions on this draft rule determination are due by **8 August 2017**.

Additional inertia for market benefit

The draft rule relates to the provision by TNSPs of the minimum level of inertia required to maintain secure operation of the power system. This can be distinguished from additional levels of inertia, or alternative frequency control services, that may increase economic benefits by allowing for greater power transfers on the network, such as greater energy flows on interconnectors.

The draft rule does not provide a mechanism to realise the market benefits that could be obtained through the provision of inertia at levels above the minimum level of inertia required to maintain secure operation of the power system.

As part of the *System security market frameworks review*, the AEMC has been assessing a rule change request received from AGL, which proposes the establishment of an inertia ancillary services market. The AEMC intends to continue its assessment of this rule change request with a view to implementing a mechanism to guide the provision of additional inertia for market benefit. The Commission has decided to extend the period of time for making a draft determination on this rule change request until 7 November 2017.

The Commission considers that the ability to maintain power system security in an efficient manner would be enhanced by the development and introduction of a mechanism to obtain and pay for inertia and that this would further contribute to the NEO. However, such a mechanism will need careful design due to the potential

impacts on the operation of the energy and ancillary services markets. Continued stakeholder engagement and consultation will be required in the development process.[7]

A market mechanism will complement and build on the certainty created through the TNSP obligation by providing the ability to continuously adjust the level of service provision in real time to maximise efficiency. Ultimately, the combined TNSP obligation and market mechanism will form an enhanced framework which efficiently balances certainty and flexibility for the management of system frequency in the long term interests of consumers.

7 The Commission's assessment of potential mechanisms for the provision of additional inertia is set out in the final report on the *System security market frameworks review*.

Contents

1 The South Australian Government's rule change request

1.1 The rule change request

On 12 July 2016, the South Australian Minister for Mineral Resources and Energy made a request to the Australian Energy Market Commission (AEMC or Commission) to make a rule regarding the management of potential fast rates of change of frequency in the power system.

The South Australian Government considers that less synchronous generation in the National Electricity Market (NEM) is leading to a lack of system inertia. Lower levels of inertia increase the susceptibility of the system to rapid changes in frequency that arise as a result of system disturbances.

Historically, most generation in the NEM has been synchronous[8] and, as such, the inertia provided by these generators has not been separately valued. As the generation mix shifts to smaller and more non-synchronous generation however, inertia is not provided as a matter of course giving rise to increasing challenges for the Australian Energy Market Operator (AEMO) in maintaining the power system in a secure operating state.

While there is a minimum level of inertia which must be provided in order to maintain the power system in a satisfactory operating state, above this level, inertia and frequency control services can both be used to manage power system frequency.

The rule change request proposes that AEMO should be provided with powers to determine the services necessary to manage sudden changes in frequency and procure these services through an efficient and competitive process.

1.1.1 Approach to the draft determination

This draft determination has been made in response to the South Australian Government's rule change request and accompanies the Commission's final report on the *System security market frameworks review*.[9]

In making its assessment of the issues raised in this rule change request, the Commission has drawn upon the work currently being undertaken by AEMO as part of its Future Power System Security Program (FPSS), initiated in December 2015.

AEMO has identified and prioritised current and potential future challenges to maintaining system security. These challenges all stem from greater levels of non-synchronous generation in the NEM.

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8 Synchronous generating units contain large spinning turbines that are electromagnetically coupled with the power system and synchronized to the frequency (50 Hertz) of the power system.

9 The Commission has published a final report on the System Security Market Frameworks Review - http://aemc.gov.au/Markets-Reviews-Advice?reviewer=1&status=2

This draft determination specifically addresses the potential for high rates of change of frequency to occur following a sudden change in supply or demand as a result of reduced levels of system inertia.

The draft rule implements the principal components of an immediate package of measures that was set out in the directions paper on the *System security market frameworks review* published on 23 March 2017. The principal components of the draft rule include:

- an obligation on AEMO to determine sub-networks in the NEM that are required to be able to operate independently as an island and, for each sub-network, to assess whether a shortfall in inertia exists or is likely to exist in the future;
- where an inertia shortfall exists in a sub-network, an obligation on the relevant Transmission Network Service Providers (TNSPs) to make continuously available, minimum required levels of inertia, determined by AEMO through a prescribed process;
- an ability for TNSPs to contract with third-party providers of alternative frequency control services, including fast frequency response (FFR) services, as a means of meeting a proportion of the obligation to provide the minimum required levels of inertia, with approval from AEMO; and
- an ability for AEMO to enable[10] the inertia network services provided by TNSPs and third-party providers under specific circumstances in order to maintain the power system in a secure operating state.

The draft rule relates to the provision by TNSPs of the minimum level of inertia required to maintain the power system in a secure operating state. This can be distinguished from additional levels of inertia, or alternative frequency control services, that may increase economic benefits by allowing for greater power transfers on the network, such as higher flows on interconnectors.

The draft rule does not provide a mechanism to realise the market benefits that could be obtained through the provision of inertia at levels above the minimum level of inertia required to maintain secure operation of the power system.

As part of the *System security market frameworks review*, the AEMC has been assessing a rule change request received from AGL, which proposes the establishment of an inertia ancillary services market. The AEMC intends to continue its assessment of AGL's rule change request with a view to implementing a mechanism to guide the provision of additional inertia for market benefits. The Commission has decided to extend the period of time for making a draft determination on AGL's rule change request until 7 November 2017.

10 An inertia network service is enabled when AEMO has selected the relevant inertia network service and it is providing inertia to an inertia sub-network.

The Commission considers that a mechanism that guides the provision of additional inertia for market benefit would further contribute to the achievement of the national electricity objective (NEO). However, such a mechanism will need careful design due to the potential impacts on the operation of the energy and ancillary services markets. Continued stakeholder engagement and consultation will be required in the development process.[11]

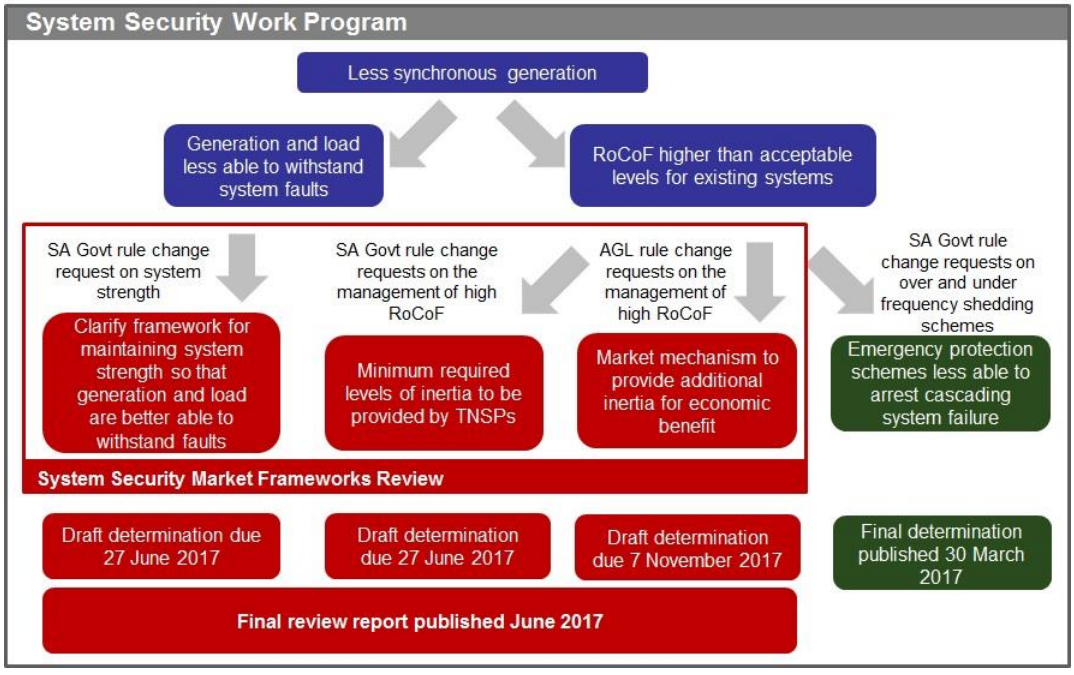
1.1.2 The System Security Market Frameworks Review

The AEMC initiated the *System security market frameworks review* on 14 July 2016 to consider changes to wholesale energy market frameworks to complement the shift to non-synchronous forms of generation in the NEM.

The AEMC's system security work program comprises the *System security market frameworks review* and five related rule change requests received on system security matters.[12] These rule change requests have been progressed concurrently and in coordination with the AEMC's Review. Four of these rule changes were submitted by the South Australian Government, with the fifth requested by AGL.

The AEMC's system security work program draws upon the work undertaken by AEMO to identify and prioritise the current and potential future challenges to maintaining system security. Figure 1.1 shows the relationship between the issues being considered under the system security work program and how these issues relate to the *System security market frameworks review* and the related rule change requests.

Figure 1.1 AEMC System Security Work Program



11 The Commission's assessment of potential mechanisms for the provision of additional inertia is set out in the final report on the *System security market frameworks review*.

12 Information on these rule change requests can be found at www.aemc.gov.au/Rule-Changes.

The Commission initiated the *System security market frameworks review* as a vehicle to coordinate the assessment of these inter-related issues and develop appropriate recommendations for future policy changes.

One of the rule change requests received from the South Australian Government and the rule change request received from AGL both relate to the management of high rates of change of frequency through the provision of inertia and frequency control services. This draft determination has been made with respect to the rule change request received from the South Australian Government. The Commission will publish a draft determination on AGL's rule change request in November 2017.

The Commission has also published a draft determination on the South Australian Government's rule change request on system strength. This draft rule introduces amendments to the National Electricity Rules (NER) to assign responsibility for power system fault levels.[13]

The South Australian Government's rule change requests regarding over and under-frequency shedding schemes were progressed separately to the review and the other three rule change requests. A final determination on these rule change requests was published on 30 March 2017.[14] Changes to the rules arising from these rule change requests are intended to address some of the more immediate concerns in relation to the governance and operation of emergency protection schemes, particularly as they apply to managing the impact of a sudden separation of South Australia from the rest of the NEM.

1.2 Current arrangements

The interconnected national electricity system operates within the constraints of a number of defined physical parameters. One such parameter is system frequency. Conventional electricity generation, like hydro, coal and gas, operate with large spinning turbines that are synchronised to the frequency of the grid. Changes to the balance of supply and demand for electricity can act to speed up or slow down the frequency of the system. Conventional generators support the stability of the power system by working together to maintain a constant operating frequency across the interconnected network.

In each synchronous generating unit, the large rotating mass of the turbine and alternator has a physical inertia which must be overcome in order to increase or decrease the rate at which the generator is spinning. In this manner, large conventional generators that are synchronised to the system act to dampen changes in system frequency. In the electricity system, the greater the number of generators synchronised to the system, the higher will be the system inertia, and the greater will be the ability of the system to resist changes in frequency due to sudden changes in supply and demand.

13 AEMC, *Managing power system fault levels - draft determination*, 27 June 2017.

14 AEMC, *Emergency frequency control schemes - final determination*, 30 March 2017.

Whether the system frequency is rising or falling depends on the balance between generation and load. Whenever total generation is higher than total electricity consumption the system frequency will be rising and vice versa.

Managing frequency becomes more challenging when it is changing rapidly because there is less time in which to arrest the decline or rise before it strays beyond acceptable bounds.

The rate of change of frequency is proportional to the size of the sudden change in supply or demand as a result of the contingency event and inversely proportional to the level of system inertia at the time that the contingency occurs.[15] The greater the size of the contingency event, or the lower the system inertia, the faster the frequency will change.

Managing changes in power system frequency

To keep the power system in a secure operating state, the frequency must be controlled within a defined range. This range, specified in the Frequency Operating Standards (FOS), sets out the range of allowable frequencies for the electricity system under different conditions, including normal operation, following contingency events, and during emergency situations.[16] Under the FOS, AEMO is required to maintain the system frequency within the operational frequency tolerance band of 49.0 to 51.0 Hz for a reasonably possible ("credible") contingency event.[17] Generator, network and end-user equipment must be capable of operating within the range of frequencies defined by the FOS.

AEMO maintains the secure operation of the system by continuously monitoring the system frequency as it dispatches generation to meet consumer demand. Calculations on the level of generation to be dispatched are undertaken every dispatch interval to meet expected energy consumption over the next five minutes. There is a possibility in each five-minute dispatch interval that the level of actual energy consumption is different to what was anticipated. A substantial difference has the potential to result in a large shift in system frequency.

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15 Contingency events may be classified as either credible or non-credible. A credible contingency is an event which AEMO considers to be reasonably possible. Generally, such events would involve the loss of one generating unit or network element. A non-credible contingency is any other contingency, a sequence of credible contingencies within a five-minute period, or a further separation event in an island.

16 The Reliability Panel sets the level of the Frequency Operating Standards in consultation with AEMO. A review of the Frequency Operating Standards is undertaken by the Reliability Panel based on terms of reference received from the AEMC. The AEMC has provided the Reliability Panel with Terms of Reference to review the Frequency Operating Standard that applies in the national electricity market. The terms of reference for this review were published on 30 March 2017 and can be found on the AEMC website - http://www.aemc.gov.au/Markets-Reviews-Advice/Review-of-the-Frequency-Operating-Standard#

17 Clause 4.3 of the NER.

AEMO may restrict the operation of the power system to reduce the potential size of sudden changes in generation or load. AEMO continually monitors the system to determine the likely impact of the occurrence of the largest credible contingency and may limit flows on the network, or power station output, to reduce the potential size of the contingency, or the likely impact, should it occur.

In addition to constraining the system, variations in frequency are managed in the NEM through the procurement of Frequency Control Ancillary Services (FCAS). These services are provided by generators to control system frequency in response to supply or demand disturbances. In particular, "contingency FCAS" is used to control frequency in response to major variations caused by contingency events such as the loss of a generating unit, a significant transmission line, or a large industrial load. Contingency FCAS acts to arrest steep rates of change of frequency and then stabilises and recovers the system frequency over time to bring it back within the normal operating frequency bands.

There are six contingency FCAS markets: up to six-second, 60-second and five-minute markets for both raise and lower services. The six-second service is therefore currently the quickest acting. In the event of a frequency deviation away from 50 Hz, for the system to remain within the current requirements of the FOS requires a relatively low rate of change of frequency (RoCoF) compared with those now possible in the NEM, notably in an islanded South Australia.

If the level of dispatched generation is significantly below the level of energy consumption, the shedding of load may be required to keep the frequency within the limits of the FOS. Under the NER arrangements, AEMO is obliged to return the power system to a satisfactory operating state following any contingency event, including all non-credible contingency events.[18] This may include restoring the power system following a range of different events, including the loss of interconnection between two regions or the simultaneous trip of multiple generating units within a region.

In any instance that the level of dispatched generation is different to total energy consumption, the rate that the frequency changes will be determined by the size of this difference and the level of system inertia. The lower the system inertia, the greater will be the rate of frequency deviation in response to a given change in supply or demand, and the greater will be the requirement for FCAS to revert the system frequency to normal operating levels.

AEMO procures FCAS to maintain system frequency within the limits of the FOS by ensuring that total generation matches total demand in real time. FCAS is used to meet

18 This obligation is established in various clauses of the NER and the Frequency Operating Standards. This includes clause 4.3.2, which places an obligation on AEMO to achieve the AEMO power system security responsibilities in accordance with the power system security principles. NER clause 4.2.6(c) then sets out these principles, which includes a requirement that adequate load shedding facilities initiated automatically by frequency conditions outside the normal operating frequency excursion band should be available and in service to restore the power system to a satisfactory operating state following significant multiple contingency events. The FOS also requires AEMO to maintain the frequency of the power system within the extreme frequency excursion tolerance limits, for any multiple contingency event.

the FOS under normal system operating conditions and in response to credible contingency events. Under multiple contingency events and non-credible 'separation' events, the under-frequency load shedding (UFLS) scheme is used to prevent the system frequency from breaching the extreme frequency excursion tolerance limits, which define the maximum boundaries of the FOS.[19] Outside of these limits, there are no obligations on generators or loads to remain connected to the system. The UFLS scheme is used as a last resort to minimise the impact of major disturbances in the system to prevent the occurrence of wide ranging blackouts.

1.3 Rationale for the rule change request

The ability of the power system to resist large changes in frequency arising from the loss of a generator, transmission line or large industrial load is initially determined by the inertia of the power system. Inertia is naturally provided by conventional electricity generators, like hydro, coal and gas, operating with large spinning turbines and alternators that are synchronised to the frequency of the grid. These generators have significant physical inertia and support the stability of the power system by working together to maintain a constant operating frequency.

Newer types of electricity generators connected to the national electricity system, such as wind and rooftop solar, are not synchronous machines, have low or no physical inertia, and are, therefore, currently limited in their ability to dampen rapid changes in frequency. Some of these technologies have the capability to rapidly respond to changes in electricity supply or consumption, and are likely to play a key role in providing these rapid response services to manage the future security of the power system. While these services are currently not actively employed in the NEM, AEMO has been undertaking investigations into their potential use in the management of power system frequency and intends to report on its findings as part of its FPSS work program.

Historically, most generation in the NEM has been synchronous and, as such, the inertia provided by these generators has not been separately valued. As the generation mix shifts to smaller and more non-synchronous generation however, inertia is not provided as a matter of course giving rise to increasing challenges for AEMO in maintaining the power system in a secure operating state.

In addition, the majority of existing contingency FCAS is also provided by synchronous generators. Generators that wish to be available to provide contingency FCAS typically need to reduce energy output, which entails an opportunity cost. This has meant that the revenue provided by these services has typically been seen as supplementary to the principal source of revenue from energy. To date, these services have been provided by the existing stock of generators and significant investment in these services has not been necessary. However, the existing FCAS spot market arrangements, while providing an effective means for efficiently prioritising and

19 A multiple contingency event is defined in the FOS as either a contingency event other than a credible contingency event, a sequence of credible contingency events within a period of five minutes, or a further separation event in an island.

dispatching these services, provide little in the way of revenue certainty that would be sufficient for significant investment in FCAS facilities to occur.

The South Australian Government's rule change request suggests that less synchronous generation in the NEM is leading to a lack of system inertia, which is increasing the susceptibility of the system to rapid changes in frequency and reducing system stability.

The shift to newer types of generation has been more pronounced in some regions of the NEM than others. South Australia, in particular, has experienced a substantially faster change than other regions as an increasing volume of renewable energy is integrated. Flows on the interconnector with Victoria allow power system security to be maintained because of inertia provided by generators in other parts of the NEM. Where there is an outage of this interconnector, the risks to system security in South Australia increase significantly because it must rely on inertia provided by generators within the region. If there is minimal generation capacity online at the time of the interconnector outage that has the ability to provide inertia in that region, the frequency could be subject to very rapid changes. This makes it harder to arrest the frequency change and restore the frequency to normal operating levels. As the generation mix changes in a similar way across the NEM these risks may become more widespread.

1.4 Solution proposed in the rule change request

The South Australian Government proposes two principal changes to establish a more effective framework for the management of increased risks to system security arising from rapid changes in frequency.

1. AEMO should be provided with the powers to:

    (a) determine the types and amount of ancillary services that may assist in addressing the potential for high rates of frequency change; and

    (b) procure the necessary ancillary services via ancillary services agreements and to develop guidelines for the efficient and competitive procurement of these services.

2. A system standard for the rate of change of frequency (RoCoF) should be established to guide the procurement of the services and to clarify responsibilities of AEMO, TNSPs and market participants. The level of this standard should be determined by the Reliability Panel in accordance with a process prescribed in the NER.

1.5 Relevant background

The ability to maintain control of power system frequency following a contingency event, such as the loss of a large generator, load or transmission line can be considered through the following three-part framework:

1. The initial RoCoF, influenced by the size of the contingency and the level of system inertia.

2. The capacity to restore the stability of the system through the use of frequency response services.

3. The ability of generators and loads to withstand or "ride-through" changes in frequency.

The initial rate of change of frequency

The rate at which system frequency changes determines the amount of time that is available to arrest any decline or increase in frequency before it moves outside of the permitted operating bounds.

Prior to the occurrence of a contingency event, there are two actions that could be taken to minimise the resulting initial frequency change:

- constrain generator output or interconnector flow to minimise the impact of the contingency; and/or

- increase the level of inertia in the system to resist the initial frequency change.

For credible contingencies, AEMO has the ability to introduce constraints, in order to maintain system security, that alter the operation of the power system. Constraints to control the RoCoF would limit the maximum contingency size, relative to the amount of inertia online. However, the effect of a binding constraint is likely to be an increase in the wholesale electricity price. For example, a constraint on an interconnector may limit the ability of power to flow from a lower priced region to a higher priced region.

An alternative to constraining the system to limit the impact of the contingency would be to increase the level of inertia in the power system. A higher level of inertia would permit the occurrence of larger contingencies for a given level of initial RoCoF.

There is currently no ability for AEMO or any other party to obtain and pay for additional inertia. In the past, inertia has been plentiful and so such a mechanism has not previously been required.

Capability to restore the supply-demand balance

Limiting the initial rate of change of frequency will only act to increase the amount of time before frequency moves outside of acceptable bands. Inertia does not act to arrest the frequency change or revert frequency back to normal operating levels.

Currently, AEMO is able to procure FCAS, to maintain frequency within defined limits set out in the FOS. In particular, "contingency FCAS" is used to control frequency in response to major variations caused by contingency events such as the loss of a generating unit or a significant transmission line. Contingency FCAS acts to arrest steep rates of change of frequency and then stabilises and recovers the system

frequency over time to bring it back to within the normal operating frequency bands. The current fastest contingency FCAS operates over a timeframe of up to six seconds.

To permit a greater potential level of RoCoF for credible contingency events would require the development of a faster-acting contingency FCAS, which has come to be termed a "fast frequency response (FFR) service". FFR services are faster than the existing six-second service and would provide greater flexibility in the level of RoCoF that could be permitted. The Commission consequently considers that managing frequency in a low inertia system should aim to facilitate the use of fast-frequency technologies and to be able to effectively co-optimise the provision of these services with the provision of inertia.

While a number of technologies exhibit very rapid response times, the physical realities of accurately measuring frequency changes may limit the response capabilities of FFR technologies.

The time delay of FFR technologies implies that there is a minimum level of inertia that must be online at any point in time to resist frequency changes caused by contingency events. The inertia slows the frequency change to provide time for frequency response services to be activated. Beyond this initial time period, fast frequency response technologies have the potential to be used in combination with inertia above a minimum threshold level to stabilise system frequency.

Tolerance of the system

In designing a framework for inertia and FFR services, and consequently a RoCoF limit, it will be important to understand the tolerance of all parts of the system to that level of RoCoF. A RoCoF limit of 2 Hz/s would not be effective if the maximum RoCoF that could be tolerated by individual generators and loads was 1 Hz/s.

In practice, generators and loads will have a range of withstand capabilities. While it will likely be important to understand these in general, that will particularly be the case for equipment providing inertia and FFR services. For example, a generator contracted to provide inertia would need to be able to withstand RoCoF to at least the targeted RoCoF limit.

The performance standards relating to the ability of generators to withstand rates of change of system frequency are set out in the NER.[20] These standards have been imposed as a condition of generator connection agreements since 2007.

The current standards are automatically met if a generating unit can withstand a RoCoF of ±4 Hz/s for quarter of a second. Generators may negotiate a lower standard, but the minimum standard is ±1 Hz/s for one second. There is no obligation on generators to remain connected to the system through an event where the RoCoF exceeds those levels, even if the frequency remains within the bounds of the FOS.

20 Schedule 5.2.5.3 of the NER.

1.6 The rule making process

On 8 September 2016, the Commission published a notice advising of its commencement of the rule making process and consultation in respect of the rule change request.[21] A consultation paper identifying specific issues for consultation was also published. Submissions closed on 13 October 2016.

On 15 December 2016, the Commission published its interim report to the COAG Energy Council on the *System security market frameworks review*. The interim report set out the Commission's preliminary findings and canvassed a number of options to obtain system security services to address the potential for high rates of change of frequency arising from reduced levels of inertia. Submissions closed on 9 February 2017.

On 23 March 2017, the Commission published a directions paper on the *System security market frameworks review*. The directions paper presented the Commission's proposed approach to address the management of system frequency with reduced levels of synchronous generation. Submissions closed on 20 April 2017.

The Commission received 21 submissions in response to the directions paper. A summary of the issues raised in submissions and the Commission's response to each issue is contained in Appendix A.

The Commission has considered all issues raised by stakeholders in submissions received in response to all of the above published reports with respect to this rule change request. Issues raised in submissions are discussed and responded to throughout this draft rule determination.

1.7 Structure of draft rule determination

This draft rule determination is set out as follows:

- Chapter 2 provides an overview of the Commission's draft rule determination, including its assessment framework and summary of reasons for making the draft rule.
- Chapter 3 explores the concept of the minimum level of inertia required to maintain a secure operating system and sets out further detail on the Commission's draft rule to place an obligation on AEMO to define inertia sub-networks and to determine minimum required levels of inertia.
- Chapter 4 sets out the Commission's draft rule to place an obligation on the relevant TNSP to make continuously available the minimum required levels of inertia and explores the specific conditions under which AEMO may enable inertia to be provided to the system.

21 This notice was published under s. 95 of the National Electricity Law (NEL).

- Chapter 5 sets out the Commission's draft rule to allow TNSPs to contract with third-party providers of alternative frequency control services, including fast frequency response services, as a means of meeting an agreed proportion of the obligation to provide the minimum levels of inertia.

- Appendix A provides the Commission's response to stakeholder comments that are not addressed elsewhere in the draft rule determination.

- Appendix B sets out the relevant legal requirements under the NEL for the Commission to make this draft rule determination.

1.8 Consultation on draft rule determination

The Commission invites submissions on this draft rule determination, including the draft rule, by **8 August 2017**.

Any person or body may request that the Commission hold a hearing in relation to the draft rule determination. Any request for a hearing must be made in writing and must be received by the Commission no later than 4 July 2017.

Submissions and requests for a hearing should quote project number ERC0214 and may be lodged online at www.aemc.gov.au or by mail to:

Australian Energy Market Commission
PO Box A2449
SYDNEY SOUTH NSW 1235

2 Draft rule determination

The Commission's draft rule determination is to make a more preferable draft rule. The more preferable draft rule places an obligation on TNSPs that are Inertia Service Providers to provide, and make continuously available, minimum required levels of inertia, or in some cases alternative services, to allow AEMO to maintain the system in a secure operating state.

This chapter outlines:

- the key features of the draft rule;
- the rule making test for changes to the NER;
- the more preferable rule making test;
- the assessment framework for considering the rule change request; and
- the Commission's consideration of the more preferable draft rule against the national electricity objective.

Further information on the legal requirements for making this draft rule determination is set out in Appendix B.

2.1 The Commission's draft rule determination

The more preferable draft rule made by the Commission is attached to and published with this draft rule determination. The key features of the more preferable draft rule are as follows.

AEMO determines inertia requirements

- An obligation on AEMO to:
  - determine the boundaries of inertia sub-networks in the NEM taking into account, among other things, the connections between the proposed inertia sub-network and adjacent parts of the national grid and the likelihood of the proposed inertia sub-network being islanded;[22]
  - develop and publish an inertia requirements procedure setting out the process it will use to determine the inertia requirements for each inertia sub-network, having regard to matters specified in the NER;[23]
  - determine, generally no more than once in any 12 month period, the "inertia requirements" for each inertia sub-network, being:

22 Draft Rule clause 5.20B.1(d).

23 Draft Rule clause 5.20B.2(b), (c).

- the minimum level of inertia required to operate the sub-network in a satisfactory operating state when the sub-network is islanded (the minimum threshold level of inertia);[24] and

- the minimum level of inertia required to operate the sub-network in a secure operating state when the sub-network is islanded (the secure operating level of inertia).[25]

— Publish the inertia requirements for each inertia sub-network in the National Transmission Network Development Plan (NTNDP).

AEMO determines and provides notice of any inertia shortfall

- An obligation on AEMO to:

  — assess whether, in its reasonable opinion, there is or is likely to be an inertia shortfall in an inertia sub-network, taking into account matters specified in the draft rule.[26] An inertia shortfall is a shortfall in the level of inertia typically provided in an inertia sub-network compared to the secure operating level of inertia most recently determined by AEMO for the sub-network;[27]

  — give notice of its assessment in the NTNDP including the identity of the TNSP that is the Inertia Service Provider for the inertia sub-network. The Inertia Service Provider is the TNSP for the inertia sub-network or, if there is more than one TNSP for the inertia sub-network, the jurisdictional planning body for the relevant jurisdiction;[28]

  — give notice of the date that the Inertia Service Provider must provide for the availability of inertia network services, which must not be earlier than 12 months after the NTNDP providing notice of the assessment is published;[29]

  — provide projections of inertia shortfalls in its Electricity Statement of Opportunities (ESOO).[30]

Services that qualify as inertia network services

- The draft rule specifies the types of services that can be provided by Inertia Service Providers to meet an inertia shortfall. These services must be for the

24 Draft Rule clause 5.20B.2(a)(1).

25 Draft Rule clause 5.20B.2(a)(2). In practice, the secure operating level of inertia will always be higher than the minimum threshold level of inertia.

26 Draft Rule clause 5.20B.3(a).

27 Draft Rule, new Chapter 10 definition of "inertia shortfall".

28 Draft Rule clause 5.20B.4(a). The Inertia Service Provider will be AEMO in Victoria.

29 Draft Rule clause 5.20B.3(c).

30 Draft Rule clause 3.13.3(q)(6).

provision of inertia[31] and are called "inertia network services" under the draft rule.

- The inertia network services that qualify to provide inertia up to the minimum threshold level of inertia are:[32]
  - services made available by the Inertia Service Provider investing in synchronous condensors; and
  - services made available to the Inertia Service Provider by a Registered Participant and provided by means of a synchronous generating unit or synchronous condensor.
- The inertia network services that qualify to provide inertia beyond the minimum threshold level of inertia and up to the secure operating level of inertia are those services that can be used for the minimum threshold level of inertia and other types of inertia network services provided by a Registered Participant.[33]

Inertia Service Provider makes inertia network services available

- In sub-networks of the NEM where an inertia shortfall has been identified by AEMO an obligation on the TNSP that is the Inertia Services Provider to:
  - make "inertia network services" available to AEMO that when enabled will provide inertia:
    - to the secure operating level of inertia determined by AEMO for that sub-network;[34] or
    - an amount of inertia less than the secure operating level of inertia but at least the minimum threshold level of inertia if AEMO has approved other activities that may contribute to the operation of the inertia sub-network in a secure operating state when the inertia sub-network is islanded.[35]
  - make the inertia network services available by the date specified by AEMO in the NTNDP;[36]

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31 Draft Rule, new Chapter 10 definition of "inertia" - Contribution to the capability of the *power system* to resist changes in *frequency* in response to a *contingency event* by means of an inertial response from a *generating unit* or *network element* that is electro-magnetically coupled with the *power system* and *synchronised* to the *frequency* of the *power system*.

32 Draft Rule clause 5.20B.4(d).

33 Draft Rule clause 5.20B.4(e).

34 Draft Rule clause 5.20B.4(b)(1); clause 4.3.4(j).

35 Draft Rule clause 5.20B.4(b)(2), 5.20B.5(a); clause 4.3.4(j). Other activities that may be approved may include provision of frequency control services or emergency protection schemes.

36 Draft Rule clause 5.20B.4(c)(1).

- identify and procure the least cost option or combination of options that will satisfy its obligation in the time required.[37]

Inertia Service Provider provides information on inertia network services

- In sub-networks of the NEM where an inertia shortfall has been identified by AEMO an obligation on the TNSP that is the Inertia Services Provider to:
  - provide information in its Transmission Annual Planning Report (TAPR) about the activities undertaken to meets its obligations to provide inertia network services;[38]
  - give AEMO a schedule setting out the inertia network services available (and any activities approved by AEMO that reduce the secure operating level of inertia) and the Inertia Service Provider's proposed order of priority for those services and activities to be enabled by AEMO;[39]
  - register any synchronous generating unit from which it is procuring inertia network services as an inertia generating unit with AEMO and specify that the generating unit must be constrained on when it is providing inertia under clause 3.9.7(c) of the draft rule;[40] and
  - provide specified details of the inertia network services it is making available to AEMO and seek AEMO's approval for the technical specifications and performance standards for those services and for the information necessary for AEMO to enable or cease the provision of those services. AEMO must approve this information or advise the Inertia Service Provider of its concerns and the changes it requires to this information.[41]

Recovery of Inertia Service Provider's costs of making inertia network services available

- The obligation to make inertia network services available is a regulatory obligation or requirement imposed on the relevant TNSP in connection with the provision of prescribed transmission services. The Inertia Service Provider will be entitled to seek a revenue allowance that includes forecast operating expenditure or capital expenditure for its efficient costs of meeting the requirement.
- The draft rule amends the definition of "network support payment" to include payments made by a TNSP under an inertia services agreement (inertia support payments). This means that the TNSP can use a network support pass through under clause 6A.7.2 of the existing Rules to recover the difference between inertia

37 Draft Rule clause 5.20B.4(f).

38 Draft Rule clause 5.20B.4(g).

39 Draft Rule clause 5.20B.6(a); clause 4.3.4(k).

40 Draft Rule clause 5.20B.6(b).

41 Draft Rule clause 5.20B.6(c) to (h); clause 4.3.4(k).

support payments included in its opex allowance for a regulatory year and its actual inertia support payments.[42]

TNSP planning investments to meet requirement to provide inertia network services

- Under the draft rule the Regulatory Investment Test for Transmission (RIT-T) does not apply to proposed expenditure on "inertia support payments" but will apply to capital projects undertaken by a TNSP to meet inertia network service requirements where those projects are above the cost threshold for the RIT-T.

Obligations on AEMO to enable inertia network services

- AEMO may enable a range and quantity of inertia network services to:
  - the minimum threshold level of inertia where a contingency event that would result in the islanding of an inertia sub-network has been classified as a credible contingency event or defined as a protected event; and
  - the secure operating level of inertia where an inertia sub-network is islanded.
- AEMO may enable or cease inertia network services by giving instructions to a Registered Participant who has contracted with the TNSP to provide inertia network services.[43]
- A Registered Participant providing an inertia network service must comply with an instruction given by AEMO to enable inertia network services.[44]

Further detail on each aspect of the more preferable draft rule listed above can be found in the remaining chapters of this draft determination.

2.2 Rule making test

2.2.1 Achieving the national electricity objective

The Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the national electricity objective (NEO).[45] This is the decision making framework that the Commission must apply.

42 Draft Rule amendment to chapter definition of "network support payment", clause 5.20B.4(h).

43 Draft Rule clause 4.4.4(d) or (e).

44 Draft Rule clause 4.4.4(g).

45 Section 88 of the NEL.

The NEO is:[46]

> "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."

2.2.2 Making a more preferable rule

Under s. 91A of the National Electricity Law (NEL), the Commission may make a rule that is different (including materially different) to a proposed rule (a more preferable rule) if it is satisfied that, having regard to the issue or issues raised in the rule change request, the more preferable rule will or is likely to better contribute to the achievement of the NEO.

2.3 Assessment framework

In assessing the rule change request against the NEO the Commission has considered the following principles:

- **Risk allocation**: System security is necessary for the efficient functioning of the power system and benefits all market participants as well as the wider community. However, there are costs associated with maintaining the secure operation of the power system.

  A trade-off exists between the level of costs that should be incurred in avoiding or minimising the impact on the system should a disturbance occur, and the probability of the level of costs that would likely be incurred as a result of the failure to maintain the system in a secure operating state.

  Costs of avoiding or minimising the impact on the system may include the application of limits on transmission lines or constraining off generation to limit the size of the impact should these generation or network elements suddenly fail. It may also include the upfront costs of the provision of frequency response services to stabilise the system should a supply disruption occur.

  Risk allocation and the accountability for investment decisions should rest with those parties best placed to manage them. Under a centralised planning arrangement, risks are more likely to be borne by customers. Solutions that allocate risks to market participants, such as businesses who are better able to manage them, are preferred where practicable.

46 Section 7 of the NEL.

- **Certainty versus flexibility**: Achieving a secure operating system in an economically efficient manner requires regulatory and market frameworks to be designed to encourage investment in system security services and to maximise flexibility in the provision of those services to achieve an economically efficient outcome.

  A secure power system demands the availability of system security services at all times. Regulatory frameworks must be designed to accommodate this requirement by providing certainty to prospective investors as well as existing providers. However, while greater investment certainty may help to make sure that the services are available when they are needed, this may come at the expense of the flexibility to continuously adjust the requirement under changing market conditions.

  Further, regulatory or policy changes should not be implemented to address issues that arise at a specific point in time or in a specific jurisdiction only. Solutions should be flexible enough to accommodate different circumstances at different times and in different jurisdictions. They should be effective in maintaining system security where it is needed while not imposing undue market or compliance costs on other areas.

- **Technology neutral**: Arrangements should be designed to take into account the full range of potential market and network solutions. They should not be targeted at a particular technology, or be designed with a particular set of technologies in mind. Technologies are changing rapidly and, to the extent possible, a change in technology should not require a change in arrangements.

  When considering how frameworks accommodate new technologies, it is the functions they perform that need to be the focus, not the technologies themselves. The relative immaturity and inherent delay in the operation time of fast frequency response technologies at present means that some level of system inertia is required to maintain a stable system frequency. However, fast frequency technologies may have an important future role in reverting frequency to normal operating levels following a contingency.

- **Competition**: Competition and market signals generally lead to better outcomes than prescriptive rules or centralised planning since they are more flexible to changing conditions and give businesses the ability to meet consumers' needs as efficiently as possible. Such outcomes should be less likely to change over time, creating regulatory certainty. Markets should be designed to maximise opportunities for the provision of services in order to send the right price signals and lower the overall cost of achieving a secure electricity system.

  However, requiring solutions that address issues in specific network locations may limit the ability to maximise opportunities for service provision. System frequency is a global issue while system strength issues tend to be locationally specific. The range of service providers that are available to address system

frequency may narrow if the same service providers are also required to address issues of system strength.

2.4 Summary of reasons

The costs incurred as a result of the failure to maintain the system in a secure operating state are varied and include such things as damage to equipment, the opportunity costs of lost production, and the additional costs of restoring the system. Depending on the extent of failure, other societal costs may also be incurred.

The Commission considers that an obligation on TNSPs to make minimum levels of inertia continuously available will provide a high degree of confidence that system security can be maintained when separation and islanding of sub-networks occurs. The requirement for TNSPs to identify the least cost option, or combination of options, to provide the minimum levels of inertia, together with the existing economic regulatory framework for TNSPs, will provide discipline on the level of expenditure on inertia network services by enabling the Australian Energy Regulator (AER) to assess the efficiency of that expenditure.[47]

Having regard to the issues raised in the rule change request and during consultation, the Commission is satisfied that the more preferable draft rule will, or is likely to, better contribute to the achievement of the NEO for the following reasons:

- Contracts entered into by the TNSPs to meet the obligation will provide certainty to prospective third-party investors in inertia and alternative frequency control services, thereby improving the security of the national electricity system for the benefit of consumers. The draft rule will allow the TNSP to meet the obligation in the short-term by contracting with existing third-party providers of inertia, while concurrently assessing the most efficient means of meeting the obligation over the long term.

- The periodic review of the level of the obligation on TNSPs to provide inertia network services, and the requirement for the TNSP to identify and procure the least cost option or combination of options to meet its inertia obligation, will assist in making sure that further investments are efficient and reflective of changing market conditions.

- The obligation on TNSPs to provide inertia network services will only apply to sub-networks where AEMO has identified that an inertia shortfall exists. This will promote efficient investment and use of services by:

  - maintaining system security where it is needed while not imposing undue market or compliance costs on other areas; and

47 AEMO is responsible for planning, authorizing and directing augmentation of the declared shared network in Victoria. Different arrangements for the provision of shared transmission services, including inertia network services, will apply to AEMO in its role as the Inertia Service Provider for Victoria.

- providing for future shortfalls in inertia to be identified in a timely manner.

- Placing the obligation on TNSPs to provide inertia network services will provide a greater ability to coordinate the provision of inertia network services with other network support requirements for the relevant sub-network, such as system strength. This should result in a more efficient outcome for consumers in the long term by avoiding the potential duplication of investment.

- The ability for the TNSP to make available inertia network services through contracts with third-party providers of services other than the provision of inertia will promote efficiency in investments by expanding the range of options available to manage the secure operation of the system.

The draft rule relates to the provision by TNSPs of the minimum level of inertia required to maintain secure operation of the power system. This can be distinguished from additional levels of inertia, or alternative frequency control services, that may increase economic benefits by allowing for greater power transfers on the network.

This draft rule does not provide a mechanism to realise the market benefits that could be obtained through the provision of inertia at levels above the minimum level of inertia required to maintain secure operation of the power system. The Commission considers that the ability to maintain power system security in an efficient manner would be enhanced by the development and introduction of a mechanism to obtain and pay for inertia and that this would further contribute to the NEO.

A market mechanism will build on the certainty created through the TNSP obligation by providing the ability to continuously adjust the level of service provision in real time to maximise efficiency. Ultimately, the combination of the obligation on TNSPs to provide minimum levels of inertia, and a market mechanism for additional inertia that provides market benefits, will form an enhanced framework which efficiently balances certainty and flexibility for the management of system frequency in the long term interests of consumers.

2.5 Strategic priority

This rule change request relates to the AEMC's strategic priority relating to markets and networks.

This strategic priority relates to the flexibility and resilience of energy market frameworks to respond to changes in technology and new business models. This includes changes in the generation mix, such as the increased penetration of non-synchronous generation and the subsequent retirement of large synchronous units. This links to the development of a framework to provide services to manage the security of the national electricity system. This framework is designed to support the maintenance of a resilient and secure power system as the generation mix changes.

3 Determining the minimum required levels of inertia and inertia shortfalls

The time delay of frequency response services implies that there is a minimum level of inertia that must be online at any point in time to resist frequency changes caused by contingency events. The inertia slows the frequency change to provide time for the frequency response services to be activated.

This chapter explores the concept of the minimum level of inertia required to maintain the power system in a secure operating state and sets out further detail on the Commission's draft rule to place an obligation on AEMO to:

- determine the boundaries of inertia sub-networks in the NEM;[48]
- develop and publish an inertia requirements procedure setting out the process it will use to determine the inertia requirements for each inertia sub-network, having regard to matters specified in the NER;[49]
- determine, generally no more than once in any 12 month period, the "inertia requirements" for each inertia sub-network;
- assess whether, in its reasonable opinion, there is, or is likely to be, an inertia shortfall in an inertia sub-network, taking into account matters specified in the draft rule;[50]
- give notice of its assessment in the NTNDP including the identity of the TNSP that is the Inertia Service Provider for the inertia sub-network.[51] The Inertia Service Provider is the TNSP for the inertia sub-network, or if there is more than one TNSP for the inertia sub-network, the jurisdictional planning body for the relevant jurisdiction.
- give notice of the date that the Inertia Service Provider must make the inertia network services available, which must not be earlier than 12 months after the NTNDP providing notice of the assessment is published;
- provide projections of inertia shortfalls in its Electricity Statement of Opportunities.[52]

48 Draft Rule clause 5.20B.1(d).

49 Draft Rule clause 5.20B.2(b), (c).

50 Draft Rule clause 5.20B.3(a).

51 The Inertia Service Provider is the TNSP for the inertia sub-network or, if there is more than one TNSP for the inertia sub-network, the jurisdictional planning body for the relevant jurisdiction (Draft Rule clause 5.20B.4(a).

52 Draft Rule clause 3.13.3(q)(6).

3.1 Defining the sub-networks and levels of required inertia

The increased deployment of non-synchronous generation has been more pronounced in some areas of the NEM than others. The extent of this deployment is now at the point where levels of inertia typically dispatched in these areas are falling below the levels required to maintain system security should they be separated from the rest of the NEM.

This section sets out the Commission's approach to defining inertia sub-networks and the levels of inertia likely to be required to maintain these sub-networks in a secure operating state if they are islanded.

3.1.1 Defining inertia sub-networks

In order to maintain an islanded region in a secure operating state, a minimum level of inertia must be provided from within the region. Minimum required levels of inertia must therefore be prescribed to a specific region or other defined network area.

South Australia has experienced a substantially faster growth in new types of generation than other regions. Flows on the interconnector with Victoria allow power system security to be maintained because of inertia provided by generators in other parts of the NEM. Where there is an outage of this interconnector, the risks to system security in South Australia increase significantly because it must rely on inertia provided by generators within the region. If there is minimal generation capacity online at the time that has the ability to provide inertia in that region the frequency in that region could be subject to very rapid changes. This makes it harder to arrest the frequency change and restore the frequency to normal operating levels. As the generation mix changes in a similar way across the NEM these risks may become more widespread.

The NEM mainland and Tasmania operate as two separate synchronous systems. The two systems are separated by the Basslink DC interconnector which allows for energy transfer but does not require the two systems to operate synchronously. In order for Tasmania to operate as an island, inertia must be sourced locally. This would imply that separate required levels of inertia would be needed for Tasmania.

A requirement to source inertia locally may also be applied to other areas of the NEM where there is a possibility of separation and islanding. For example, the separation of South Australia from the rest of the NEM, caused by the unavailability or failure of the Heywood Interconnector, would require South Australia to source inertia locally to operate as an island and maintain system security.

Each area of the national network that is required to be able to operate independently as an island would need to source inertia locally. For each network area there would need to be a possibility of separation and a realistic prospect of continued operation after separation. While a comprehensive list of these areas would need to be developed, it is expected that separate levels of inertia may ultimately be needed for

each of the NEM regions and potentially North Queensland and South Queensland individually.

3.1.2 Levels of inertia required to manage power system security

The level of system inertia in the islanded sub-network determines the size of the immediate RoCoF that would result when separation occurs for a given interconnector flow. Limiting the size of the RoCoF would provide:

- a higher probability of generators remaining online following the occurrence of the contingency event;
- time for emergency frequency control schemes to operate effectively; and
- time for frequency control ancillary services in the islanded sub-network to respond and recover the frequency to normal operating levels.

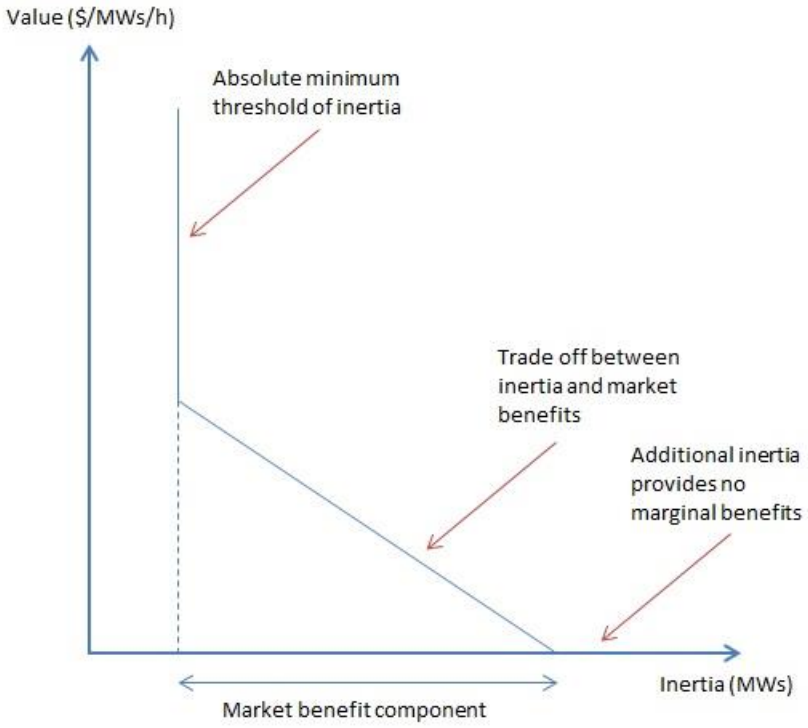
Each of these aspects contributes to the system frequency remaining within the bounds of the FOS.

The level of inertia that is required to maintain the RoCoF to a given limit can be divided into two components:

1. **Minimum level of inertia –** The minimum level of inertia that is required to maintain the islanded system in a satisfactory operating state. The minimum level represents a lower bound on the level of inertia that is required to feasibly operate the system. Operating at this minimum level may require load shedding but would be sufficient to maintain the islanded system in a satisfactory operating state and avoid a system black condition. This minimum level might permit only limited interconnector flow, prior to separation.
2. **Market benefits –** Additional inertia above the minimum level of inertia would allow for a more unconstrained operation of the islanded system or additional interconnector flows when not islanded. This would provide benefits of improved reliability and a lower overall cost of energy provision by alleviating constraints on the system.

The split between these two components is illustrated in figure 3.1, which shows a theoretical demand curve for inertia.

Figure 3.1 Value of inertia and the amount of inertia provided

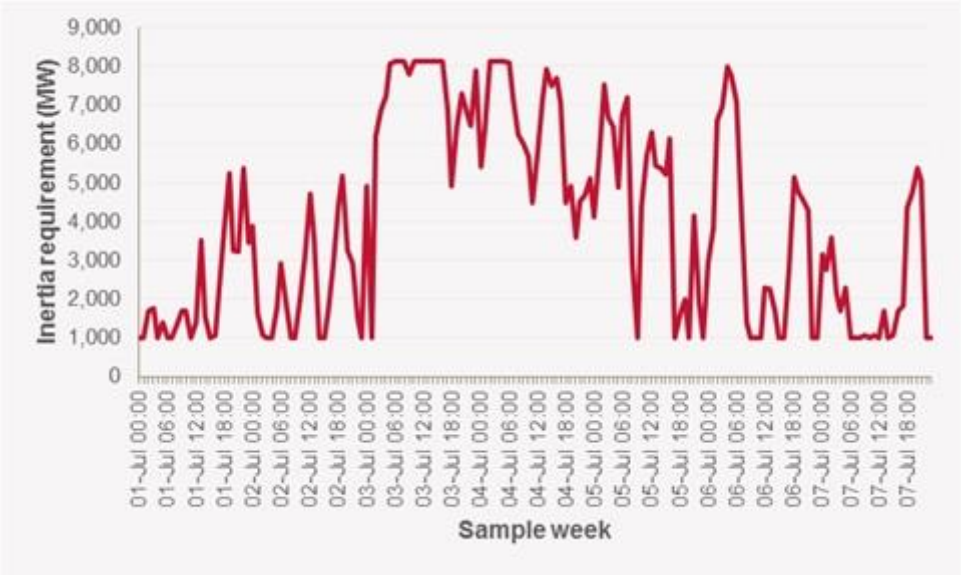


The vertical line on the left represents the minimum level of inertia that is required to maintain the islanded system in a satisfactory operating state. This vertical line is a lower bound on the level of inertia that could feasibly be required in order to operate the system within the FOS and maintain a satisfactory operating state when operating the system as an island. Beyond this level, the sloped line represents the trade-off that exists between the costs of supplying more inertia and other options for managing system security, such as constraining the system or obtaining FFR services. A continuation of the line shows that any additional inertia supplied to the market has no effect in further alleviating constraints on the system and so provides no additional benefit for either maintaining system security, improving reliability, or lowering the overall cost of energy production.

Figure 3.1 represents a theoretical trade-off between increasing levels of inertia and obtaining market benefits. This trade-off is unique to the specific set of operating conditions present in the system at a given point in time. In practice, the level of inertia required to limit RoCoF and maintain the secure operation of the power system varies with changing system conditions.

Figure 3.2 shows how inertia requirements can vary over time depending on the prevailing system and network conditions.

Figure 3.2 Potential variability in required inertia in South Australia[53]



Minimum required levels of inertia

Clause 4.2.2 in the NER defines the conditions under which a system is considered as being in a satisfactory operating state. There are a range of technical parameters that must be maintained within satisfactory limits, including a requirement that the system frequency is within the normal operating frequency band.

The minimum level of inertia is sufficient to maintain the islanded sub-network in a satisfactory operating state should it be separated from the rest of the NEM. However, it is not sufficient to maintain a satisfactory operating state should a further credible contingency occur. A credible contingency of even a moderate size would likely cause the system frequency to move outside the bounds of the FOS, potentially resulting in cascading loss of generation and a system black event.

Therefore, once separation has occurred, the continued operation of the islanded system requires a higher level of inertia to be provided. This level of inertia should be sufficient to enable AEMO to return the islanded system to a secure operating state.

The level of inertia required to maintain the islanded sub-network in a secure operating state would be based on a consideration of three different factors:

1. *Availability and capability of contingency FCAS* - The capabilities and expected response times of contingency FCAS in the islanded sub-network would determine the maximum RoCoF that could be managed without the frequency moving outside the bounds of the FOS. Inertia does not act to arrest the frequency drop entirely or revert frequency back to normal operating levels. Inertia slows the rate of frequency change and so provides time for contingency FCAS to operate.

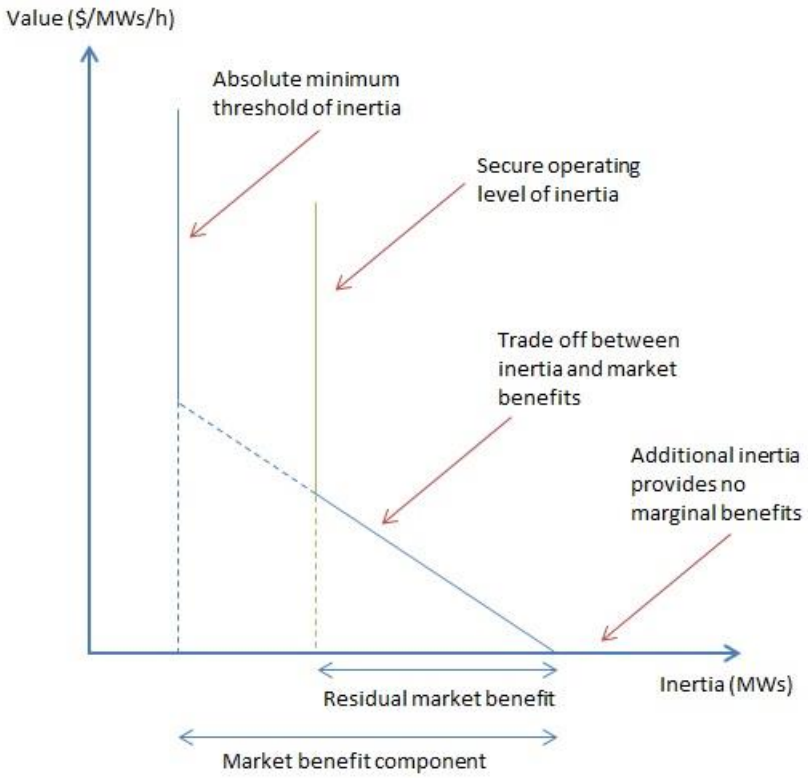
53 AEMO, Submission on the directions paper, p. 7. Assumes a RoCoF limit of 2 Hz/s.

2. *Maximum contingency size* - The maximum expected contingency size when operating as an islanded system would also influence the level of inertia required. A larger contingency size results in a higher RoCoF for a given level of inertia. It is likely that the operation of the system as an island would require the system to be operated in a specific highly constrained state, which would likely mean a lower potential contingency size as the majority of generating units would be operating at their minimum output.

3. *Possible further loss of inertia* - Additional inertia needed to account for the possible loss of a synchronous generating unit. The RoCoF that occurs as a result of a contingency event would be even higher if the contingency that occurs is the loss of a synchronous generating unit that is also providing inertia.

Figure 3.3 shows the secure operating level of inertia in relation to the minimum system threshold level of inertia.

Figure 3.3 The minimum threshold level and the secure operating level



The secure operating level of inertia can be determined through the following equation.

$$I = (25 \times \Delta P)/RoCoF' + I'$$

Where

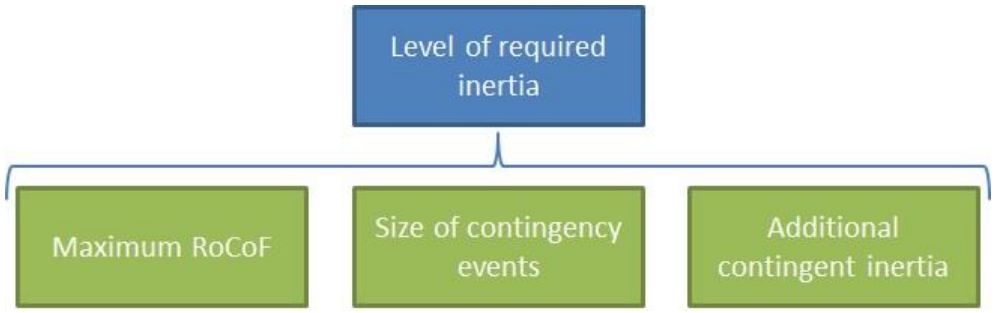
I = The secure operating level of inertia (MW.seconds)

ΔP = The size of the contingency (MW)

RoCoF′ = the maximum rate of change of frequency that would be permitted to provide sufficient time for existing contingency FCAS to operate (Hz/second)

I′ = the additional inertia needed to account for the possible loss of a synchronous generating unit as the contingency (MW.seconds)

Figure 3.4 Factors that affect the secure operating level of inertia



Maximum RoCoF

The level of inertia required to maintain the islanded sub-network in a secure operating state would depend on the availability and capability of other frequency control services in the islanded system. The RoCoF would need to be limited to provide sufficient time for the fastest FCAS to respond and maintain the system frequency within the bounds of the FOS.

Contingency FCAS is controlled locally by generators and consists of technologies designed to detect and respond to larger frequency deviations that occur following contingency events.

The fastest existing contingency FCAS operates within timeframes of less than six seconds. However, it is likely that most of this contingency FCAS could operate over shorter timeframes. Specific analysis would need to be undertaken to determine the exact range and magnitude of response times from frequency control services in each sub-network.

Faster response services, such as FFR, could also increase the allowable RoCoF by providing much shorter response times. Less inertia would be needed to maintain the system frequency within the bounds of the FOS for a given contingency size.

Size of contingency events

The level of inertia required to limit the RoCoF is proportional to the size of the immediate shortfall in supply or demand arising from the contingency event. The larger the contingency event, the more inertia is required to limit the level of the RoCoF.

The maximum expected contingency size when operating the sub-network as an islanded system would influence the level of inertia required. It is likely that separation and islanding would require the sub-network to be operated in a highly constrained

state. This would likely require some load shedding to occur and generating units to be constrained to their minimum operating output. As such, the maximum potential contingency size when operating as an island is likely to be substantially smaller than would be the case under normal operating conditions.

It is expected that the secure operating level of inertia would need to be large enough to account for a contingency equal to the largest minimum operating output from a single generating unit in the sub-network.

Additional contingent inertia

The secure operating level of inertia is intended to be able to maintain the sub-network in a secure operating state when islanded. This should mean that the islanded system can withstand the occurrence of a credible contingency within the sub-network and be able to maintain the system in at least a satisfactory operating state immediately following the contingency.

However, the likelihood of maintaining a satisfactory operating state would be greatly reduced if the contingency that occurs is the loss of a synchronous generating unit. Not only would the contingency event cause a change in the frequency but the ability of the system to dampen this change in frequency would be diminished by the loss of inertia from the synchronous generating unit.

Therefore, additional inertia will need to be provided to account for the possibility that the contingency that occurs is the loss of a synchronous generating unit. This additional inertia would be equal to the amount of inertia provided by an individual generating unit in the sub-network. This generating unit could be either:

- the generating unit providing the most amount of inertia to the system; or
- the generating unit with the highest minimum operating output, representing the largest contingency.

It is likely that the withstand capabilities of the generating units to high RoCoF would need to be taken into account in determining the specific individual generating unit.

Additional inertia for market benefit

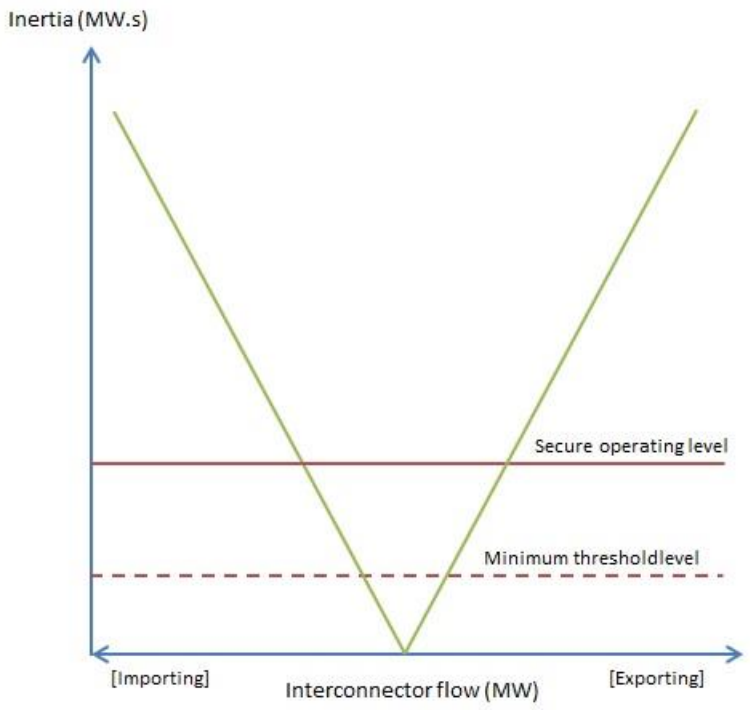
The secure operating level of inertia would only be sufficient to operate the islanded system under specific highly constrained conditions. A higher level of inertia would provide market benefits by either:

- enabling the secure operation of the islanded sub-network under a much larger range of system conditions; or
- when not operating as an island, allowing for greater flows on the interconnectors with adjacent sub-networks.

Figure 3.5 shows the absolute minimum threshold level of inertia (broken red line) and the secure operating level of inertia (solid red line) in comparison to the level of

additional inertia that would allow for increased flows on the interconnector (green line). The minimum levels of inertia would limit the potential flows on the interconnector. Additional inertia would allow for the alleviation of constraints and higher flows on the interconnector for a given limit on the RoCoF that would occur from a sudden separation of the interconnector.

Figure 3.5 Comparison of minimum required levels of inertia and additional inertia for market benefit



This draft rule does not provide a mechanism to realise the market benefits that could be obtained through the provision of inertia above the minimum obligation on TNSPs. However, the Commission considers that the ability to maintain power system security in an efficient manner would be enhanced by the development and introduction of a mechanism to obtain and pay for this additional inertia. The Commission intends to pursue the development of such a mechanism to complement the TNSP obligation imposed through this draft rule. A discussion on the potential design of this mechanism is set out in the final report on the *System security market frameworks review*.

3.2 The South Australian Government's view

The South Australian Government notes that there has been a downward trend in inertia in South Australia since 2012, due to the increased wind and rooftop PV generation and the removal from service of synchronous generation such as Northern Power Station in May 2016.[54] The South Australian Government suggests that these

54 South Australian Minister for Mineral Resources and Energy, *Managing the rate of change of power system frequency rule change request - attachment A*, 12 July 2016, pp. 1-2.

issues are likely to present themselves more broadly in the NEM as the generation mix continues to change.

The South Australian Government proposes that AEMO should be provided with powers to determine the types and amount of ancillary services that may assist in addressing the potential for high rates of change of frequency.

In support of this additional role, a system standard for RoCoF should be established to guide the required level of the services. The level of this standard should be determined by the Reliability Panel in accordance with a process prescribed in the NER. The South Australian Government considers that a RoCoF standard will give the market certainty over the most efficient level of services to be procured to ensure system security.[55]

3.3 Stakeholder views

Hydro Tasmania considers that AEMO is well placed to determine required inertia levels for mainland and Tasmanian regions. It suggests that the process to determine inertia levels should be transparent and provide an opportunity for market participants to be consulted where appropriate.[56] The South Australian Chamber of Mines and Energy (SACOME) supports this view and suggests that the level of inertia should be assessed regularly by AEMO and should be open to review by expert third parties to ensure that it is set at an appropriate level and has taken all relevant factors into account.[57] Stanwell also considers that AEMO's work should be peer reviewed by an independent expert.[58]

In its submission on the directions paper, AEMO provides in-principle support for the requirement to determine minimum required levels of inertia.[59] AEMO suggests that this level of inertia would represent its assessment of a minimum requirement to run a resilient power system.[60] It would represent the level of inertia under which the region could be operated with a high confidence of system security, taking into account any credible and protected events, but allowing the use of constraints to limit contingency size.

AEMO proposes to determine this level of inertia each year for the NTNDP, based upon a defined procedure. The methodology for establishing a workable technical minimum level of inertia would be consulted on and published, having regard to an inertia objective and principles set out in the NER.

55 South Australian Department of the Premier and Cabinet, Submission on the directions paper, p. 7.

56 Hydro Tasmania, Submission on the directions paper, p. 1.

57 SACOME, Submission on the directions paper, p. 4.

58 Stanwell, Submission on the directions paper, p. 1.

59 AEMO, Submission on the directions paper, p. 3.

60 AEMO, Submission on the directions paper, p. 13.

In addition to a workable technical minimum, AEMO proposes that a system standard for inertia should be introduced in the NER.[61] The system standard would require that the system is operated without inertia-related constraints binding for a certain percentage of the year. AEMO expects that this level of inertia would be informed by long-term modelling of a range of scenarios, assessing efficient levels of inertia. The level of the standard would be set in the NER and would be determined in consultation with AEMO, industry and other relevant parties. The standard would be set differently for the mainland and Tasmania, similar to the existing FOS.

Origin Energy also suggests that AEMO should model a number of scenarios to define a level of inertia that satisfies a defined percentage of scenarios.[62]

3.4 Determining the sub-networks and required levels of inertia

The draft rule relates to the provision by TNSPs of the minimum level of inertia required to maintain secure operation of the power system. This can be distinguished from additional levels of inertia that may increase economic benefits by allowing for greater power transfers on the network.

This section sets out further detail on the following elements of the Commission's draft rule which places an obligation on AEMO to:

- determine the boundaries of inertia sub-networks in the NEM;[63]
- develop and publish an inertia requirements procedure setting out the process it will use to determine the inertia requirements for each inertia sub-network, having regard to matters specified in the NER;[64]
- determine, generally no more than once in any 12-month period, the "inertia requirements" for each inertia sub-network.

3.4.1 Determining the sub-networks

Under the draft rule, AEMO will be required to determine the boundaries of inertia sub-networks in the NEM for the purposes of determining the required levels of inertia for those sub-networks.[65] The process for determining the inertia sub-networks will be similar in concept to the process used by AEMO for defining the electrical sub-networks for the system restart standard.

In determining the boundaries of the inertia sub-networks the draft rule requires AEMO to take into account a number of matters, including:

61 AEMO, Submission on the directions paper, p. 11.

62 Origin Energy, Submission on the directions paper, p. 1.

63 Draft Rule clause 5.20B.1(d).

64 Draft Rule clause 5.20B.2(b), (c).

65 Draft Rule clause 5.20B.1(d).

- connections between the proposed inertia sub-network and adjacent parts of the national grid;
- the likelihood of the proposed inertia sub-network islanding;[66] and
- the criticality and practicality of maintaining the proposed inertia sub-network in a satisfactory operating state if it is islanded and being able to return to a secure operating state while islanded.[67]

The structure of the national transmission network is such that the highest risk of separation and islanding tends to be consistent with the boundaries of NEM regions. It is likely that the existing geographic boundaries of NEM regions would be a fair approximation of the likely sub-networks for the purposes of requiring minimum levels of inertia. However, there are also likely to be instances where an inertia sub-network could be defined within an existing NEM region. Northern Queensland would be a candidate that is likely to satisfy the criteria of an inertia sub-network based on the distance and extent of transmission connection with southern Queensland.

There may also be instances where the boundaries of an inertia sub-network could potentially encompass parts of two or more NEM regions. The limiting factor with these sub-networks would be the difficulty of assigning responsibility to procure the required levels of inertia to more than one TNSP.

Therefore, the boundaries of any inertia sub-network determined by AEMO must be consistent with the boundaries of an existing NEM region or wholly confined within an existing NEM region.[68]

AEMO may adjust the boundaries of any inertia sub-networks or establish any new inertia sub-networks having regard to the matters referred to above. The boundaries of the inertia sub-networks will be published in the NTNDP.[69]

In determining or adjusting the boundaries of the inertia sub-networks, AEMO will be required to follow the Rules consultation procedures.

On a transitional basis, the draft rule provides that AEMO is taken to have determined inertia sub-networks having the same boundaries as the boundaries of each region in the NEM.[70]

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66 The draft rule includes a proposed definition of "island" as being in relation to an inertia sub-network, or a combination of two or more inertia sub-networks, temporary loss of connection to adjacent transmission systems.

67 Draft Rule clause 5.20B.1(d).

68 Draft Rule clause 5.20B.1(c).

69 Draft Rule clause 5.20B.1(f).

70 Draft Rule clause 11.99.2.

3.4.2 Determining the minimum required levels of inertia

The Commission's draft rule requires AEMO to determine separate required levels of inertia for each inertia sub-network.[71] The required levels of inertia will be determined periodically in accordance with an inertia requirements procedure made by AEMO.[72] AEMO will conduct the inertia process to determine the "inertia requirements" for each inertia sub-network. The inertia requirement is made up of two separate levels of inertia:

1. The minimum threshold level of inertia - The minimum level of inertia required to operate the inertia sub-network in a satisfactory operating state when islanded.

2. The secure operating level of inertia – The minimum level of inertia required to operate the inertia sub-network in a secure operating state when islanded.

The draft rule requires AEMO to take into account certain matters when determining the inertia requirements for an inertia sub-network. These matters include the capability and expected response times of frequency control services in the islanded region and the maximum load shedding or generation shedding expected to occur on the occurrence of any credible contingency events, as set out in section 3.1.2.

As the deployment of greater levels of non-synchronous generation continues, the required levels of inertia will need to remain reflective of the prevailing market and system conditions. Most FCAS is currently provided by synchronous generators. As synchronous generators become scarcer, the required levels of inertia will increase or new sources of FCAS will need to be found for AEMO to be able to manage excursions in system frequency when they occur.

Under the transitional provisions in the draft rule, AEMO must make an initial determination of inertia requirements within seven months of any final rule commencing operation and again before publication of the NTNDP due to be published by December 2018.[73] After the initial determinations, the timing for determining inertia requirements is generally at AEMO's discretion subject to AEMO not making a determination more than once every 12 months.

However, in order to make sure that the required levels of inertia remain reflective of changing market conditions, AEMO is required under the draft rule to determine inertia requirements for an affected inertia sub-network as soon as reasonably practicable after becoming aware of a major unforeseen change to the power system likely to affect the inertia requirement, such as the retirement of a large synchronous

71 Draft Rule clause 5.20B.2(a).

72 Draft Rule clause 5.20B.2(b). The development of the procedure, and any subsequent amendments made to the procedure, will be required to comply with the Rules consultation procedures.

73 Draft Rule clause 11.99.4(a).

generator.[74] The required levels of inertia for each sub-network will be published in the NTNDP.

3.4.3 Identifying shortfalls in inertia

The draft rule requires AEMO to assess the levels of inertia being provided in each inertia sub-network and assess whether, in its reasonable opinion, there is, or is likely to be, an inertia shortfall in an inertia sub-network, taking into account matters specified in the draft rule relative to the inertia requirements determined by AEMO.

The draft rule sets out the following factors that AEMO must take into account in making its assessment:[75]

(a) when AEMO reasonably expects that the levels of inertia that are typically provided in the inertia sub-network are likely to fall below the secure operating level of inertia;

(b) over what time period and to what extent the inertia that is typically provided in the sub-network is likely to be below the secure operating level of inertia; and

(c) the levels of inertia that are typically provided in adjacent connected inertia sub-networks and the likelihood of the inertia sub-network becoming islanded.

AEMO will be required to publish its projections of the levels of inertia in each inertia sub-network as part of the Electricity Statement of Opportunities.[76]

If AEMO assesses that there is, or is likely to be, an inertia shortfall in any inertia sub-network, it must give notice of the assessment in the NTNDP and specify the date when the relevant Inertia Service Provider is required to make the inertia network services available.

74 Draft Rule, clause 5.20B.2(d).

75 Draft Rule clause 5.20B.3(a).

76 Draft Rule, clause 3.13.3(q)(6).

4 Providing the minimum required levels of inertia

In sub-networks of the NEM where an inertia shortfall has been identified by AEMO, the draft rule imposes an obligation on the TNSP that is the Inertia Services Provider to:

- make inertia network services available that when enabled will provide inertia:
  - to the secure operating level of inertia determined by AEMO for that sub-network;[77] or
  - an amount of inertia less than the secure operating level of inertia but at least the minimum threshold level of inertia if AEMO has approved other activities that may contribute to the operation of the inertia sub-network in a secure operating state when the inertia sub-network is islanded.[78]
- make the inertia network services available by the date specified by AEMO in the NTNDP;[79]
- identify and procure the least cost option or combination of options that will satisfy its obligation in the time required;[80]
- provide information in its Transmission Annual Planning Report about the activities undertaken to meets its obligations to provide inertia network services;[81]
- give AEMO a schedule setting out the inertia network services available (and any activities approved by AEMO that reduce the secure operating level of inertia) and the Inertia Service Provider's proposed order of priority for those services and activities to be enabled by AEMO;[82]
- register any synchronous generating unit from which it is procuring inertia network services as an inertia generating unit with AEMO and specify that the generating unit must be constrained on when it is providing inertia under clause 3.9.7(c) of the draft rule;[83] and
- provide specified details of the inertia network services it is making available to AEMO and seek AEMO's approval for the technical specifications and performance standards for those services and for the information necessary for

77 Draft Rule clause 5.20B.4(b)(1); clause 4.3.4(j).

78 Draft Rule clause 5.20B.4(b)(2), 5.20B.5(a); clause 4.3.4(j). Other activities that may be approved may include provision of frequency control services or emergency protection schemes.

79 Draft Rule clause 5.20B.4(c)(1).

80 Draft Rule clause 5.20B.4(f).

81 Draft Rule clause 5.20B.4(g).

82 Draft Rule clause 5.20B.6(a); clause 4.3.4(k).

83 Draft Rule clause 5.20B.6(b).

AEMO to enable or cease the provision of those services. AEMO must approve this information or advise the Inertia Service Provider of its concerns and the changes it requires to this information.[84]

The draft rule also provides that:

- AEMO may enable inertia network services to the levels, and in the circumstances, specified in clauses 4.4.4(a) and (b) of the draft rule.
- AEMO may enable or cease inertia network services by giving instructions to a Registered Participant who has contracted with the TNSP to provide inertia network services.[85]
- A Registered Participant providing an inertia network service must comply with an instruction given by AEMO to enable inertia network services.[86]

This chapter sets out further detail on the Commission's draft rule to place this obligation on the relevant TNSP and explores the specific conditions under which AEMO may enable inertia network services.

4.1 The obligation on the TNSP

The directions paper on the *System security market frameworks review* proposed that the obligation for procuring the required levels of inertia would be placed on the relevant TNSP in each inertia sub-network. The TNSP would act as the provider of inertia network services to make sure that the minimum required levels of inertia determined by AEMO are made continuously available to the system.

4.1.1 The TNSP as provider

Placing an obligation on the relevant TNSP to provide the required levels of inertia is supported by:

- the existence of an economic regulatory framework that can provide some discipline on the level of expenditure by TNSPs on inertia network services by enabling the AER to assess the efficiency of that expenditure;
- the ability to coordinate the provision of inertia with other network support services, such as system strength requirements.

84 Draft Rule clause 5.20B.6(c) to (h); clause 4.3.4(k).

85 Draft Rule clause 4.4.4(d) or (e).

86 Draft Rule clause 4.4.4(g).

An existing economic regulatory framework

The purpose of an obligation to provide a minimum level of inertia is to provide a high degree of confidence that system security can be maintained when separation and islanding of the sub-network occurs.

One of the key reasons the Commission considers that the obligations should be placed on TNSPs is that the existing economic regulatory framework for TNSPs will provide discipline on the level of expenditure by TNSPs on inertia network services by enabling the AER to assess the efficiency of that expenditure.[87]

Under the RIT-T, a detailed cost benefit analysis is undertaken to identify the investment option to meet an identified need (such as the need for inertia network services) which has the highest net benefits. TNSPs are required to consider all feasible network and non-network options and are required to seek submissions from registered participants, AEMO and interested parties on all credible options.

An investment undertaken to meet network obligations may still go ahead even if an economic assessment determines that there is an associated negative net economic benefit. Investments with negative net economic benefits are permitted if the investment is undertaken to meet a reliability, system security or technical standards requirement. However, it must still be demonstrated that the investment is the least cost approach.

In Victoria, the obligation to make inertia network services available will be placed on AEMO as the jurisdictional planning body. AEMO is responsible for planning, authorizing and directing augmentation of the declared shared network in Victoria. Different arrangements for the provision of shared transmission services, including inertia network services, will apply to AEMO in its role as the Inertia Service Provider for Victoria.

Coordinating the location of services in the network

The location of sources of inertia in the system has implications for the management of system security. The location of the services may have an impact on the ability to manage frequency under some circumstances. Equally importantly, other aspects of system security including system fault levels and voltage control are likely to be substantially impacted by the network location of the provision of inertia.

Operating the power system in a secure operating state requires generating units and network components to be able to operate continuously following a major fault or disturbance to the power system, and this ability is diminished by declining system strength. This is why the system strength at a point in the power system is often referred to as the fault level.

87 In addition, under the draft rule TNSPs are required to identify the least cost option or combination of options to provide minimum levels of inertia.

As compared to system frequency, system strength has much more localised impacts. The system strength at a point in the power system depends on how well it is connected to the synchronous generating units in that part of the power system. The system strength will be higher when:

- there are a number of large generating units nearby; and
- the point is connected to those generating units with more transmission (or distribution) lines and transformers.

Non-synchronous generators do not contribute to system strength as much as synchronous generating units, if at all.[88]

The draft determination on the South Australian Government's rule change request relating to the management of power system fault levels has set out a number of obligations on TNSPs and generators in maintaining minimum levels of system strength.[89]

Procurement mechanisms for frequency control, which might lead to investments in new synchronous devices, should therefore consider the location of such investments in order to co-optimise this with any investment required to manage system strength.

The Commission considers that TNSPs are best placed to provide the required levels of inertia within each inertia sub-network and to coordinate the location of inertia with other network support services, including obligations related to minimum system strength.

4.1.2 Determining the level of inertia to be provided

The draft rule establishes an obligation on the TNSP to make sure that the required levels of inertia are continuously available. However, the maintenance of system security is unlikely to necessitate that the full required level of inertia is continuously provided to the system. The variability in system conditions will mean that decisions will need to be made around the appropriate level of inertia to be provided to the system at any given time.

The minimum threshold level of inertia will be sufficient to maintain the islanded system in a satisfactory operating state should it be separated from the rest of the NEM. The power system is defined as being in a satisfactory operating state when a series of technical parameters, such as frequency and voltage, are within normal operating limits.[90] However, a credible contingency event, of even a moderate size, would likely cause the system frequency to move outside the bounds of the FOS, potentially resulting in cascading loss of generation and a system black event.

88 Some modern inverter based generation can provide a limited contribution to system strength.

89 AEMC, *Managing power system fault levels - draft determination*, 27 June 2017.

90 Clause 4.2.2 of the NER.

The minimum threshold level of inertia will not be sufficient to maintain a secure operating state, which requires the system to remain in at least a satisfactory operating state following the occurrence of a credible contingency event or a protected event.[91] Therefore, once separation has occurred, the continued operation of the islanded system will require the higher secure operating level of inertia to be provided. This level of inertia should be sufficient to enable AEMO to return the islanded system to a secure operating state.

Clause 4.2.6 in the NER requires AEMO to take all reasonable actions to return the system to a secure operating state within 30 minutes of the occurrence of a contingency event, in this case a separation contingency event.

The prevailing system conditions at any particular time may not necessitate that the full required levels of inertia are provided by the TNSP. The exact level of inertia to be provided will also be influenced by the amount of inertia being incidentally provided from other sources that are not under the control of the TNSP. Other factors may also be taken into consideration such as the RoCoF withstand capability of the generators online at the time or specific generators of a larger contingency size that are not online.

4.2 The South Australian Government's view

The South Australian Government considers that the rules should be amended to enable AEMO to procure inertia via ancillary services agreements.[92] In support of this obligation, AEMO would develop guidelines for the acquisition of inertia, similar to the guidelines developed for System Restart Ancillary Services (SRAS). The guidelines would contain technical information, information on the contracting process for AEMO to follow when contracting with 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.

The South Australian Government notes that clause 3.11 of the NER currently enables AEMO to instruct a person to provide a non-market ancillary service under an ancillary services agreement and that the person must use reasonable endeavours to comply with this instruction.[93] The South Australian Government proposes to extend the list of these services beyond system restart ancillary services and network support and control ancillary services (NSCAS) to include a broader range of ancillary services that can be used to manage high RoCoF.

91 A protected event is a non-credible contingency that, following a declaration by the Reliability Panel, must be managed in a similar manner to credible contingencies.

92 South Australian Minister for Mineral Resources and Energy, *Managing the rate of change of power system frequency rule change request - attachment A*, 12 July 2016, p. 2.

93 South Australian Minister for Mineral Resources and Energy, *Managing the rate of change of power system frequency rule change request – attachment A*, 12 July 2016, p. 2.

4.3 Stakeholder views

Energy Networks Australia (ENA) supports the Commission's proposal to establish additional obligations on TNSPs to provide and maintain the required levels of inertia determined by AEMO.[94] S&C Electric also supports the Commission's approach and considers that the TNSP is best placed to manage the broadest range of network/system issues, including oversight of the best technical approach for any given situation.[95] Stanwell also considers that TNSPs are best placed to manage the provision of inertia and that the ability of synchronous generators to contract with TNSPs to provide inertia through a 'non-network solution' should prevent the unnecessary build of new network assets and provide a signal that these services are valued.[96]

ENGIE supports contracts-based procurement of inertia but considers that the TNSPs are not the appropriate agency to carry out this procurement task.[97] ENGIE notes that TNSPs are structured towards establishing and maintaining regulated transmission network assets, and they have little need to contend or interact with the competitive market elements of the NEM. ENGIE suggests that when faced with the task of ensuring that a certain level of power system inertia is maintained, the TNSP will be pre-disposed towards a network solution, such as the installation of a synchronous condensor. Such an approach would have the effect of locking out potential future competitive options such as shorter term contracts for the delivery of inertia services.

The Australian Energy Council (AEC) supports the view put forward by ENGIE and suggests that the conflict of interest would be easily avoided by charging AEMO with the responsibility for procurement, and allowing all potential suppliers, including existing generators, TNSPs and new entrants, to compete on a level playing field.[98]

ENGIE suggests that the procurement of inertia could be undertaken by AEMO through a contract tender process. The tender process could be open to participation by existing synchronous generators and TNSPs.[99]

Origin suggests that the requirement to develop criteria for AEMO to use when assessing competing offers is not a compelling reason to rule AEMO out of the procurement role.[100] Origin considers that clear policies and procedures will still need to be developed to ensure that TNSPs engage in an efficient level of contracting. Stanwell suggests that the search for non-network solutions by the TNSP must be

94 ENA, Submission on the directions paper, p. 5.

95 S&C Electric, Submission on the directions paper, p. 3.

96 Stanwell, Submission on the directions paper, p. 1.

97 ENGIE, Submission on the directions paper, pp. 2-3.

98 AEC, Submission on the directions paper, p. 2.

99 ENGIE, Submission on the directions paper, pp. 4-5.

100 Origin Energy, Submission on the directions paper, p. 1.

conducted in a transparent manner and the tender requirements must be set in a way that does not pre-determine network investment solution.[101]

4.4 An obligation to provide the required levels of inertia

This section sets out further detail on the Commission's draft rule to:

- place an obligation on TNSPs to make continuously available the minimum required levels of inertia determined by AEMO;
- provide inertia on instruction by AEMO.

4.4.1 Making sure the inertia is continuously available

Under the draft rule, the obligation to provide inertia network services is placed on the TNSP for the relevant inertia sub-network, or, if there is more than one TNSP for the sub-network, the TNSP that has the transmission planning responsibility in each electrical sub-network.[102] In the case of Victoria, the obligation will be placed on AEMO through its role as the jurisdictional planning body.

Placing the obligation on the TNSP with transmission planning responsibility will make sure that there is a clear path of responsibility.

The Commission considers that an absolute obligation on TNSPs to guarantee the availability of the required levels of inertia at all times is not practical. It may also result in excessive costs depending on the extent to which the TNSP needs to contract with a large number of inertia providers in order to confidently meet the obligation at all times.

Therefore, the TNSP must make a range and level of inertia network services available such that it is likely that inertia network services that provide required levels of inertia when enabled are continuously available, taking into account planned outages and the risk of unplanned outages.[103] The AEMC proposes to recommend to the COAG Energy Council that this obligation be classified as a civil penalty provision.

The obligation will only apply in relation to sub-networks where an inertia shortfall has been identified by AEMO and published in the NTNDP. The Commission considers that this will maintain system security where it is needed while not imposing undue market or compliance costs on other areas. As future shortfalls are identified, the relevant TNSP will have time to prepare and identify activities to meet the obligation.

101 Stanwell, Submission on the directions paper, p. 2.

102 Draft Rule clause 5.20B.4(a).

103 Draft Rule clause 5.20B.4(c); clause 4.3.4(j).

Meeting the obligation

Under the draft rule, the TNSP will be required to seek and identify the least-cost option or combination of options to meet the obligation to provide inertia network services. The required levels of inertia could be made available by the TNSP through either:

- directly investing in synchronous condensors;
- entering into inertia services agreements with Registered Participants to provide inertia network services by means of a synchronous generating unit or synchronous condensor; or
- in the case of the provision of inertia network services to meet an obligation beyond the minimum threshold level of inertia and up to the secure operating level of inertia, any other types of inertia network services that can be provided by a TNSP investing in its network or by Registered Participant under an inertia services agreement.

An inertia services agreement is a contractual arrangement between the TNSP and a third party under which a person agrees to provide one or more inertia network services or to undertake an activity approved by AEMO that can reduce the secure operating level of inertia by contributing to the operation of an inertia sub-network in a secure operating state. The entry into an inertia services agreement may be a more cost-effective means of providing inertia network services than the construction of new assets by the TNSP. An inertia services agreement could involve the TNSP contracting with a synchronous generator to be able to request them to be online at certain times, or to run in synchronous condensor mode.

The Commission considers that, in order for the TNSP to meet the required levels of inertia, it may need to contract with multiple potential third party providers to make sure that the required level can be met at any given time.

Where AEMO identifies an inertia shortfall in a given sub-network, the obligation on the TNSP is to make inertia continuously available for the full secure operating level of inertia, and not just for the amount of the shortfall. This is because any contracts that the TNSP has with synchronous generators to come online to provide inertia are likely to cause other synchronous generators, which are also providing inertia, to be pushed out of the dispatch merit order, potentially resulting in only a small, or no, overall increase in inertia. This means that, even in circumstances where AEMO has identified only a small shortfall in inertia, the TNSP will still be obliged to make the full secure operating level of inertia continuously available in the sub-network.

The TNSP's proposal to make the required levels of inertia available must be developed and set out as part of its Annual Planning Report (APR). The required levels of inertia will need to be sourced from within the sub-network to make sure that the inertia is available to be provided to the system should separation and islanding of the sub-network occur.

Service classification and cost recovery

The obligation to make inertia network services available is a regulatory obligation or requirement imposed on the relevant TNSP in connection with the provision of prescribed transmission services.

The TNSP will be entitled to seek a revenue allowance that includes forecast operating expenditure or capital expenditure for its efficient costs of meeting the requirement. The AER will be able to assess the efficiency of that expenditure as part of the regulatory determination process for a regulatory control period.

The commencement of the obligation on TNSPs will occur during a regulatory control period.

For capital investments that are made during the regulatory control period that is underway when the rule commences in order to meet the inertia requirement, the TNSP may be able to use the regulatory change event cost pass through under clause 6A.7.3 of the Rules. Pass-through applications under clause 6A.7.3 are subject to a materiality threshold equal to one per cent of maximum allowed revenue for the regulatory year.[104]

For payments made to third parties under inertia services agreements, the draft rule provides that TNSPs can use the network support pass through process in clause 6A.7.2 of the existing rules to recover network support payments that exceed those that are included in their revenue allowance for the relevant regulatory year.[105]

Where AEMO reviews and updates the required levels of inertia for a given sub-network during a regulatory control period, the relevant TNSP will either enter into new inertia services agreements, or update the conditions of existing agreements. The TNSP may also compare this against the cost of physically constructing the required assets in order to meet the obligation.

In the case of network support agreements, an update to the required levels of inertia, will likely require the TNSP to apply to the AER for cost recovery under the existing network support pass-through provisions in the NER.[106] Network support pass-through is not subject to a materiality test and allows for increases and decreases in the amount of payments forecast in revenue determinations to be adjusted annually on an "overs and unders" basis. In making a determination on the TNSP's application for cost pass-through, the AER takes into consideration the efficiency of the TNSP's activities in meeting the obligation.

If the TNSP determines that the construction of network assets would be the most efficient way to meet the obligation to provide inertia network services in the relevant regulatory control period then this should form part of the TNSP's capital expenditure allowance for the period. In this case, the value of the network assets would be rolled

104 Clause 6A.7.3 of the NER.

105 Draft Rule amendment to chapter definition of "network support payment", clause 5.20B.4(h).

106 Clause 6A.7.2 of the NER.

into the TNSP's regulatory asset base at the beginning of the following regulatory control period.

Timing and location

As set out in section 3.4, AEMO will determine separate required levels of inertia for each defined inertia sub-network to operate as an island should it be separated from the rest of the NEM. AEMO will assess the levels of inertia that are typically being provided in each sub-network and determine whether or not a shortfall exists, or is likely to exist, with respect to the minimum required levels of inertia.

In the event that a shortfall is declared for a given sub-network, the TNSP will be required to meet the obligation to make the minimum required levels of inertia available. The TNSP must meet the obligation by the date specified by AEMO in the NTNDP (which must be no earlier than 12 months after the NTNDP is published).

The TNSP will also be required to meet any adjustments made by AEMO to the required levels of inertia for as long as a shortfall in inertia remains. The TNSP will be required to make the inertia available to meet the adjustment by the date specified by AEMO in the NTNDP (which must be no earlier than 12 months after the NTNDP is published).

If AEMO determines that a downward adjustment needs to be made to the required level of inertia, or that there will no longer be a shortfall in inertia within a sub-network, then AEMO must specify in the NTNDP the date from which the inertia obligation no longer applies to the TNSP. This date cannot be earlier than 12 months after the publication of the NTNDP. This should provide certainty to the TNSP and third-party providers when evaluating the benefits of investing in the construction of physical assets compared to expenditure under inertia services agreements.

As part of the transitional amendments with the draft rule, the Commission proposes that TNSPs will not be required to meet any obligation to make sure that the inertia services are continuously available until 1 July 2019.[107] This may restrict the options available to TNSPs in the initial stage of meeting the obligation and it is likely that TNSPs will need to contract with existing generators, or owners of existing synchronous condensors, to make sure that the obligation can be met.

Generally, a RIT-T is applied for all augmentation investments greater than six million dollars. For investments under the six million dollar threshold, the TNSP has discretion to determine the most appropriate assessment.

It is conceivable that the costs of meeting the obligation to procure the required levels of inertia will be in excess of six million dollars on an annual basis and, therefore, the RIT-T should be applied when determining the least-cost means of making the required levels of inertia available.

107 Draft Rule clause 11.99.4(b)(2).

However, the length of time required to conduct a full RIT-T process is around 18 months, which is not consistent with meeting the obligation in the initial 12 months, or maintaining the availability of inertia in line with AEMO's annual updates to the level of the obligation.

The Commission considers that a more flexible and expeditious approach will be to allow the TNSP to enter into inertia services agreements with third-party providers of inertia without the requirement to conduct a full RIT-T process.[108] Under this arrangement, the TNSP will still be required to identify the least-cost means of meeting the obligation. However, the proposed framework will allow the TNSP to negotiate the provision of inertia from third parties in a much shorter timeframe than would be necessary to undertake a RIT-T.

The Commission recognises the view held by some stakeholders that the TNSP may be more predisposed to building physical network assets than contracting with third parties for the provision of inertia and that this may result in a higher cost outcome or foreclose subsequent market sourcing options. The Commission considers that the potential costs associated with this risk are relatively low given that the TNSPs are only required to make the absolute minimum levels of inertia available. However, in order to promote the likelihood of a more efficient outcome, the Commission proposes to retain the existing requirement to conduct a RIT-T when assessing the benefits of physically constructing additional network assets to meet the obligation. The Commission considers that a RIT-T should still be undertaken in such instances, given the likely large upfront capital cost and long operating life of these assets.

When investing for the provision of inertia, the TNSP will necessarily need to assess the location of the new synchronous devices in order to determine the impacts on system strength. These synchronous devices will also have an impact on the control of system frequency and may either partially or fully address the required levels of inertia needed to maintain system security. Meeting the required levels of inertia and minimum required levels of system strength in a coordinated manner should be an inherent part of the TNSP's planning process.

Further, the Commission considers that allocating the responsibility to the TNSP for the provision of inertia would be more likely to avoid the possibility of higher costs that would be incurred through the duplication of network assets. For example, the TNSP would be in a better position to identify that the construction of a single synchronous condensor would be a more cost effective approach to the simultaneous management of both frequency and system strength. There is a greater likelihood that separate assets would be constructed to address frequency and system strength individually if separate entities were given responsibility or separate mechanisms were used.

108 Draft Rule clause 5.16.3(a).

4.4.2 Providing inertia to the system

This section sets out further detail on the provision of inertia to the system based on the sources of inertia made available by the TNSP.

The obligation to provide inertia to the system when instructed by AEMO

Under the draft rule:

- AEMO may enable inertia network services to:[109]
  - the minimum threshold level of inertia where a contingency event that would result in the islanding of an inertia sub-network has been classified as a credible contingency event or defined as a protected event; and
  - the secure operating level of inertia where the inertia sub-network is islanded.
- AEMO may enable or cease inertia network services by giving instructions to a Registered Participant who has contracted with the TNSP to provide inertia network services;[110]and
- Registered Participants that provide an inertia network service must comply with instructions from AEMO to enable the inertia network services.

The Commission considers that a role for AEMO to enable inertia is consistent with AEMO's role in managing the secure operation of the power system. Any generators that receive dispatch instructions will be required to meet the dispatch target provided by AEMO.[111] The AEMC proposes to recommend to the COAG Energy Council that the obligation on Registered Participants to comply with the instructions provided by AEMO be classified as a civil penalty provision.

AEMO will give instructions to enable inertia network services in an inertia sub-network to provide up to the minimum threshold level of inertia in circumstances where an event that would result in the islanding of the sub-network has been classified as a credible contingency event or defined as a protected event.

AEMO will give instructions to enable inertia network services in an inertia sub-network to provide up to the secure operating level of inertia[112] in circumstances where an inertia sub-network is islanded.

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109 Draft Rule clause 4.4.4(a) or (b). An inertia network service is enabled when AEMO has selected the relevant inertia network service and it is providing inertia to an inertia sub-network.

110 Draft Rule clause 4.4.4(d) or (e).

111 Clause 3.8.23 of the NER..

112 Or the secure operating level of inertia adjusted for activities approved by AEMO under clause 5.20B.5 of the draft rule.

AEMO will not be obliged to provide the full secure operating level of inertia to the system if it does not consider that level of inertia to be necessary to maintain the islanded sub-network in a secure operating state. The Commission considers that AEMO is best placed to be able to determine the optimal amount of inertia to be provided based on changing system conditions, including maximum contingency size and the tolerance of the system to RoCoF. For example, the amount of inertia required to maintain the system in a secure operating state at any particular point in time is likely to be principally determined by the generating unit with the largest contingency size that is online at the time. AEMO will also be able to take into account any additional inertia being incidentally provided at the time by other providers of inertia that are not contracted with the TNSP.

The TNSP will be required to provide AEMO with a schedule of the inertia network services which it has made available to meet the obligation.[113] The schedule will rank the inertia network services and will act as a guide to the most efficient means of providing the required levels of inertia to the system from the various sources.

AEMO's oversight of the power system suggests that it will be best placed to coordinate the provision of inertia from different sources. AEMO will instruct Registered Participants to provide inertia to the system in accordance with the schedule of inertia network services provided by the TNSP. AEMO will be required to use reasonable endeavours to select services higher in the order of priority specified in the schedule.[114]

Conditions of contracting with generators

The operation of inertia services agreements with generators for the provision of inertia will be similar to existing provisions under clause 5.4AA of the NER in respect of network support payments. If a TNSP contracts with a generator under an inertia services agreement for the provision of inertia, the TNSP must register the relevant generating unit with AEMO as an inertia generating unit that may periodically be used to provide inertia network services.[115]

When AEMO elects to use the generator to provide inertia, it will notify the TNSP of its intention. At these times, AEMO will constrain on the generator providing inertia and the generator will not be eligible to set the spot price in relation to its minimum loading level.[116] Any generation capacity that the generator offers over and above its minimum loading level will be dispatched and settled as normal through the NEM dispatch process.

AEMO will be required to review and approve the technical conditions of any inertia services agreements to be entered into between the TNSP and third parties. The Commission considers it necessary that any technical limitations associated with TNSP

113 See clause 5.20B.6(a) of the draft rule.

114 Draft Rule clause 4.4.4(c).

115 Draft rule clause 5.20B.6(b).

116 Draft rule clause 3.9.7(c).

contracts for inertia are consistent with AEMO's ability to maintain the power system in a secure operating state.

The majority of existing sources of inertia in the NEM are thermal generators that were built ten or more years ago. In many cases, changes to technical performance standards were not applied to these generating units at the time the standards were introduced. Contracts with these generators for the provision of inertia should establish that certain performance standards can be met, in particular the capability to ride through instances of high RoCoF.

Under the draft rule, the TNSP will be required to provide AEMO with specified details of inertia services agreements. This information will include but is not necessarily limited to:[117]

- details of the contracted generator so it can be registered with AEMO, including the nature of the service, the purpose for which the service is being provided, and the location of the service;
- details of the availability of the service, including its minimum loading level, the RoCoF withstand capability of the contracted generator[118], periods of notice and response times, and any other restrictions;
- levels of inertia provided by the contracted generator.

While technical specifications and performance standards for inertia network services will be required to be approved by AEMO, AEMO will not have a role in assessing or approving the commercial terms of inertia services agreements.

The Commission recognises that the ability for AEMO to determine the timing and magnitude of the provision of inertia may create some challenges for the TNSP when negotiating contract terms with third parties. The conditions and payment structures for the provision of inertia will likely be influenced by the frequency with which inertia network services are enabled by AEMO, which the TNSP may find difficult to forecast. However, AEMO will base its decisions with respect to the enablement of inertia network services on the schedule of inertia network services provided by the TNSP. The TNSP will be able to use the schedule as a basis for forecasting the expected costs of inertia services agreements that it enters into.

117 Draft Rule clause 5.20B.6(c).

118 To the extent that information is available or there are reasonable indications.

5 Other activities to meet the obligation

This chapter sets out further detail on the aspect of the draft rule which allows TNSPs to meet part of its obligation to make available inertia network services through contracts with third-party providers of services other than the provision of inertia. These services may include alternative frequency control services, including fast frequency response services.

5.1 Meeting the obligation through other activities

The directions paper on the *System security market frameworks review* proposed that, in meeting the obligation to provide the required levels of inertia, the TNSP would be able to contract with third-party providers of FFR services as a means of meeting an agreed proportion of the obligation.

This section explores the potential options available to the TNSP, including:

- opportunities for the provision of FFR services and special protection schemes; and
- other opportunities to contract with generators to reduce contingency size or not run at certain times.

5.1.1 Fast frequency response and special protection schemes

One of the matters required to be considered by AEMO under the draft rule when determining the required levels of inertia for an inertia sub-network is the availability and capability of existing frequency control services in the sub-network.[119] The greater the amount, and the faster the speed, of frequency response services, the less inertia will be needed to maintain the frequency within the bounds of the FOS and revert the frequency to the normal operating bands following a contingency.

An increase in the size or speed of frequency control services should reduce the amount of inertia needed to maintain the secure operation of the power system. However, the extent to which increased levels of frequency response services can be used as an alternative to inertia is limited. Frequency control services would not be able to substitute for the minimum threshold level of inertia, which is the minimum amount of inertia needed to operate the inertia sub-network in a satisfactory operating state when islanded.

Fast frequency response

Inertia and FFR are distinct services which perform different roles in the management of system frequency. Inertia acts to slow the rate of frequency change caused by a contingency. This is different to FFR, which actively injects power or reduces

119 Draft rule clause 5.20B.2(c)(1).

consumption to arrest the frequency change and revert the frequency back towards normal operating levels. Technologies that are capable of acting as a direct substitute for inertia by instantaneously and continuously maintaining local frequency are not technically possible at present. However, research suggests that these technologies are likely to become available in the future.

Greater amounts of FFR, or faster acting FFR services, will reduce the amount of inertia required to maintain system frequency within the bounds of the FOS. Consequently, co-optimisation of the services would likely lead to lower overall cost arrangements. The use of FFR to reduce the required level of inertia will be influenced by a number of factors:

- *Response to frequency change*: The level of inertia provided is an inherent physical property of a synchronous generating unit or synchronous condensor and acts to dampen changes in system frequency following a sudden shift in generation or load. This is different to frequency response services which involve a power injection following a change in frequency in order that the system frequency can be stabilised back to normal operating levels.

  As such, all frequency response services involve a time delay following the change in generation or load, with some response services being faster than others. Even FFR technologies involve a time delay between the initial change in frequency and the frequency response. This delay is comprised of four separate components which sum to equal the total time to respond:

  1. the period of time taken to measure the change in frequency and determine an appropriate response;

  2. the time taken to communicate to the device providing the response;

  3. the time taken to activate the response; and

  4. the time taken to ramp up from the point of activation to the maximum response output.

  The local detection of a change in frequency can be done very quickly, in the order of two cycles (40 milliseconds).[120] However, such a short period of time risks false identification and longer periods are likely to be required to provide a more accurate measurement and/or confirmation of the size and nature of the frequency change before an appropriate response can be determined. Once the frequency change has been measured, and an appropriate response determined, there are a range of technologies capable of providing a frequency response. Activation and ramping times are technology specific.

  The time delay of FFR technologies therefore implies that there is a level of inertia that must be online at any point in time to resist frequency changes at the

120 AECOM, *Feasibility of fast frequency response obligations of new generators - Report to the AEMC*, 8 June 2017, p. 13.

time of the contingency event as well as over the first few hundred milliseconds following a contingency event. Beyond this initial time period, FFR technologies have the potential to be used in combination with inertia to stabilise system frequency.

- *Fault ride-through capability*: Faults in the transmission system can quite often be the cause of contingency events. Under these circumstances, inverter-connected generation can be limited in its ability to provide active power to the network. This limitation is greater the closer the proximity to the fault. Inverter connected technologies cannot provide FFR services until such time as the fault is cleared.

  Following the clearance of a fault, the active recovery time of the inverter-connected technology is influenced by the strength of the system, with slower recovery times occurring in weak systems. The provision of FFR services by wind generators is an example of a technology that is affected by system strength. The ability to provide power injections following disturbances is usually dependent on voltage stability and a weak system may suppress the ability for wind generators to provide a frequency response.

  The period of time required to clear faults is likely to have an impact on the minimum response time capability of FFR services, which may limit the extent to which FFR can be relied upon as a substitute for inertia.

- *Specification of FFR services*: There are a variety of different technologies that have the potential to provide a fast frequency response contingency service to manage sudden changes in system frequency. Each of these technologies may provide these services with distinct operational characteristics, including whether the service is capable of rapidly injecting as well as withdrawing active power, whether the service is capable of sustaining the delivery of active power over a period of time, and the specific profile of the power injection in response to the frequency change.

- *Maturity of FFR technologies*: Fast frequency response services are not a mature technology, and are at an early stage of development or deployment. There are only limited examples of fast frequency response technologies being used to provide a contingency service in major power systems in the world. Consequently, the ability to use FFR technologies is to be limited initially, but is also likely to increase over time as experience is gained through active use in power systems. The Commission therefore considers that a long-term solution to managing frequency in a low inertia system should anticipate the use of FFR technologies.

Special protection schemes

A special protection scheme is a form of FFR that could be used to provide enhanced frequency control. These schemes utilise designated sensors and communication equipment to trigger immediate load or generation shedding as soon as a specific event has occurred, such as the trip of an interconnector. As a special protection scheme is triggered by the specific event, rather than a fall in frequency, it may act much faster

than conventional load shedding schemes. This allows for a faster response to the event, potentially preventing a change in frequency rather than arresting a change once it has already begun.

5.1.2 Contracting with generators to reduce the required levels of inertia

The level of inertia provided to the system determines the instantaneous RoCoF that will result from the occurrence of a contingency event of a given size. The speed at which the frequency changes determines the amount of time that is available to arrest the decline or increase in frequency before the frequency moves outside the fixed bounds of the FOS.

Contracting with large generators to reduce potential contingency size by not generating at certain times would reduce the level of inertia required to maintain secure operation of the system.

A further constraint is the withstand capability of generators to high rates of change of frequency. The capability of generators within a sub-network to withstand high RoCoF will influence the level of inertia required to maintain system security.

Generators that trip as a consequence of high RoCoF may exacerbate the disturbance to the system and lead to an even higher RoCoF by both contributing to the overall size of the contingency as well as reducing the level of inertia in the system.

Contracting with specific generators with low RoCoF withstand capability to not generate at certain times would also reduce the level of inertia required to maintain secure operation of the system.

5.2 South Australian Government's View

The South Australian Government proposes that the rules should be amended to enable AEMO to determine and procure the necessary range of ancillary services to manage high RoCoF.[121] The South Australian Government proposes that the focus should not be solely on inertia and that a broader range of ancillary services should be considered to address the issue.

5.3 Stakeholder views

A number of stakeholders support the proposal to allow TNSPs to contract with third-party providers of FFR services.[122] The AER considers that TNSP procurement of services is needed and will improve the stability of the system.[123]

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121 South Australian Minister for Mineral Resources and Energy, *Managing the rate of change of power system frequency rule change request – attachment A*, 12 July 2016, p. 2.

122 RES, submission on the directions paper, p3; Tesla, submission on the directions paper, p2

123 AER, Submission on the directions paper, p. 2.

However, both the AER and RES are concerned that an explicit requirement for inertia in the NER would limit the opportunity for alternative technologies to participate in the underlying requirement to manage RoCoF.[124] The AER suggests that a distinction between inertia and FFR creates a potential for over-investment in network solutions to deliver inertia.[125] RES suggests that the FOS should be amended to reflect the desired RoCoF instead of imposing an obligation on minimum required levels of inertia.[126] The RoCoF limit would reflect the RoCoF withstand capability of connected generators and the performance of under-frequency load shedding schemes and special protection schemes.

The Clean Energy Council (CEC) supports this view and considers that obligations should be placed on AEMO to report on the uptake and deployment of FFR capability.[127] The CEC proposes that AEMO should be provided with a clear mandate to investigate and explore new technologies with a focus on ensuring technological diversity in the provision of system security services. Where AEMO has identified opportunities to deploy FFR to meet the minimum required levels of inertia, the TNSP should be required to adopt this solution. Tesla also suggests that AEMO should give immediate prioritisation to testing FFR capabilities and consulting on technical requirements as soon as possible.[128]

Reach Solar considers that the rules should permit participation from customer-led solutions, including the use of customer-based synchronous machines and interruptible demand.[129]

5.4 Other activities to meet the obligation

Under the draft rule, a TNSP may seek AEMO approval to meet part of its obligation to make available the secure operating level of inertia through contracts with third-party providers of services other than the provision of inertia. AEMO may approve this where it is satisfied that the other services will contribute to the operation of an inertia sub-network in a secure operating state when it is islanded.[130] Additional activities may include, but are not limited to:

- installing or contracting for the provision of frequency control services, including fast frequency response services;
- installing special protection schemes;
- contracting with generators to reduce contingency size at certain times; and

124 AER, Submission on the directions paper, p. 2; RES, Submission on the directions paper, p. 3.

125 AER, Submission on the directions paper, p. 2.

126 RES, Submission on the directions paper, p. 1.

127 CEC, Submission on the directions paper, pp. 3-4.

128 Tesla, Submission on the directions paper, p. 3.

129 Reach Solar, Submission on the directions paper, p. 1.

130 Draft Rule clause 5.20B.5(a).

- contracting with generators with low RoCoF withstand capability to not run at certain times.

As discussed in section 3.1, the minimum threshold level of inertia is considered to be the absolute minimum level of inertia for which the system is capable of being operated in a satisfactory operating state when it is islanded. As such, any additional activities undertaken by the TNSP will only be permitted to meet the obligation to make available the secure operating level of inertia and not the minimum threshold level of inertia.

Any additional activities undertaken by the TNSP to meet the obligation will require approval from AEMO and will only contribute to the secure operating level of inertia at times they are available.

AEMO will assess whether, and to what extent, the additional activity could be used to meet the secure operating level of inertia. This will be undertaken on a case-by-case basis in order to account for the varying characteristics of different technologies.

As part of the approval process, TNSPs will be required to work closely with AEMO and potential service providers to assess the implications for network and power system operations. As with the delivery of inertia, a range of factors will need to be assessed by the TNSP in coordination with AEMO, including potential impacts on system strength at different locations, risk of intra-regional separation and islanding, and consideration of services provided by generators with low RoCoF withstand capability. The availability and provision of additional activities will need to be factored into the formulation of constraints for power system operation.

The Commission recognises the concerns raised by the CEC and RES that an explicit requirement for inertia in the NER may limit the opportunity for alternative technologies to participate in the underlying requirement to manage RoCoF. However, the Commission considers that not all alternative technologies can be considered as a substitute for inertia and that, for FFR technologies in particular, there has been little operational experience in using these technologies as a contingency service in Australia.

Similar to inertia services agreements for inertia, the Commission proposes to allow TNSPs to enter into contracts with third-party providers of additional activities without a requirement to conduct a RIT-T. As with inertia, TNSPs will still be required to assess the least-cost approach to meeting the requirement to provide inertia.

The TNSP's assessment of additional activities may be a complex task, as it might have to compare offers of very different service characteristics. Even within similar services, there are likely to be a range of potential options. As discussed in section 5.1, there are various characteristics of FFR that would need to be taken into account in comparing projects, including the capability to provide both raise and lower services, the design of the control systems as either open-loop or closed-loop, allowance for energy recovery periods following the provision of FFR, and the ability to ride-through faults and maintain active power levels.

Abbreviations

AEC	Australian Energy Council
AEMC or Commission	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APR	Annual Planning Report
CEC	Clean Energy Council
ENA	Energy Networks Australia
ESOO	Electricity Statement of Opportunities
FCAS	Frequency Control Ancillary Services
FFR	fast frequency response
FOS	Frequency Operating Standards
FPSS	Future Power System Security Program
MCE	Ministerial Council on Energy
NEL	National Electricity Law
NEM	National Electricity Market
NEO	national electricity objective
NER	National Electricity Rules
NSCAS	network support and control ancillary services
NTNDP	National Transmission Network Development Plan
RIT-T	Regulatory Investment Test for Transmission
RoCoF	rate of change of frequency
SACOME	South Australian Chamber of Mines and Energy
SRAS	System Restart Ancillary Services

TAPR	Transmission Annual Planning Report
TNSP	Transmission Network Service Provider
UFLS	under-frequency load shedding

A Summary of other issues raised in submissions

This appendix sets out the issues raised in the consultation on the directions paper to the *System security market frameworks review* that are relevant to this rule change request. The AEMC's response to each issue is provided. If an issue raised in a submission has been discussed in the main body of this document, it has not been included in this table.

Stakeholder	Issue	AEMC Response
General comments		
ENA	The Commission's proposed approach should formalise roles and responsibilities for TNSPs and AEMO in regards to assessing system security in the NEM, with additional obligations for managing the impact on frequency and system strength caused by reduced levels of synchronous generation (p. 5)	Agreed. The Commission considers that the draft rule sets out clear roles and paths of responsibility for AEMO and TNSPs.
TransGrid	The roles for TNSPs and AEMO need to be clearly defined and well understood (p. 2)	
ENA	Clarification should be provided as to whether the proposed additional obligations on TNSPs are intended to apply to all TNSPs regardless of whether they are the Jurisdictional Planning Body for a particular jurisdiction (p. 5)	The obligation will be placed on the TNSP that has the transmission planning responsibility in each electrical sub-network.
AER	The ROCOF challenge is one which is not unique to the NEM with a number of jurisdictions facing similar challenges. These are new and evolving complex engineering issues and careful consideration of all available evidence would be valuable before committing to a particular path	The Commission has drawn upon the work currently being undertaken by AEMO as part of its *Future power system security program*. The AEMC has also considered the findings of investigations into the international experience of RoCoF, including reports from GE, DGA and AECOM.

Stakeholder	Issue	AEMC Response
	(p. 2)	
Inertia procurement		
SA Government	In determining a minimum operating level of inertia, a number of scenarios related to protected events would also be modelled by AEMO. This presents further complication on setting a required level of inertia should AEMO take some ex ante actions (FCAS and/or constraining dispatch) or the EFCS scheme associated with that event triggering ex-post load or generation shedding. (p. 3)	The capabilities of existing frequency response services will be taken into consideration by AEMO when determining the minimum required levels of inertia.
SA Government	It does not seem the NSCAS framework is sufficient to cover the provision of inertia. The AEMC should consider if the rules need to be changed for TNSPs to be able to provide a prescribed operating level of inertia (p. 5)	The Commission considers that obligating TNSPs to provide a required level of inertia provides a more immediate solution then pursuing a similar outcome through the existing NSCAS framework.
SA Government	The AEMC needs to consider what level of flexibility is appropriate for AEMO in determining the minimum operating level of inertia (p. 5)	The Commission has proposed that the minimum required levels of inertia would be prescriptive and would be based on maintaining the islanded sub-network in either a satisfactory operating state or a secure operating state.
SA Government	If AEMO determines the required operating level of inertia in a region, the TNSP should have freedom to locate where the inertia is to be supplied to maximising the synergy between inertia system strength (p. 6)	Agreed. The TNSP should be best placed to coordinate the location of services to optimise inertia and system strength requirements.
SA Government	If the issues with contracting for inertia from synchronous machines cannot be resolved, the Division considers that the most likely and	The draft rule allows the TNSP to meet the obligation through either contracting with third-party providers of inertia or physically constructing the required assets. The Commission proposes that this

Stakeholder	Issue	AEMC Response
	straightforward solution is to limit inertia provision to non-generating sources in the interim. (p. 7)	decision should be based on a least-cost assessment.
Reach Solar	The inertia needed on a real time basis should be quantified by AEMO (p. 3)	AEMO will not be obliged to provide the full secure operating level of inertia to the system if it does not consider it necessary to maintain the islanded sub-network in a secure operating state. The Commission considers that AEMO is best placed to be able to determine the optimal amount of inertia to be provided based on changing system conditions, including maximum contingency size and the tolerance of the system to RoCoF.
Energy Queensland	Where a disparity exists between the type and volume of generation it will become increasingly important to localise the inertia requirements beyond a single state level. Mechanisms to localise the inertia requirements in such instances will be critical to maintain the stability of the system. (p. 4)	AEMO will be required to determine the sub-networks for the purposes of procuring the required levels of inertia. It will be at AEMO's discretion to adjust the boundaries of any inertia sub-networks or establish any new inertia sub-networks.
Tesla	Tesla would like to see an inertia market that is open to accepting synthetic inertia where technical capabilities meet AEMO defined requirements (p. 3)	Under the draft rule, the TNSP will be able to undertake activities in addition to the procurement of inertia to meet its obligation to procure the secure operating level of inertia. Any additional activities undertaken by the TNSP to meet the obligation will require approval from AEMO.
ENA	The Commission should also consider how the prescribed process for determining the required operating level of inertia relates to: the timing of the TAPR process; the establishment of the obligation; the RIT-T process; the final procurement of the service (p. 6)	The Commission has included transitional as well as enduring amendments with the draft rule to account for the timing implications of implementing the obligation on TNSPs.
ENA	The AEMC may also wish to consider how arrangements currently applying to AEMO could	The Commission considers that an absolute obligation on TNSPs to guarantee the availability of the required levels of inertia at all times is

Stakeholder	Issue	AEMC Response
	be applied to transmission networks when discharging similar obligations under the Rules. In many circumstances, the Rules afford AEMO necessary powers and/or reliefs from liability to ensure it is protected when meeting its obligations. Alternatively, the AEMC will need to consider how TNSPs price risk when determining the service response to meet obligations. (p. 8)	not practical. It may also result in excessive costs depending on the extent to which the TNSP needs to contract with a large number of inertia providers in order to confidently meet the obligation at all times. Therefore, under the draft rule, the TNSP will be required to make a range and level of services available such that it is reasonably likely that the required levels of inertia are continuously available, taking into account planned outages and the risk of unplanned outages.
SEA Gas	SEA Gas queries how it is intended that the TNSP will factor into its decisions the impact that incremental energy contributed by synchronous generators dispatched for the purpose of procuring additional inertia will have on market price (p. 1)	The TNSP will negotiate commercial terms of agreements with generators providing inertia. The contracted generators will be constrained on by AEMO and their minimum loading level will not be factored into the calculation of the dispatch price.
Hydro Tasmania	AEMO is well placed to determine required inertia levels for mainland and Tasmanian regions. The process to determine inertia should be transparent and provide an opportunity for market participants to be consulted where appropriate (p. 1)	The development of the process to determine the required inertia levels will follow the Rules consultation procedures. AEMO will review the required levels of inertia no more frequently than once every 12 months.
SACOME	The level should be assessed regularly by AEMO and open to review by expert third parties to ensure that it is set at an appropriate level and has taken all factors into account for a respective market in the NEM (p. 3)	
Clean Energy Council	Inertial contribution from these units to meet a minimum inertia level requires greater confidence in performance, given the fundamental nature of system security. Therefore, it is unacceptable that generating	Under the draft rule, the TNSP will be required to provide information to AEMO on the final form of network support agreements that it enters into with generators for the provision of inertia. The information will include details of the RoCoF withstand capability of the contracted

Stakeholder	Issue	AEMC Response
	units within unknown or undeclared RoCoF withstand capability might contribute to firm system security inertia limits. (p. 5)	generator.
	The Commission and National Electricity Rules must be clear that only generating units with clearly stated and known RoCoF performance standards may participate in the provision of inertia services. (p. 6)	
AEMO	AEMO does not consider it reasonable to require a TNSP to maintain a fixed level of inertia available at all times. This would result in an oversupply of inertia in many periods, and would be an overly onerous requirement on both the TNSP and potential providers. Requiring a constant level of inertia would also deliver inefficient investment, and potential limit participation to only baseload inertia providers. (p. 5)	Agreed. The minimum required levels of inertia will only be required to be provided at times determined by AEMO for reasons of system security. The Commission is further investigating the variable provision of additional inertia for market benefit.
	AEMO recommends that the responsibility for dispatching inertia sit with AEMO. This is similar to other grid services procured by the TNSP, such as NSAs for reactive power. Once procured by the TNSP, AEMO should be advised of the contracts, and develop procedures for committing inertia if it was required (p. 8)	Agreed. Under the draft rule, AEMO will provide instructions for the provision of inertia in accordance with a schedule prepared by the TNSP.
	AEMO suggests that restrictions be placed on the inertia procurement contracts, determined in consultation with AEMO. The TNSP should consider how contracts could be dispatched operationally, and the interaction of inertia	The TNSP will be required to provide information to AEMO on the final form of network support agreements that it enters into with generators for the provision of inertia, including periods of notice and response times, and any other restrictions.

Stakeholder	Issue	AEMC Response
	providers and the energy market (p. 8)	
ENA	Understanding the consequences of failing to provide the required operating level of inertia will be an important consideration for TNSPs in managing associated risks and costs in developing contractual arrangements to meet obligations (p. 7)	The Commission considers that an absolute obligation on TNSPs to guarantee the availability of the required levels of inertia at all times is not practical. Under the draft rule, the TNSP will be required to make a range and level of services available such that it is reasonably likely that the required levels of inertia are continuously available, taking into account planned outages and the risk of unplanned outages.
	In instances where TNSPs may not be able to procure the necessary operating level of inertia, or alternatively where the cost of procurement appears to be excessive due to the limited market, some form of transitional arrangement may be necessary (p. 8)	
Origin Energy	The directions paper suggests that it may be difficult to develop clear criteria by which AEMO could assess competing disparate offers and that consumers would bear risks of over or under-procurement. This, however, is not a compelling reason to rule out AEMO from the procurement role given that these issues would also need to be overcome if the TNSPs were given responsibility for contracting. Irrespective of which party is responsible for procuring inertia and FFR, clear policies and procedures will need to be developed to help ensure an efficient level of contracting. (p. 1)	Agreed. However, the Commission considers the existing economic regulatory framework provides a means for the TNSP to assess the least-cost approach to meeting the obligation with oversight and approval by the AER.
Fast frequency response		
S&C Electric	Throughout the directions paper there is a sense that FFR is a new and untried service. This is not	The Commission considers that the use of FFR as a contingency service is untested in the Australian context. However, the

Stakeholder	Issue	AEMC Response
	correct and S&C Electric has delivered over 17 MW of batteries to deliver this service (p. 2)	Commission considers that FFR services are likely to be effective in managing power system frequency and should be included as a possible means of meeting the secure operating level of inertia.
Tesla	AEMO's capability testing and drafting of FFR technical guidance should begin as soon as the draft rules are published. This will provide technology providers sufficient time to adjust systems and adapt interfaces as required. (p. 2)	Under the draft rule on power system frequency, the TNSP will be able to enter into contract arrangements with third party providers of FFR services, with approval from AEMO. This will be undertaken on a case-by-case basis in order to account for the varying characteristics of different technologies. Over time, greater experience with the implementation of these technologies will be developed.
	Tesla recommends that minimum contractual duration for FFR services would significantly advance first mover projects in the Australian market (p. 5)	The Commission has not proposed to place a minimum contract duration on FFR services. The Commission considers that these arrangements should remain at the discretion of the negotiating parties in order to maintain flexibility and efficiency in the provision of the services.
Australian Energy Council	The directions paper suggests that TNSPs should be used as a stop gap means of acquiring the necessary FFR. This conclusion overlooks the possibility that existing synchronous generators may also be able to provide FFR (p. 1,2)	While the Commission proposes that TNSPs would be able to contract for the FFR services in order to meet an agreed proportion of the required levels of inertia, this is unlikely to be relevant for synchronous generators that already provide inertia. A future market sourcing approach to FFR would allow all FFR providers to participate.
SACOME	If the funding avenues are too restrictive it may cause TNSPs to seek the cheapest option of FFR, which is load shedding. For SACOME members this can cause risks to personnel and plant, unacceptable interruptions to production, and material disruptions that endure for a prolonged period after the outage (p. 4)	Under the NER, the management of frequency through load shedding is not permitted for credible contingencies (under a notification by the jurisdictional system security coordinator for South Australia, the Frequency Operating Standards for South Australia following a separation event are such that frequency is assumed to be maintained within the standards through operation of the UFLS scheme). Future FFR services may include controlled load reductions. However, these services would be provided through negotiation and payment with the service provider.

Stakeholder	Issue	AEMC Response
Origin Energy	We question an unlimited contract length for FFR services, especially if the AEMC intends to transition to a market based approach after 3 years. A limit on contract length would not unduly undermine investment certainty and will provide greater clarity around the planned transition (p. 2)	The Commission has not proposed to place a maximum contract duration on FFR services. The Commission considers that these arrangements should remain at the discretion of the negotiating parties in order to maintain flexibility and efficiency in the provision of the services.
AEMO	AEMO proposes that the transitional FFR mechanism should achieve two objectives: Ensure a large, competitive pool of FFR providers is available in future, when it will offer substantial value to consumers and allow AEMO and other market participants to gain practical experience with a wide range of types of FFR providers, ensuring these services can be used effectively and with high confidence when they are ultimately required. (p. 19)	Under the draft rule, the ability for the TNSP to contract for the provision of alternative services should allow market participants and AEMO to gain practical experience with different types of FFR. The Commission is also investigating additional future measures for FFR services.
AER	We do not believe that TNSPs procuring ROCOF services should be required once a market in fast-frequency is established (p. 2)	In the current power system there is a minimum threshold level of inertia which must be provided in order to maintain at least a satisfactory operating state. FFR services cannot be substituted for this minimum level of inertia.
ATCO	Concerned with the apparent bias towards central planning and investment, evidenced by the proposal to rely on TNSPs to manage the procurement of inertia and FFR (p. 2)	The Commission considers that the potential costs associated with this risk are relatively low given that the TNSPs are only required to make the absolute minimum levels of inertia available. The Commission is further investigating the variable provision of additional inertia for market benefit.
	It is likely that this approach will create perverse incentives to encourage investment in potentially redundant infrastructure. (p. 2)	

Stakeholder	Issue	AEMC Response
	A more effective mechanism would be open markets for system frequency and inertia as contestable ancillary services. (p. 3)	

B Legal requirements under the NEL

This appendix sets out the relevant legal requirements under the NEL for the AEMC to make this draft rule determination.

B.1 Draft rule determination

In accordance with s. 99 of the NEL, the Commission has made this draft rule determination in relation to the rule proposed by the South Australian Minister for Mineral Resources and Energy.

The Commission's reasons for making this draft rule determination are set out in section 2.4.

A copy of the more preferable draft rule is attached to and published with this draft rule determination. Its key features are described in section 2.1.

B.2 Power to make the rule

The Commission is satisfied that the more preferable draft rule falls within the subject matter about which the Commission may make rules. The more preferable draft rule falls within s. 34 of the NEL as it relates to the operation of the NEM (section 34(1)(a)(i)), the operation of the national electricity system for the purposes of the safety, security and reliability of that system (section 34 (1)(a)(ii), and the activities of persons (including Registered participants) participating in the NEM or involved in the operation of the national electricity system (section 34(1)(a)(iii)).

B.3 Commission's considerations

In assessing the rule change request the Commission considered:

- its powers under the NEL to make the rule;
- the rule change request;
- submissions received during first round consultation;
- submissions received with respect to consultation on the *System security market frameworks review*; and
- the Commission's analysis as to the ways in which the proposed rule will or is likely to, contribute to the achievement of the NEO and how the more preferable draft Rule will, or is likely to, better contribute to the achievement of the NEO..

There is no relevant Ministerial Council on Energy (MCE) statement of policy principles for this rule change request.[131]

The Commission may only make a rule that has effect with respect to an adoptive jurisdiction if satisfied that the proposed rule is compatible with the proper performance of AEMO's declared network functions.[132] The more preferable draft rule is compatible with the performance of those functions as it leaves those functions unchanged.

B.4 Civil penalties

B.4.1 Amended provisions

The Commission's draft rule amends clauses of the existing NER (as set out in Table A.2 below) that are currently classified as civil penalty provisions under Schedule 1 of the National Electricity (South Australia) Regulations. The Commission considers that these clauses should continue to be classified as civil penalty provisions and therefore will not recommend any change to their classification to the COAG Energy Council.

Table B.1 Amended clauses that the Commission recommends should continue to attract a civil penalty

New clause reference	Who the obligation is imposed upon	Recommendation
4.10.2(c)	Any person operating equipment interfacing with a transmission network. Change relates to persons operating equipment interfacing with the transmission network that is involved in the provision of inertia network services	Retain
4.11.1(b)	The provider of inertia network services	Retain

B.4.2 New provisions

The Commission cannot create new civil penalty provisions. However, it may recommend to the COAG Energy Council that new or existing provisions of the NER

131 Under s. 33 of the NEL, the AEMC must have regard to any relevant MCE statement of policy principles in making a rule. The MCE is referenced in the AEMC's governing legislation and is a legally enduring body comprising the Federal, State and Territory Ministers responsible for Energy. On 1 July 2011 the MCE was amalgamated with the Ministerial Council on Mineral and Petroleum Resources. The amalgamated council is now called the COAG Energy Council.

132 Section 91(8) of the NEL.

be classified as civil penalty provisions. The new provisions that the Commission will recommend to the COAG Energy Council to be civil penalty provisions are set out below in Table B.2. The Commission considers that the new provisions should be classified as civil penalty provisions for the reasons set out in the table.

Table B.2 New clauses that the Commission recommends should attract a civil penalty

New clause reference	Who the obligation is imposed upon	Recommendation
3.9.7(c)	Generator in respect of inertia network services provided by inertia generating unit	This clause should be classified as a civil penalty provision because the obligation to comply with dispatch instructions is key to the provision of inertia network services when they are required in an inertia sub-network
4.3.4(j)	Transmission Network Service Provider that is a Inertia Service Provider	This clause should be classified as a civil penalty provision because the obligation to provide inertia network services when they are required is key to AEMO being able to manage the power system with required levels of inertia
4.3.4(k)	Transmission Network Service Provider that is a Inertia Service Provider	This clause should be classified as a civil penalty provision because the obligation to provide information on inertia network services to AEMO will allow AEMO to enable inertia services in order to manage the power system with required levels of inertia
4.4.4(g)	Registered Participant providing an inertia network service	This clause should be classified as a civil penalty provision because the obligation to provide inertia network services when they are required is key to AEMO being able to manage the power system with required levels of inertia
4.4.4(h)	Registered Participant providing an inertia network service	This clause should be classified as a civil penalty provision because the obligation to make sure that appropriate personnel and facilities are available to receive and respond to AEMO instructions to enable inertia services is key to AEMO being able to manage the power system with required levels of

New clause reference	Who the obligation is imposed upon	Recommendation
		inertia.
4.9.9C	Transmission Network Service Provider that is Inertia Service Provider	This clause should be classified as a civil penalty provision because the provision of information on changes to the availability of inertia services is key to AEMO being able to manage the power system with required levels of inertia.
5.20B.5(f)	Transmission Network Service Provider that is Inertia Service Provider	This clause should be classified as a civil penalty provision because prior approval by AEMO of changes to activities that may reduce inertia requirements is key to AEMO being able to manage the power system with required levels of inertia
5.20B.6(f)	Transmission Network Service Provider that is Inertia Service Provider	This clause should be classified as a civil penalty provision because prior approval by AEMO of the specifications and performance standards relating to inertia network services is key to AEMO being able to manage the power system with required levels of inertia

B.5 Conduct provisions

The Commission's more preferable draft rule does not propose any changes to conduct provisions.

B.6 Northern Territory legislative considerations

From 1 July 2016, the NER, as amended from time to time, apply in the Northern Territory, subject to derogations set out in Regulations made under Northern Territory legislation adopting the NEL.[133] Under those Regulations, only certain parts of the NER have been adopted in the Northern Territory.[134] As the proposed rule relates to parts of the NER that currently do not apply in the Northern Territory, the

133 National Electricity (Northern Territory) (National Uniform Legislation) (Modifications) Regulations.

134 For the version of the NER that applies in the Northern Territory, refer to : http://www.aemc.gov.au/Energy-Rules/National-electricity-rules/National-Electricity-Rules-(Northern-Territory).

Commission has not assessed the proposed rule against additional elements required by Northern Territory legislation.[135]

135 National Electricity (Northern Territory) (National Uniform Legislation) Act 2015.