AEMC

RULE

Australian Energy Market Commission

CONSULTATION PAPER

EFFICIENT PROVISION OF INERTIA - CONSULTATION PAPER

PROPONENT

Australian Energy Council

2 MARCH 2023

INQUIRIES

Australian Energy Market Commission
GPO Box 2603
Sydney NSW 2000

E aemc@aemc.gov.au
T (02) 8296 7800

Reference: ERC0339

ABOUT THE AEMC

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

COPYRIGHT

CITATION

To cite this document, please use the following:
AEMC, Efficient provision of inertia - Consultation paper, Consultation paper, 2 March 2023

SUMMARY

1 Australia's National Electricity Market (NEM) is at the forefront of the energy transition globally. It has one of the highest penetrations of inverter-based resources (such as wind, solar and batteries) worldwide, which are rapidly displacing synchronous generation (coal and gas). A variety of influencing factors are driving us towards new and previously unobserved operational conditions, including declining system inertia.

2 On 15 December 2021, the Australian Energy Council (AEC) lodged a rule change request, identifying a need to reconsider the existing inertia framework in the context of declining system inertia and the associated system needs through the rapid energy transition. The AEC proposes an ancillary service spot market for inertia as a solution to address the problems identified in its rule change request and meet the long-term power system needs.

3 The Australian Energy Market Commission (AEMC or Commission) has commenced its consideration of the AEC's rule change request. The commencement of this rule change and the publication of this consultation paper have been informed by stakeholder feedback on a joint paper published by AEMC and the Australian Energy Market Operator (AEMO) in June 2022, titled "Essential system services and inertia in the NEM" (the Joint Paper).

4 The existing inertia framework, introduced in 2017, aims to ensure minimum levels of inertia are supplied to keep the NEM secure. AEMO must determine the minimum required levels of inertia for each sub-network and assess whether a shortfall in inertia exists or likely to exist in the future. If AEMO identifies a projected shortfall in a region at risk of islanding, the relevant transmission network service provider (TNSP) is required to ensure that the region has sufficient inertia to maintain power system security through an islanding event. TNSPs ensure minimum inertia levels are met through network investment or procurement.

5 This framework provides an important backstop for managing security in the immediate term. However, the Commission considers it prudent to commence this rule change now. This will allow enough time to develop a better technical understanding of inertia, consider all options, and avoid any potential security issues caused by declining system inertia and changing technological capabilities.

6 The Commission notes that this rule change is progressing in the context of a suite of other essential system services reforms including those that have been implemented such as the introduction of mandatory primary frequency response and associated incentives; and evolving the existing system strength framework to be more proactive in approach. It also includes those currently under consideration, such as operational security mechanism (OSM), which is seeking to find a more efficient way of procuring, scheduling and pricing essential system services. We are cognisant of the need for these reforms to work together, to not create conflicting incentives, and not to have multiple tools seeking to do the same thing. As such will consider how this rule change should complement and be consistent with others.

7 This consultation paper outlines and seeks stakeholder feedback on various aspects of the AEC's rule change request and related issues, including the:

- key challenges arising from declining system inertia and the adequacy of the existing inertia framework in ensuring the secure and efficient operation of the power system in the long term;
- further work required to better understand the long-term power system needs and inform the development of an updated approach to inertia (most importantly relating to technical matters); and
- AEC's inertia spot market proposal and other alternatives.

8 Submissions on the consultation paper are due on 31 March 2023. The policy and technical aspects of the proposed inertia spot market and alternative options will take time to work through. To allow time for these inputs and further stakeholder consultation, the Commission has extended the statutory timeframe for a draft determination until **29 February 2024**.

This consultation paper builds on stakeholder feedback to the joint ESS and inertia paper published in 2022

9 This consultation paper has been informed by stakeholder feedback on the Joint Paper. That paper was published to set out the progress on ESS reform initiatives generally, as well as to seek stakeholder feedback on factors that the Commission needed to weigh up in determining how to progress the AEC's rule change request. These factors included:

- the risks of decreasing system inertia,
- the need to coordinate the implementation of any changes to the inertia framework with other ESS reform initiatives underway, and
- further technical work required to understand the long-term power system needs.

10 In response to the Joint Paper, the Commission received 18 submissions. The majority supported the initiation of the AEC's rule change request and developing a long-term solution for inertia concurrently with the other ESS reform initiatives underway.

11 Most stakeholders also agreed that consideration of a long-term solution for inertia will likely take considerable time given the complexity and extent of further work required to assess various technical and economic considerations. Many stakeholders noted that the rule change process should start now to ensure there is sufficient time to consider options and potentially implement a solution before the risk of inertia shortages materialises. The Commission agrees with this sentiment and so has commenced this rule change at this time.

We are seeking your views on the problems associated with declining system inertia and the adequacy of the existing inertia framework

12 There are various potential operational challenges associated with declining system inertia, such as many existing synchronous generators being unable to withstand high rates of change of frequency (RoCoF), existing protection equipment potentially being unable to operate with high RoCoF and maintaining a stable system more generally.

13 In the context of declining system inertia, the AEC considers that the current framework for

managing inertia in the NEM is inefficient and not fit for purpose in meeting the long-term power system needs. The Commission considers that the key challenges identified in the AEC's rule change request can be summarised as:

- Declining inertia may pose a future threat to power system security. Further technical work is needed to better understand the long-term needs of the power system and inform the development of an updated approach for inertia.
- Inertia is not efficiently procured or allocated in real-time. This is because the existing framework relies on the static annual inertia requirements and does not allow co-optimisation of inertia with energy and other system services.
- Clearer investment signals are needed to meet long-term inertia needs. Valuing inertia and providing transparency on inertia needs could incentivise efficient investment and promote innovation.

14 These challenges incorporate both the fundamental issue of keeping the system secure and meeting minimum security requirements, as well as the issue of doing this in the most efficient way possible - both in the short-term and the longer-term. The Commission considers that it is important to meet security requirements in an efficient way - and that we do not need to wait until there is a security shortfall before considering the most efficient mechanisms for security.

15 Chapter 3 'Problem definition' of this consultation paper outlines these issues in more detail and seeks stakeholder feedback on the materiality of these key challenges and related technical and economic considerations. Stakeholder feedback on this section will help the Commission develop a clearly defined problem statement, which will lay the foundation for the Commission to assess which course of action is in the best long-term interests of consumers.

We are seeking your views on the AEC's inertia spot market proposal and other alternative options

16 The AEC's rule change request proposes an inertia spot market as a solution to address the problems arising from declining system inertia and potential gaps in the current inertia framework in meeting the long-term power system needs. The AEC's proposal is described in section 3.1.

17 Various alternatives to a spot market approach have been discussed in the AEC's rule change request, the Commission's previous consideration of related matters, and stakeholder feedback to past processes.

18 Section 3.2 of this consultation paper outlines a set of alternative options based on these sources. The Commission is interested in stakeholder feedback on the ability of the proposed spot market or other options to address the problems identified.

The AEC's proposed spot market option

19 The AEC's proposed design follows the form of other ancillary service spot markets in the NEM, particularly FCAS markets. It features:

- a centrally priced and cleared spot market for inertia, in which potential providers of inertia offer their inertia through bids
- the quantity of inertia demanded would be set by AEMO on a dynamic basis, in line with the variable needs of the power system
- the market would be cleared at the bid price of the marginal participant, with all dispatched providers paid the same price
- participants would be supported in their decision-making by inertia demand and price forecasts that would be produced by AEMO.

20 The AEC considers its proposal to be the best option for a long-term framework for the provision of inertia to support the transition for several reasons. In the operational timeframe, a spot market could procure inertia more efficiently by procuring inertia dynamically in line with the dynamic needs of the power system. It would also co-optimise dispatch across frequency control services and energy to dispatch the lowest-cost mix of services. Over the longer term, the AEC considers its proposal would provide more consistent and transparent price signals to support more efficient entry and exit decisions, as well as guide investment in innovation in inertia provision.

Alternative options

Market based mechanisms

21 Three of the alternative options discussed in section 3.2 can broadly be classified as market based mechanisms. These options are as follows:

1. *Ahead or close to real-time market* — A market that operates ahead of, but close to, dispatch. Under this option, AEMO could seek competitive bids to provide inertia in the lead-up to dispatch. AEMO would select providers that meet the system need at the lowest cost — and potentially additional providers if this lowered the overall cost of dispatch. Units would be scheduled close to real-time across multiple dispatch intervals for the duration of the system need. The draft determination on the OSM outlined one potential design for such a market. Given the Commission is already considering such a change through the OSM process, which could include unbundled system services as they become known (such as inertia), this will not be considered in detail through this rule change. Instead, this rule change will be coordinated with consideration of the OSM.
2. *Shadow pricing* — This approach would assign a value to inertia by determining how much money could have been saved if the constraint were relaxed by a very small amount — the marginal value of inertia. Under this model, inertia providers would be paid to relieve inertia constraints where this results in economic benefits to the market. The model specifically focuses on relieving inter-regional RoCoF constraints because, in the near future at least, RoCoF constraints on the mainland are most likely to be applied on an inter-regional basis, and by restricting flows between regions, these constraints are likely to have the greatest economic impacts.
3. *RoCoF control service* — A variation on the AEC's proposed spot market option could be implementing a RoCoF control service, similar to the service implemented in the Western Australia's Wholesale Electricity Market (WEM). Under this framework, participants make

offers for their facilities to supply a RoCoF control service (defined as an inertial response which slows down the RoCoF on the power system). This RoCoF control service is then co-optimised in real-time with energy dispatch and other frequency services. This approach allows dynamic setting of the RoCoF requirements for the power system and real-time co-optimisation between system inertia, energy, other ESS, and system conditions (e.g. contingency size).

Structured procurement mechanisms

22 Two of the alternative options discussed in section 3.2 can broadly be classified as mechanisms for structured procurement. These options are as follows:

1. *Adjustments to existing TNSP procurement framework* — Various changes could be considered to improve the operation of the existing framework and fill any gaps in its current ability to meet the long-term needs of the power system. These include:
   - re-considering the required level of procurement to ensure sufficient inertia is available in operational timeframes — for example, requiring TNSPs to provide the minimum level of inertia in all sub-networks rather than just procuring for those where AEMO identifies a shortfall.
   - evolving the existing framework in a similar way to the changes implemented under the system strength framework, by moving away from a shortfall framework to a more proactive framework that involves TNSPs procuring inertia to meet forecasted future needs. Other amendments such as a more streamlined RIT-T process to facilitate a shorter timeframe between identification of any inertia shortfall and delivery of the solution
2. *AEMO forward procurement* — AEMO could be required to procure inertia to meet system needs through bilateral forward contracts. These could consist of both multi-year inertia supply contracts and shorter-term contracts for additional flexibility.

Maintain the current framework until technical work informs the best approach

23 Another option is to maintain the current inertia framework and allowing more time for further technical work to inform the appropriate design of an updated inertia framework and mitigate implementation risks, as proposed by some stakeholders in submissions to the Joint Paper.[1]

24 Under this approach, TNSPs would continue to be responsible for providing inertia when AEMO identifies a projected shortfall in a region at risk of islanding. AEMO would also retain the existing tools (constraints and directions) to address inertia levels if the security of the power system is threatened in the operational timeframe.

Implementation considerations

25 The Commission has identified several implementation considerations that need to be investigated further to guide its assessment of the AEC's proposal and alternative options.

1 Transgrid, ENA and Neoen

These include:

- technical considerations — determining parameters such as the system need and capabilities of different technologies to provide inertia would be essential for implementing changes to the framework;
- the initial and ongoing costs of different approaches;
- how any evolution to the existing inertia framework would interact with other system security frameworks, including those currently implemented and those being considered.

Technical input to this rule change

26 Further work is needed to better understand the technical inertia requirements of the power system through the transition alongside other system services. The findings from further technical work will help to clarify the nature and magnitude of technical problems arising from the declining system inertia and assess any potential gaps in the current inertia framework in achieving a secure and efficient operation of the power system. Further, they will also inform our assessment of the suite of feasible options for evolving the inertia provision framework. As such, they will be an important input to this rule change process.

27 Specifically, the AEMC considers that the following questions need to be answered to inform the rule change process:

- defining system inertia needs;
- defining the relationship between inertia from new technologies (for example, synthetic inertia from grid-forming batteries) and rotational inertia; and
- determining interactions with other security services

28 As part of its Engineering Framework, AEMO is progressing several pieces of technical work that will be useful to inform this process. To date this has included working to increase publicly available information on NEM inertia and improving the measurement of real-time inertia. AEMO is also progressing a number of Priority Actions in Financial Year 23-24 as part of its Engineering Framework. These include:

- assessing the role of rotational inertia in general power system stability and the need for a locational distribution of rotational inertia
- assessing emergency frequency control scheme adequacy with increasing aggregate distributed photovoltaics uptake
- undertaking dynamic inertia measurement trials

  In addition to these Priority Actions, AEMO's 'Engineering Roadmap to 100% Renewables' initiative plans to assess:

- technical specifications on inertia capability for IBR and understanding of 'synthetic' inertial response, including how the response might differ to rotational inertia and potential plant-level constraints on the capability to provide synthetic inertia;

29 In this process, the Commission will consider whether any additional technical work is required for this rule change process and if so, work closely with AEMO to explore options to obtain all technical inputs required in a timely and effective manner.

We consider that there are five assessment criteria that are most relevant to this rule change request

30 Considering the NEO and the issues raised in the rule change request, the Commission proposes to assess the rule change request against five assessment criteria.

31 Stakeholder feedback is sought on the Commission's proposal to assess this rule change against the following assessment criteria:

- Power system security
- Principles of market efficiency
- Costs and complexity
- Timing and uncertainty
- Innovation and flexibility

32 These criteria and their selection process are explained in detail in section 4.2.

Submissions are due by Friday, 31 March 2023 with other engagement opportunities to follow

33 There are multiple options to provide your feedback throughout the rule change process.

34 Written **submissions** responding to this consultation paper must be lodged with the Commission **by Friday, 31 March 2023** via the Commission's website, www.aemc.gov.au.

35 There are other opportunities for you to engage with us, such as one-on-one discussions. See the section of this paper below about "How to make a submission" for further instructions and contact details for the project leader.

36 The policy and technical aspects of the proposed inertia spot market and alternative options will take time to work through. Prior to making a draft determination, the Commission expects further public consultation will be required. This could, for example, take the form of a directions paper on the detailed design and likely costs and benefits of an inertia spot market and any other potential solutions. To allow time for these inputs and further stakeholder consultation, the Commission has extended the statutory timeframe for a draft determination until **29 February 2024**.

CONTENTS

APPENDICES

FIGURES

FULL LIST OF CONSULTATION QUESTIONS

QUESTION 1: TECHNICAL INFORMATION ON INERTIA

Do stakeholders consider there is any additional technical information required to assess the challenges and long-term system requirements related to inertia beyond what AEMO is doing?

Do stakeholders have their own technical information or studies that can be shared to help answer these questions?

QUESTION 2: **INERTIA PROCUREMENT AND ALLOCATION IN REAL-TIME**

What are stakeholders' views on the merits (or not) of defining and procuring inertia requirements dynamically in operational timeframes, as opposed to the current approach (that is, annual assessments that inform longer-term inertia procurement to specified minimum levels)?

QUESTION 3: INVESTMENT SIGNALS FOR INERTIA

What are stakeholders' views on the adequacy of the current inertia framework in providing long-term investment signals and the need for reform?

QUESTION 4: **WILL THE AEC'S PROPOSED SOLUTION BEST ADDRESS THE PROBLEMS RAISED?**

What are stakeholders' views on the AEC's proposed solution?

Is it the best solution to improve the:

- efficiency of inertia provision in the operational timeframe?
- efficiency of inertia provision in the investment timeframe?
- transparency of the power system's inertia requirements?

QUESTION 5: ALTERNATIVE OPTIONS

Do stakeholders consider that any of these options address the problems identified (see Chapter 3) more effectively than the proposed solution of an inertia spot market?

Are there any additional options not identified in this consultation paper that should be investigated?

QUESTION 6: IMPLEMENTATION CONSIDERATIONS

What are stakeholders' views on the implementation considerations identified?

QUESTION 7: DO YOU AGREE WITH THE PROPOSED ASSESSMENT FRAMEWORK?

Do you agree with the proposed assessment framework? Are there additional principles that the Commission should take into account or principles included here that are not relevant?

HOW TO MAKE A SUBMISSION

We encourage you to make a submission

Stakeholders can help shape the solutions by participating in the rule change process. Engaging with stakeholders helps us understand the potential impacts of our decisions and, in so doing, contributes to well-informed, high-quality rule changes.

We have included consultation questions in this paper, however, you are welcome to provide feedback on any additional matters that may assist the Commission in making its decision.

How to make a written submission

Due date: Written submissions responding to this consultation paper must be lodged with the Commission by Friday, 31 March 2023.

How to make a submission: Go to the Commission's website, www.aemc.gov.au, find the "lodge a submission" function under the "Contact Us" tab, and select the project reference code ERC0339.[2]

Tips for making submissions on rule change requests are available on our website.[3]

Publication: The Commission publishes submissions on its website. However, we will not publish parts of a submission that we agree are confidential, or that we consider inappropriate (for example offensive or defamatory content, or content that is likely to infringe intellectual property rights).[4]

Other opportunities for engagement

There are other opportunities for you to engage with us, such as one-on-one discussions. For more information, please contact the project leader with questions or feedback at any stage.

Project leader: John Kim

Email: john.kim@aemc.gov.au

Telephone: 02 8296 0625

2 If you are not able to lodge a submission online, please contact us and we will provide instructions for alternative methods to lodge the submission.

3 See: https://www.aemc.gov.au/our-work/changing-energy-rules-unique-process/making-rule-change-request/our-work-3

4 Further information is available here: https://www.aemc.gov.au/contact-us/lodge-submission

1 THE CONTEXT FOR THIS RULE CHANGE REQUEST

This chapter provides an overview of the AEC's rule change request and the relevant context and background for this consultation paper. It outlines how the AEC's rule change request relates to recent and ongoing work by the ESB and market bodies and provides a summary of the Commission's pre-initiation paper jointly published with AEMO to facilitate initial engagement with stakeholders on how to progress inertia reform.

1.1 The AEC has proposed an inertia spot market to provide a secure and efficient level of inertia

The AEC submitted a rule change request to the AEMC in December 2021, identifying a need to reconsider the existing inertia framework in the context of declining system inertia and the need to support the rapid energy transition and associated system needs. The AEC considers there are various issues with the existing inertia framework which mean it is not as efficient or capable of supporting the transition and longer-term investment as it should be.

The AEC proposes an ancillary service spot market for inertia as a solution to address the problems identified in its rule change request and best meet the National Electricity Objective (NEO). The AEC suggests that the key benefits of this solution would include providing a price signal and forecasting certainty to promote efficient investments in inertia sources, and allowing inertia to be co-optimised with other NEM spot markets to reduce total dispatch costs, which would benefit consumers.

The AEC recognises that in considering this rule change request, further work is needed to understand the technical requirements of the system for inertia and the best approach to manage inertia in the future.

The AEC's rule change request can be found on the AEMC's project webpage: "Efficient provision of inertia". Further details about the problems identified by the AEC and the proposed inertia spot market are outlined in the following sections (see 'chapter 2 — Problem definition' and 'chapter 3 — Options for further consideration').

1.2 Investigating an inertia spot market will progress the ESB reform pathway

The AEMC's consideration of this rule change request will progress the ESB's post-2025 recommendation to give further consideration to an inertia spot market as "a possible longer-term reform" in the ESS workstream.

In its market design final advice to energy ministers, published in August 2021, the ESB identified a spot market approach for valuing and procuring inertia as a longer-term reform for development.[5] System inertia would be managed in the near-term using the current arrangements for TNSPs to procure minimum levels of inertia, and potentially the proposed

5 ESB, Post-2025 Market Design — Final advice to Energy Ministers — Part A, p. 31

operational security mechanism (OSM), noting that the Commission is currently working through feedback to the draft determination on the OSM, if required.

In recommending further consideration of a spot market as a long-term priority, the ESB noted further development and technical consideration are necessary before developing an inertia spot market.

The areas of further work identified by the ESB include the continued analysis of the needs of the power system in managing frequency control, rotational inertia, and equivalent synthetic inertia services. The ESB also noted further technical learnings could be obtained from the reform program of the Wholesale Electricity Market (WEM) in Western Australia, which has introduced a RoCoF control service to value, procure and co-optimise inertia with other frequency services in the real-time market.

Since the ESB's recommendation was released in August 2021, various ESS reforms and market developments have progressed, including:

- a very fast FCAS market,[6]
- PFR arrangements,[7]
- an enhanced system strength framework[8], and
- the Frequency Operating Standard Review.[9]

AEMO is also continuing to progress its work on the Engineering Framework[10] to define the full range of operational, technical, and engineering requirements needed to deliver the future envisaged in the Integrated System Plan.[11] This includes coordinating the technical studies and activities required to understand the requirements and supply options for the range of ESS going forward — including inertia (more detail is outlined in section 3.3 of this paper and the previous paper on ESS and inertia in the NEM[12]). These developments and pieces of work will provide important context for the AEMC's consideration of the AEC's rule change request and the best approach for inertia.

---

6 For more information, see *Fast frequency response market ancillary service* project page at https://www.aemc.gov.au/rule-changes/fast-frequency-response-market-ancillary-service

7 For more information, see *Mandatory primary frequency response* project page at https://www.aemc.gov.au/rule-changes/mandatory-primary-frequency-response, and *Primary frequency response incentive arrangements* project page at https://www.aemc.gov.au/rule-changes/primary-frequency-response-incentive-arrangements

8 For more information, see *Efficient management of system strength on the power system* project page at https://www.aemc.gov.au/rule-changes/efficient-management-system-strength-power-system

9 For more information, see *Review of the Frequency operating standard 2022* page at https://www.aemc.gov.au/market-reviews-advice/review-frequency-operating-standard-2022.

10 For more information on the *Engineering Framework* see https://aemo.com.au/en/initiatives/major-programs/engineering-framework

11 For more information on the ISP see https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp

12 See *Essential system services and inertia in the NEM* at https://www.aemc.gov.au/sites/default/files/2022-06/Essential%20system%20services%20and%20inertia%20in%20the%20NEM.pdf

1.3 We have conducted initial engagement on how to progress inertia reform

This consultation paper has been informed by stakeholder feedback on a joint AEMC and AEMO paper published in June 2022, titled "Essential system services and inertia in the NEM".[13]

This paper set out the progress on ESS reform initiatives that the ESB recommended in its post-2025 market design reform work — including inertia, frequency, system strength and the Operational security mechanism.

It also looked in more detail at inertia as the potential next ESS priority, investigating interdependencies between ESS recommended reforms and considering how inertia reform could be informed by ongoing technical work such as the engineering framework, integrated system plan, and amendments to the market ancillary service specification.

Through this paper, the AEMC sought stakeholders' feedback on factors informing how to progress the AEC's rule change request to implement an inertia spot market. The joint paper highlighted that in progressing this rule change proposal, the AEMC needs to weigh up:

- the risks of decreasing system inertia,
- opportunities to leverage efficiencies and benefits from improving inertia frameworks,
- the need for better technical understanding to inform the rule change process, and
- the need to coordinate any implementation with other ESS reforms underway.

The joint paper discussed that although technical understanding of the power system needs to be improved, we need to progress the rule change so there is adequate time to develop and implement a long-term solution for inertia before any threats to security and efficiency materialise.

1.3.1 The AEMC has decided to initiate the AEC's rule change request because we consider it is timely to consider how the existing inertia frameworks need to evolve

A total of 18 submissions were received from various stakeholders, including market participants, network service providers, consumer groups and government agencies.

The majority of stakeholder submissions supported the initiation of the AEC's rule change request and considered that the development of a long-term solution for inertia should be undertaken concurrently with the other ESS reform initiatives underway.[14]

Most stakeholders also agreed with the AEC's statement that it will likely take considerable time (i.e. at least four years) to assess and implement a long-term inertia solution. These stakeholders considered the rule change process needs to be started now to ensure there is

13 See *Essential system services and inertia in the NEM* at https://www.aemc.gov.au/sites/default/files/2022-06/Essential%20system%20services%20and%20inertia%20in%20the%20NEM.pdf

14 Submissions to the AEMO-AEMC Joint Paper: Tesla, p. 2; CS Energy, p. 6; Energy Australia, p. 3; Stanwell, p. 2; Snowy Hydro, p.3; AGL, p.1; Alinta Energy, p. 2; Engie, p. 1; Delta Electricity, p. 1; Public Interest Advocacy Centre, p. 1

sufficient time to consider options and implement a solution before the risk of inertia shortages materialises.[15]

However, many stakeholders also agreed that further work is needed to better understand the technical requirements of the power system related to inertia and inform the design and scope of a spot market or any other long-term solutions for inertia.[16] The Commission has outlined the areas of further technical work required for this rule change in more detail in section 2.2 of this paper.

The Commission is initiating this rule change in recognition that inertia is the next area of system services for consideration of reform following the implementation of changes to system strength[17] and frequency frameworks. The Commission also considers that commencing this rule change now allows an opportunity to coordinate the development of an longer-term arrangement for inertia with other ESS reform initiatives currently underway, rather than considering it in isolation.

Although this framework provides an important backstop for managing security in the immediate term, the Commission considers it prudent to commence this rule change now, to allow enough time to consider any evaluations to this framework that are required. Starting now means mitigating any security issues caused by declining system inertia and changing technological capabilities of plant occurring. The Commission will also coordinate its consideration of inertia reforms with other ESS reforms underway, and this also takes time and careful consideration. Starting now allows us to identify and implement the best solution for inertia, whereas if we delay the consideration of improved inertia frameworks, there is a risk that inertia issues become urgent and require rushed and sub-optimal solutions.

1.3.2 The AEMC is extending the timeframe for a draft determination

The proposed inertia spot market would be a significant and complex change to the energy market. Investigating the problem identified by the AEC, the proposed spot market, and any other potential solutions is likely to require significant time, resources and stakeholder input before draft and final determination stages. This was recognised by stakeholders submitting to the joint paper. Further work will be required within and alongside this rule change process to investigate various technical, operational, and regulatory requirements related to declining system inertia and the changing needs of the power system through the energy transition.

Further work is also required as part of this rule change process to investigate various technical, operational, and regulatory requirements related to declining system inertia and the changing needs of the power system through the energy transition.

Given this complexity, prior to making a draft determination, the Commission expects further public consultation will be required. This could, for example, take the form of a directions

15 Submissions to the AEMO-AEMC Joint Paper: Tesla, p. 2; CS Energy, p. 6; Energy Australia, p. 3; Stanwell, p. 2; Snowy Hydro, p. 3; AGL, p. 1; Alinta Energy, p. 2; Engie, p. 1; Delta Electricity, p. 1; Public Interest Advocacy Centre, p. 1

16 Submissions to the AEMO-AEMC Joint Paper: CS Energy, p. 2; Energy Australia, p. 1; Snowy Hydro, p. 3; Alinta Energy, p. 1; Engie, p. 1; Delta Electricity, p. 2

17 Especially given the changes implemented to evolve the system strength framework, which is mirrored in the current inertia framework

paper on the detailed design and likely costs and benefits of an inertia spot market and any other potential solutions. To allow time for these inputs and further stakeholder consultation, the Commission has extended the statutory timeframe for a draft determination until **29 February 2024**. The Commission will update stakeholders on more precise timeframes on next steps once it has considered submissions to the consultation paper.

2 PROBLEM DEFINITION

The purpose of this chapter is to facilitate an informed discussion and seek stakeholders' feedback on the problems identified by the AEC and related technical and economic considerations. A clearly defined problem statement lays the foundation for the AEMC to assess which course of action is in the long-term interests of consumers, as per the National Electricity Objective (NEO).

AEMO's 2022 Inertia Report projects a future decline in system inertia. There are various potential operational challenges associated with a reduction in inertia, such as many existing synchronous generators being unable to withstand high RoCoF,[18] existing protection equipment potentially being unable to operate with high RoCoF, and maintaining a stable system more generally.

In the context of declining system inertia, the AEC considers that the current framework for managing inertia in the NEM is inefficient, does not provide sufficient incentives for inertia provision, and does not provide adequate transparency over system needs. This section explores the issues that the AEC considers exist under the current inertia procurement framework, in more detail.

These challenges incorporate both the fundamental issue of keeping the system secure and meeting minimum security requirements, as well as the issue of doing this in the most efficient way possible — both in the short-term and the longer-term. The Commission considers that it is important to meet security requirements in an efficient way; and that we do not need to wait until there is a security shortfall before considering the most efficient mechanisms for security. in this case in relation to inertia.

2.1 The current inertia framework

The current inertia framework was introduced in 2017 to ensure minimum levels of inertia are supplied to keep the NEM secure. Transmission network service providers (TNSPs) are required to ensure that regions at risk of islanding from the rest of the NEM have sufficient inertia to maintain power system security through an islanding event. AEMO determines whether there are inertia shortfalls in the system by assessing:

- the minimum inertia requirements for each region (the level required to operate the region in either a satisfactory or secure operating state — depending on the region's requirements)
- the projected level of inertia in that region over the following five years, and
- the likelihood of the region becoming islanded.

AEMO must determine the minimum required levels of inertia for each sub-network and assess whether a shortfall in inertia exists or likely to exist in the future (i.e. regardless of

18 The rate of change of frequency (RoCoF) refers to the rate at which the system frequency changes following a contingency event. It 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. The greater the size of the contingency event, or the lower the system inertia, the faster the frequency will change.

whether there is a risk of islanding). Under the current framework, however, there is no mechanism in place to value and procure inertia during normal operation in the NEM. This is because, historically, inertia requirements have generally been met through the prevalence of synchronous generation in the generator mix, and that inertia has been provided as a by-product of energy when synchronous generators are dispatched.

If AEMO identifies a projected shortfall in a region at risk of islanding, the relevant TNSP is required to procure the inertia or an alternative frequency control service (including FFR) to meet this shortfall. The TNSP must make the secure operating level of inertia continuously available.

AEMO is required to assess inertia sub-networks and requirements annually for each region of the NEM and declare any identified shortfalls or gaps for the coming five-year period. This means the current inertia framework requires inertia to be procured to meet a static requirement that is set annually and represents the largest amount of inertia required under the worst possible conditions.

Proposed investments by the TNSPs to provide inertia network services are subject to a regulatory investment test for transmission, as are any proposed inertia service payments.

TNSPs must meet the minimum threshold level using rotational inertia — that is, synchronous condensers and generators. The remainder (to meet the secure operating level) can be provided by either rotational inertia or other 'inertia support activities' with AEMO's approval.

AEMO also has tools to address inertia levels if the safety and security of the power system are threatened in the operational timeframe, including:

- constraining inter-connectors to reduce the largest contingency size, which may result in more synchronous generators operating in the region to meet demand
- using directions as a last resort, for example, to direct a synchronous machine online if insufficient inertia is available in operational timeframes.

Further information and history on the inertia framework in the NEM are outlined in Appendix A.

2.2 Declining inertia may cause future security challenges

2.2.1 Inertia currently plays a critical role in ensuring the secure operation of the power system

Inertia can be defined as an object's resistance to any change in its momentum. Inertia is important in the power system as this resistance to change helps to maintain frequency and voltage within the technical limits of a secure and stable power system. The greater the inertia on the power system, the less vulnerable it is to disturbances, all else kept equal.

For example, inertia limits the rate of change of power system frequency following a sudden change in the balance of generation and load on the power system, such as caused by a large generator disconnecting from the power system. The NEM operates at a frequency range as close to 50 Hertz as possible, meaning the power system safely and securely transmits power from generators to consumers. When there is more inertia on the power

system, frequency changes more slowly. This allows more time for frequency control services, such as primary frequency response[19] and FCAS,[20] to address the energy imbalance and arrest the change in frequency.

In a similar manner, inertia also supports a stable voltage waveform by dampening oscillations in active power[21] and so can contribute to system strength. Therefore, as system inertia decreases, there is an expectation that the RoCoF following contingency events will increase.[22] There is currently a minimum level of inertia required to support an acceptable RoCoF by providing:

- 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[23]
- a higher probability of generators remaining online following the occurrence of the contingency event.

2.2.2 Declining inertia may pose a future threat to power system security

The NEM is at the forefront of the energy transition globally. It has one of the highest penetrations of inverter-based resources worldwide, which is rapidly displacing the dispatch of synchronous generation.

Inertia in the power system has historically been provided by synchronous generators, such as coal, gas, and hydro. As the energy transition progresses and the power system decarbonises, these historical sources of inertia are expected to retire at an increasing rate, and the way we meet the power system's requirement for inertia is expected to evolve as the generation mix changes.

As the generation mix shifts and system inertia decreases, there is an expectation that post-contingency RoCoF will increase, which would likely test the existing operational practices of the power system.

By reference to the AEMO's 2020 ISP,[24] the AEC's rule change request notes that inertia in the power system is forecast to progressively decrease such that, in the absence of interventions, inertia will exceed the minimum threshold level in the NEM mainland only 95% of the time by 2029-30, in the step change scenario. The 2022 ISP included an updated forecast that

19 Primary frequency response (PFR) is the first stage of deliberate frequency control in a power system. It is the response of generating systems and loads to arrest and correct locally detected changes in frequency by changing their active power output or consumption.

20 Frequency control ancillary services (FCAS) is a set of services used by AEMO to maintain the frequency of the system within the normal operating band of around 50 Hz.

21 The power system's voltage waveform is the pressure rhythm that pumps power from the generation source, down the transmission lines to where it is consumed. A strong voltage waveform means that this pressure rhythm cannot be easily disrupted, and all the equipment attached to the power lines can operate securely, and reliably.

22 A contingency event is an event that affects the power system in a way that would likely involve the failure or sudden and unexpected removal from operational service of a generating unit or transmission element

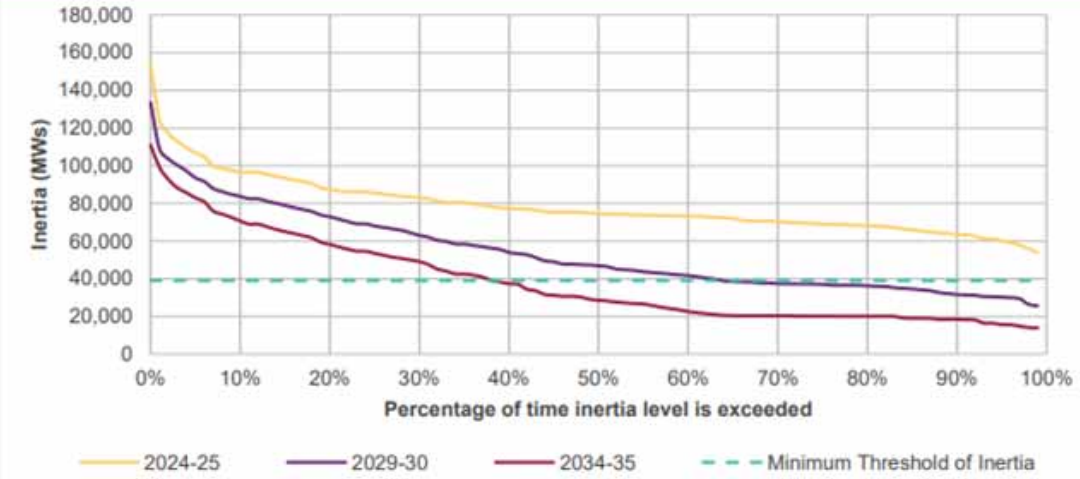
23 In rare circumstances following unlikely, or non-credible contingency events, the frequency deviation can be large. If this happens, emergency frequency control schemes may be activated. Under-frequency load shedding (UFLS) is one such scheme implemented to manage a large drop in frequency following an unexpected event that results in too little electricity supply to meet demand.

24 ISP 2020 documents can be found here: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp

incorporated new information, for example updated generator closure dates and transmission project completion dates. The more recent forecast projects that the threshold level of inertia is expected to only be exceeded 65% of the time by 2029-30 as illustrated in Figure 2.1 below.

Figure 2.1: AEMO step change inertia projections

Inertia projections (*Step Change* scenario)				
	2024-25	**2029-30**	**2034-35**	**Comments**
Available inertia 99% of the time (MWs)	53,950	25,700	13,850	The projections show that the NEM mainland inertia is expected to decline significantly by 2029-30 compared to 2024-25, decreasing below the minimum threshold of inertia.



Source: AEMO, 2022 ISP Appendix 7. Power system security

In addition, AEMO's 2022 Inertia Report[25] has forecast two new inertia shortfalls in Queensland (ranging from 8,200 MWs to 10,352 MWs) and Victoria (from 2,421 MWs to 2,482 MWs) against the secure operating level from 1 July 2026 onwards. These new shortfalls are in addition to the existing shortfalls declared in 2021 for South Australia and Tasmania. AEMO has also noted that inertia in New South Wales will decline below the secure operating level in 2026 but did not declare a shortfall on the basis that New South Wales is not considered sufficiently likely to island on its own.[26]

Inertia is an important power system parameter, which plays a critical role in managing the RoCoF following the occurrence of a contingency event. Its projected decline could cause challenges for system security, with many stakeholders considering that it would be one of the major challenges of the power system through the energy transition.[27]

25 available at https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/operability/2022/2022-inertia-report.pdf

26 Power system islanding occurs when distributed generation becomes isolated from the power system grid and continues to provide power to the portion of the grid it remains connected to.

27 Submissions to the AEMO-AEMC Joint Paper: Energy Australia, p. 1; Stanwell, p. 1; Snowy Hydro, p. 1; AGL, p. 2; Alinta Energy, p. 1; Delta Electricity, p. 1; Engie, p. 2

2.2.3 Technical advice to inform the rule change

Further work is needed to better understand the technical inertia requirements of the power system through the transition alongside other system services, as acknowledged by the AEC and many other stakeholders[28]

The findings from further technical work will help to clarify the nature and magnitude of technical problems arising from the declining system inertia and assess any potential gaps in the current inertia framework in achieving a secure and efficient operation of the power system. Further, they will also inform our assessment of the suite of feasible options for evolving the inertia provision framework. As such, they will be an important input to this rule change process.

Specifically, the AEMC considers that the following questions need to be answered to inform the rule change process:

- **defining system inertia needs**, including:
  - the level of inertia that will be required for secure system operation in the interconnected NEM during normal operation;
  - considering whether the future system needs should be defined in terms of RoCoF requirements instead of inertia levels;
- **defining the relationship between rotational inertia** and **other technologies:** assessing how other technologies (e.g. synthetic inertia) can contribute to meeting the current and future system needs, and the relationship of these with rotational inertia; and
- **determining interactions with other security services:** investigating technical interactions between inertia and other synchronous services, such as system strength and FFR, to assess the feasibility of unbundling inertia and the locational impacts of different resource dispatches.

The need for further technical work partly arises from the need to better understand system needs for inertia. For example, the current inertia framework does not require AEMO to assess inertia requirements and NEM-wide shortfalls during normal operation (see section 2.1). Instead, AEMO must define the minimum levels of inertia required to operate each NEM region as an island. Accordingly, the system is only explicitly managed to ensure that defined minimum levels of inertia are available when a region is at risk of islanding or is islanded.

This approach assumes that there is sufficient inertia to support a secure system while the system is interconnected. In the past, this assumption has been reasonable to make. However, this may not be the case in the future, with the majority of the synchronous plant that supplies inertia expected to leave the system by 2035 in AEMO's 'step change' scenario.[29] As such, the inertia requirements of the mainland NEM during normal operation will need to be investigated as part of this process.

In determining system needs, it will also be important to address potential challenges associated with accurate inertia monitoring and forecasting. The current inertia estimation is

28 Submissions to AEMO-AEMC joint paper: CS Energy, pp. 4-5; ENA, p. 1

29 AEMO, 2022 Integrated system plan, p. 50

based on synchronous generation unit commitment and does not consider load-side inertia contributions. As inertia reduces, it will likely become increasingly difficult to determine when low inertia thresholds have been crossed. Further, accurately calculating inertia levels will likely become increasingly critical for inertia-dependent constraints and the coordination of FCAS requirements. This assessment would also look at the potential for a system-wide inertia floor under the RoCoF limits.[30]

It will also be important to develop a better understanding of how evolving technology can meet system frequency and inertia needs. It is expected that secure operating level inertia requirements (i.e. above the current minimum threshold level) can increasingly be met using FFR services from battery-connected IBR to arrest major changes in RoCoF. This in turn could reduce the amount of rotational inertia required to ensure a secure operating level. Below certain minimum levels, however, rotational inertia currently has no substitute. Its complete replacement with IBR or other technologies remains to be investigated.

Some 'grid-forming' IBR emulate the inertial response of a synchronous machine and have the potential to replace rotational inertia. However, further investigation is needed to assess if these could clearly substitute for traditional rotational inertia. Further sources of rotational inertia could be unlocked in future by modifications to existing and proposed plants, such as adding flywheels on synchronous condensers or enabling gas turbines to operate in synchronous condenser mode.

2.2.4 AEMO's existing and planned technical studies related to inertia and technical inputs required for this rule change

To develop a better understanding of the future inertia needs of the power system and inform the development of a long-term solution the ESB recommended using AEMO's Engineering Framework.[31] AEMO's progress made to date includes publishing an initial roadmap in December 2021, the priority actions report in June 2022, and the Engineering Roadmap to 100% Renewables report in December 2022.

Under its Engineering Framework, AEMO is working to increase publicly available information on power system phenomena by reporting on NEM inertia and improving the measurement of real-time inertia.[32]

AEMO is also progressing a number of Priority Actions in Financial Year 23-24 as part of its Engineering Framework. These include:

- studies to assess the role of rotational inertia in general power system stability and the need for suitable locational distribution of rotational inertia[33]
- AEMO and TNSPs to assess emergency frequency control scheme adequacy with increasing aggregate Distributed Photovoltaics (DPV) uptake [34]

30 AEMC, 2022 Review of the Frequency operating standard, Draft determination, p.21

31 ESB Post 2025 market design final advice to energy ministers Part A, p. 35, accessible at: https://www.datocms-assets.com/32572/1629944958-post-2025-market-design-final-advice-to-energy-ministers-part-a.pdf

32 NEM Engineering Framework — priority actions June 2022

33 Engineering Framework Priority Action 2 for FY23

34 Engineering Framework Priority Action 18 for FY23

- undertake dynamic inertia measurement trials, which could include using phasor measurement units to measure system inertia (including on the generation and load side) following a small active power generation from a capacitor or battery [35]

In addition to these Priority Actions, AEMO's 'Engineering Roadmap to 100% Renewables' initiative plans to assess:

- technical specifications on inertia capability for IBR and understanding of 'synthetic' inertial response, including how the response might differ to rotational inertia and potential plant-level constraints on the capability to provide synthetic inertia;

AEMO's existing and planned work programs would deliver valuable technical findings toward answering the list of questions above. Through this work, the AEMC understands the minimum system inertia needs for the interconnected system under normal operation and by location, will be better understood, as will the relationship between rotational and synthetic inertia.

In this process, the Commission will consider whether any additional technical work is required for this rule change process and if so, work closely with AEMO to explore options to obtain all technical inputs required in a timely and effective manner.

> QUESTION 1: TECHNICAL INFORMATION ON INERTIA
>
> Do stakeholders consider there is any additional technical information required to assess the challenges and long-term system requirements related to inertia beyond what AEMO is doing?
>
> Do stakeholders have their own technical information or studies that can be shared to help answer these questions?

2.3 Inertia is not efficiently procured or allocated in real-time

Current arrangements do not procure or allocate an optimal volume of inertia

The AEC considers the current inertia framework for forecasting and procuring inertia in the planning timeframe does not result in the efficient procurement and allocation of an optimal level of inertia in the power system.[36] This is because the obligation to make the minimum required inertia continuously available is likely to result in the TNSPs contracting at levels above what is usually required in the system during normal operation — especially given that regions are often not islanded.

As noted in section 2.1, under the existing inertia framework, inertia is procured to meet a static requirement that represents the largest amount of inertia that could be required under the worst possible conditions.

In reality, the volume of inertia that is required for a secure and efficient system depends on multiple factors that are all subject to change over time, including:

35 Engineering Framework Priority Action 13 for FY23

36 AEC, Inertia Spot Market Rule Change Request, p.3

- the largest credible contingency size — which depends on the generators and transmission elements and their technical capabilities that are in service[37]
- the volume of load that is being served
- the speed and volume of 'fast' frequency response services available, and
- network elements that are in service.

The AEC also notes that the variability of the need for inertia at an operational timescale is expected to increase, citing AEMO's assessment of the potential variability in inertia requirements in South Australia, which shows that the inertia need may increase eight-fold in a matter of hours.[38]

The AEC describes that over-procurement of inertia under the current framework is a problem that is closely associated with the current inertia requirements, which are assessed on an annual basis, using typical dispatch levels. The AEC states this approach is likely to result in over-procurement as it sets the minimum level of inertia statically based on an annual assessment, which can be higher than the true minimum level that changes in real-time based on the operational conditions of the power system. The AEC states that the costs of over-procurement of inertia are ultimately borne by consumers.[39]

The AEC notes that all of these factors lead to the potential for more inertia to be procured in planning timeframes than is needed in operational timeframes, increasing costs for consumers. For example, when AEMO instructs inertia providers to come online in line with their contractual obligations with TNSPs, those inertia providers may not be needed for inertia and simply be causing other generators to be pushed out of the dispatch merit order, thereby resulting in no security benefit while still incurring the costs of inertia. The AEC considers that costs for consumers to meet minimum inertia levels could be reduced by dynamically identifying and setting the 'true' minimum inertia requirements and procuring against these requirements in real-time.[40]

There are unrealised benefits that would flow from co-optimising inertia with energy and other services and procuring efficient (rather than minimum) levels

The AEC also considers that there are unrealised benefits that would be unlocked by enabling the procurement of additional inertia for economic benefits.[41] The current inertia framework does not contain a mechanism for procuring additional inertia above the minimum levels associated with system security. However, in some cases, procuring above the minimum level of inertia can allow the system to be operated in a more unconstrained manner, unlocking lower-cost energy, and/or reduce the need for other market ancillary services, such as FFR and fast FCAS. This can reduce costs for consumers.

37 Changes to the contingency event framework for the *Enhancing operational resilience in relation to indistinct events* rule commence on 9 March 2023. These changes allow AEMO to include and manage 'indistinct events' through the contingency event framework. These events are events that can impact multiple generators or transmission lines in an unpredictable and uncertain manner, such as major storms, widespread fires, and cyberattacks. AEMO's assessment of these events will be included in its assessment of the largest credible contingency size.

38 AEC, Inertia Spot Market Rule Change Request, p. 18

39 AEC, Inertia Spot Market Rule Change Request, p.27

40 AEC, Inertia Spot Market Rule Change Request, p.22

41 AEC, Inertia Spot Market Rule Change Request, p.38

The AEC proposes that co-optimisation between inertia, energy and other ancillary services would unlock these benefits, maximising the scope for trade-offs between inertia and other frequency services when cheaper alternatives are available.[42]

Currently, the AEC notes that although there are provisions in the NER for trade-off with inertia support services (e.g. FFR), the co-optimisation can only take place at the time of contracting with TNSPs (usually every 2-3 years), and such static assessment of the trade-offs between inertia and inertia support services is further restricted by a requirement for AEMO's approval.[43]

QUESTION 2: **INERTIA PROCUREMENT AND ALLOCATION IN REAL-TIME**

What are stakeholders' views on the merits (or not) of defining and procuring inertia requirements dynamically in operational timeframes, as opposed to the current approach (that is, annual assessments that inform longer-term inertia procurement to specified minimum levels)?

2.4 Clearer investment signals are needed to meet long-term inertia needs

In the context of declining system inertia and evolving technology, it is important that investment signals provide the right incentives for existing and/or new sources of inertia and other security services to meet the needs of the power system through the transition.

Providing clear, long-term signals of system security needs, such as inertia, promotes efficient investment in the power system and helps minimise long-term costs for consumers. Missing or opaque investment signals, combined with the long asset life and typically capital-intensive nature of building plant, risks insufficient inertia provision and an insecure system in the future.

The AEC's rule change request considers that there is a lack of investment signals for potential inertia service providers and for those who may invest in inertia R&D and technology.[44]

Valuing inertia and providing transparency on inertia needs would incentivise efficient investment

The AEC considers there needs to be clearer financial incentives for current and prospective inertia suppliers to invest in and continue to operate assets that can supply the required levels of inertia through the transition.[45]

42 AEC, Inertia Spot Market Rule Change Request, p. 3
43 AEC, Inertia Spot Market Rule Change Request, p.26
44 AEC, Inertia Spot Market Rule Change Request, p.26
45 AEC, Inertia Spot Market Rule Change Request, p.3

The AEC is of the view that the current inertia framework does not provide sufficient incentives, as it treats inertia as an unrewarded by-product of other products, such as energy, FCAS and/or system strength. The AEC considers that this:[46]

- is unpredictable as inertia arises only because it is the by-product of other services; and
- undervalues the resource by not unbundling the inertia service from other services, and therefore not rewarding inertia provision at its marginal value.

To address this, the AEC considers there is a need to value inertia as an unbundled service, which would provide confidence to investors that their long-term investment and ongoing operation of inertia-providing assets will be rewarded in line with the specific system security and/or economic benefits.[47] The AEC proposes a market-based mechanism to signal this value (see section 3.1).

In their submissions to the AEMO-AEMC Joint Paper, many stakeholders agreed with the AEC's view on the need for long-term investment signal, although there have been mixed views on the root cause of such a problem. While many stakeholders identified absence of a market for inertia as the key driver for a lack of long-term investment signals, one stakeholder suggested the fundamental driver for long-term investment is the expectation of ongoing revenues, which can be achieved through bilateral contracts and does not necessitate a market.[48]

The AEC also raises issues with transparency of the current financial incentives for providing inertia. Under the current inertia framework, TNSPs procure any inertia required to address shortfalls. While TNSPs are required to consider options outside of augmenting their own networks as part of the RIT-T process, the public information on pricing through this process is limited and bespoke to each instance of procurement.[49] AEMO have made some progress in increasing transparency on inertia provision, for example, through the implementation of inertia data snap constraints in NEMDE that show the volume of inertia present in each NEM region. However, there are likely more opportunities to improve transparency.

The AEC notes that the current arrangements result in limited information being available to potential investors to assess the commercial viability of providing inertia services.[50] This issue is compounded by the fact that inertia capabilities are inherently linked to the engineering design of the units, and these designs are prepared several years in advance of the provision of inertia.

The need for reform to provide long-term investment signals has been echoed by a number of stakeholder submissions to the Joint Paper. For example, Stanwell stated that a 'wait-and-see' approach will risk too little inertia being available at some point, with new sources arriving too late and at an inefficient cost that will ultimately be borne by customers.[51]

---

46 AEC, Inertia Spot Market Rule Change Request, p.3
47 AEC, Inertia Spot Market Rule Change Request, p.45
48 Neoen, Submission to the AEMO-AEMC Joint Paper, p. 4
49 AEC, Inertia Spot Market Rule Change Request, p. 3
50 AEC, Inertia Spot Market Rule Change Request, p. 27
51 Stanwell, submission to AEMO-AEMC joint paper, p. 2

Similarly, Energy Australia also noted that the provision of better inertia data is vital for informing future inertia investment business cases.[52]

Clearly signalling the value of inertia could also promote innovation

As noted earlier in this paper, the current inertia framework requires that inertia up to the minimum threshold level must be provided by rotational inertia. Above this level, the service may be provided by inertia support service providers, subject to AEMO's approval.

The AEC notes that with evolving technology, synthetic and other forms of inertia are expected to increase in the future. The current technical understanding is that non-rotational inertia — also referred to as synthetic inertia — is not yet capable of fully replacing rotational inertia below minimum requirements. However, continuing to exclude synthetic inertia from meeting minimum requirements under the inertia framework in the future could decrease the long-term incentives and could stifle innovation and investment in emerging inertia technologies.[53]

The AEC considers that one of the benefits of its proposed rule would be incentivising inverter based resources (IBR) to be designed with grid-forming capability and to supply inertia, where it is efficient to do so.[54]

However, it also notes that AEMO would need to complete detailed supporting technical work to determine the technical quality of inertia sources and the substitutability of rotational inertia in order to change this requirement.[55] AEMO is currently working on this technical piece as part of its Engineering Framework project, the results of which will inform this rule change process.[56]

QUESTION 3: INVESTMENT SIGNALS FOR INERTIA

What are stakeholders' views on the adequacy of the current inertia framework in providing long-term investment signals and the need for reform?

52 Energy Australia, submission to AEMO-AEMC joint paper, p. 4
53 AEC, Inertia Spot Market Rule Change Request, p.27
54 AEC, Inertia Spot Market Rule Change Request, p. 8
55 AEC, Inertia Spot Market Rule Change Request, p. 3
56 See https://aemo.com.au/en/initiatives/major-programs/engineering-framework for more information on AEMO's Engineering Framework project

3 THE AEC'S INERTIA SPOT MARKET PROPOSAL AND ALTERNATIVE OPTIONS

This chapter outlines the inertia spot market option proposed in the AEC's rule change request and potential alternatives to address the challenges for the efficient and secure operation of the power system in the long-term as identified in Chapter 3.

The Commission and ESB considered various options for managing inertia over time, as outlined in Appendix A. This chapter outlines all viable options identified from the AEC's rule change request, stakeholder feedback, as well as other options that have been considered in the NEM over the past several years.

While this chapter focuses on identifying a list of all available options for initial consideration, the Commission will likely undertake further detailed assessment of short-listed options through a separate directions paper in the future. The Commission will adopt a flexible and adaptive approach to ensure that the assessment of the relative costs and benefits of each short-listed option is informed by the evolving understanding of the long-term power system needs.

Stakeholder feedback on this chapter will inform whether there are any additional alternatives that should be considered by the Commission and/or which options should be short-listed for more detailed options development and assessment through the next stages of this rule change process.

3.1 The AEC's inertia spot market proposal

The rule change request seeks to address the challenges identified in Chapter 2 of this paper by implementing an inertia ancillary service (IAS) spot market.

The AEC's proposed design follows the form of other ancillary service spot markets in the NEM, particularly FCAS markets.[57] It features:

- a centrally priced and cleared spot market for inertia, in which potential providers of inertia offer their inertia through bids
- the quantity of inertia demanded would be set by AEMO on a dynamic basis, in line with the variable needs of the power system
- the market would be cleared at the bid price of the marginal participant, with all dispatched providers paid the same price
- participants would be supported in their decision-making by inertia demand and price forecasts that would be produced by AEMO.

Participant eligibility

AEMO would be responsible for deciding what technologies are eligible to participate in the inertia spot market, with the AEC suggesting the following technologies be eligible:

57 AEC rule change request p.28 - 44

- synchronous generators that are also dispatched in energy
- grid forming IBRs to the extent that AEMO deems them to be capable
- synchronous generators capable of remaining synchronised at zero generation

In line with typical competitive market practice, under the proposal, monopoly assets would not be eligible to participate. Instead, the inertia supplied by NSP assets would be taken into account when determining market demand

Demand curve

The volume of inertia procured would be determined by AEMO in a similar manner to present, as is outlined in AEMO's *Inertia Requirements Methodology*.[58] However, this would be updated on a regular basis to ensure the inertia demand curve changes with the real-time needs of the power system. The AEC notes that establishing the technical input to dynamically calculate inertia requirements would likely be complex and challenging for AEMO.[59]

The demand curve would be divided into:

- *Non-discretionary inertia demand* — the volume of inertia that is required for a secure power system. This level must be procured at all times
- *Discretionary inertia demand* — above the non-discretionary level, inertia would be traded-off with other frequency control services to achieve the lowest total cost of dispatch. That is, additional discretionary inertia would be demanded if it cost less than the equivalent volume of other frequency control services — and therefore decreased costs for consumers.

Forecasting

To assist participants in making their decision, AEMO would be required to produce and publish pre-dispatch inertia market forecasts. These would indicate forecast demand and price to the market to provide it with sufficient information to facilitate decentralised decision making.

Bidding

Participants would submit bids that include:

1. bid price — in $/MWs/hr
2. whether they are available to provide inertia
3. where applicable, the minimum level they need to be dispatched for in energy to provide inertia

The quantity of inertia — in megawatt-seconds or MWs — provided by each participant would be standing information and would be combined with the bid parameters of each participant to form an inertia supply curve.

58 for more information, see Chapter 7 — Determining inertia requirements at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-security-market-frameworks-review/2018/inertia_requirements_methodology_published.pdf?la=en

59 AEC, Inertia Spot Market Rule Change Request, p. 8

Price setting

Similar to other spot markets in the NEM, the inertia market would feature a common clearing price that is paid to all participants that are dispatched. This price would either be global or regional, depending on whether the region is at risk of islanding and thus needs to procure inertia locally. The price for inertia would be set by the marginal participant's bid price. That is, the price would be set by the highest-priced unit that is dispatched, as in the energy and FCAS markets.

As being dispatched in inertia could result in out-of-merit-order dispatch in energy, units that are dispatched in inertia would not be able to set the price in energy. This means that units that can supply both energy and inertia would need to manage the risk of being dispatched below their energy bid through their inertia bid.

Under the proposal, prices would be floored at $0/MWs, and there would be a market price cap that could be set by the Reliability Panel, similar to energy. The floor price would reflect that there are no negative consequences of having additional inertia in the power system, past the optimal level.

Settlement

All inertia providers who are dispatched would be paid the common clearing price, with the marginal provider only being paid for the volume of their inertia that is dispatched.

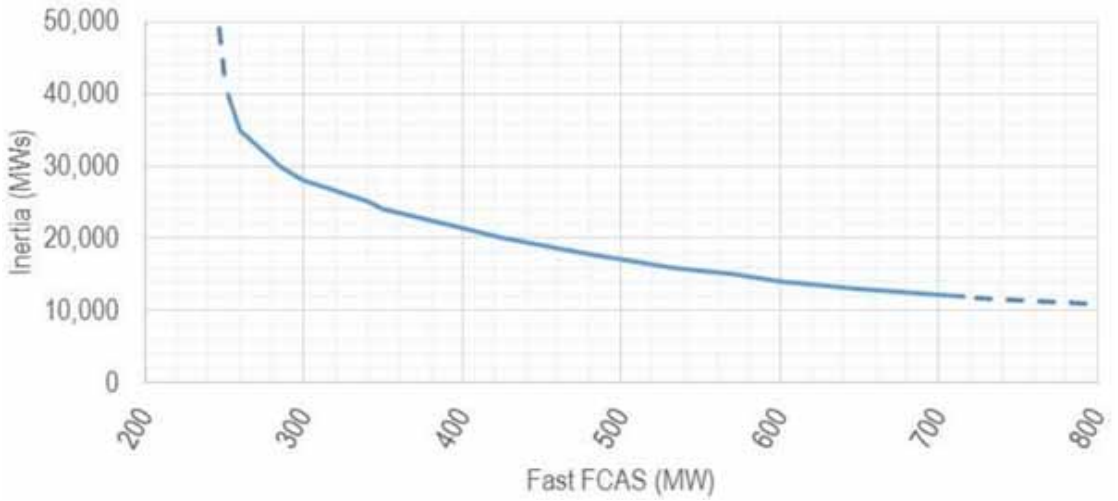
Dispatched inertia providers who are also energy providers would be paid the energy spot price additional to the inertia price. However, as mentioned previously, they would be unable to price set in energy.

Similarly, inertia providers that are dispatched through the energy market but not the inertia market would only be paid the energy spot price, even though they are supplying inertia.

Co-optimisation

Above the non-discretionary inertia level, the AEC proposes that inertia would be traded off against other frequency control services such as FFR and FCAS. This would allow NEMDE to optimise for the lowest total cost of dispatch. For example, above the minimum level, dispatching additional inertia could reduce the amount of FFR required, or vice versa. This trade-off is reflected in Figure 3.1 below, depicting a typical plot of inertia levels and their associated fast FCAS requirements. Co-optimisation would allow NEMDE to assess these tradeoffs and dispatch the solution with the lowest total cost across all markets.

Figure 3.1: Stylised plot of inertia-FFR tradeoff



Source: AEMO, Inertia requirements methodology, p. 19

Cost recovery

The rule change request does not propose a cost recovery mechanism but suggests it could be modelled from that of FCAS markets.[60]

The existing TNSP framework and directions processes would remain as a backstop

The AEC proposes that the existing TNSP procurement framework would remain, but is envisaged to be used less — that is, it becomes a 'last resort' service provision. AEMO direction would also be available in the operational timeframe as last resort — the AEC envisages the use of directions for inertia would decrease under its spot market proposal.

3.1.1 A spot market could help procure inertia more efficiently in the operational timeframe

The AEC considers that a spot market is the most efficient procurement method where a service can be unbundled, pointing to FTI Consulting's similar recommendation in its *Essential System Services in the National Electricity Market* paper for the ESB.[61] It notes that a spot market would allow all inertia to be valued, decreasing the risk of shortfalls in the longer term.

Dynamically forecasting and allocating inertia in real-time could reduce over-procurement and increase transparency

The AEC considers that the current framework tends to procure more inertia than is usually necessary for secure system operation — that is, a volume of inertia that is higher than the typical level of a variable minimum constraint. Dynamically forecasting inertia needs, and

60 AEC, Inertia Spot Market Rule Change Request, p. 3
61 AEC, Inertia Spot Market Rule Change Request, p. 4

procuring in a more flexible way to meet these changing needs, would allow for a more efficient outcome because it can avoid over-procurement.[62] Providing a variable demand and price on inertia would also incentivise providers to make inertia services available when they are most needed.

Additionally, publishing current and forecast inertia requirements to the market would increase transparency of the power system's inertia requirements. This would make it more accessible for potential providers of inertia to assess opportunities in the market. It would also provide other parties with an increased ability to assess how the market is operating — for example, regulators and rule makers.

Co-optimisation could ensure the least-cost mix of frequency control services is dispatched

The AEC proposes that the market design would dynamically trade off inertia requirements above the minimum level to identify the least-cost mix of frequency control services. This process is outlined in more detail above, in section 3.1.

Inertia and other frequency control services would be co-optimised with the energy market, to enable the procurement of additional inertia if this would lower the overall cost of dispatch.[63] This would, in turn, reduce costs for consumers.

3.1.2 A spot market could provide consistent and transparent price signals to guide investment

As noted in section 2.4, the AEC considers that the current framework does not provide transparent price signals. The inertia spot market proposal aims to address this by providing a single clear, transparent price signal for inertia. The proposal considers that this would promote efficient investment in inertia to ensure the security of the national electricity system through the energy transition.[64]

Compensating coincident inertia providers at a market price could support efficient entry and exit decisions

The AEC notes that the current inertia provision framework does not explicitly compensate suppliers of coincident inertia (that is, inertia provided as a by-product of energy generation). It considers that this is likely to result in providers of inertia leaving the system earlier than would otherwise be efficient as the transition progresses.[65] It considers that the single, transparent price that would be provided under its spot market proposal would address this by explicitly paying suppliers of coincident inertia, in addition to the revenue they obtain from energy. In a similar way, this would provide a signal to potential investors in assets that provide inertia.

A spot price would incentivise investment in innovation in inertia technologies

In addition to guiding entry and exit decisions for existing technologies, the AEC considers that a common spot price for inertia would guide investment in innovation in new and

62 AEC, Inertia Spot Market Rule Change Request, p. 22
63 AEC, Inertia Spot Market Rule Change Request, p. 7
64 AEC, Inertia Spot Market Rule Change Request, p. 6
65 AEC, Inertia Spot Market Rule Change Request, p. 3

emerging technology that can provide inertia. It notes that this should lead to lower costs for consumers in the long term, due to increased competition.[66]

The Commission considers there is a need to assess whether a derivative contracts market is necessary and feasible to drive efficient inertia investment

Given the capital intensity of many of the assets and projects that provide inertia such as synchronous condensers (syncons) and end-of-life synchronous generator syncon conversions, investors are likely to desire longer-term revenue certainty than a spot market alone provides. Thus, any spot market would likely need to be supported by a derivative contracting market to provide investors with long-term revenue certainty.

A functional hedging market requires both buyers and sellers. Buyers of contracts would typically be the parties that have been allocated costs and are looking to remove the risk of unexpected variations in price. As such, the Commission's assessment of different cost recovery options will include the viability of the parties as inertia hedging counter-parties.

The Commission considers there is a need to assess whether efficiency would be lost by excluding monopoly assets from the inertia framework

The AEC's proposal would exclude TNSPs from participation in the proposed inertia spot market and would use the existing TNSP procurement framework for inertia as a 'last resort'.[67] Monopoly businesses like TNSPs are typically excluded from participating in competitive markets (except through ring-fencing arrangements.[68]). This is because TNSPs, as regulated monopoly businesses, already recover the costs of their infrastructure investments and service provision from consumers. It would not be appropriate for this infrastructure to participate in a competitive market where it would be paid for again by consumers. Using TNSP procurement as a 'last resort' would only result in an efficient spot market if non-monopoly — that is, market participant — resources are always the dominant and most cost-effective sources of inertia in the NEM. If this is not the case, there would be lost opportunities and decreased efficiency in cases where TNSP-led provision is the most cost-effective option.

QUESTION 4: **WILL THE AEC'S PROPOSED SOLUTION BEST ADDRESS THE PROBLEMS RAISED?**

What are stakeholders' views on the AEC's proposed solution?

Is it the best solution to improve the:

- efficiency of inertia provision in the operational timeframe?
- efficiency of inertia provision in the investment timeframe?

66 AEC, Inertia Spot Market Rule Change Request, p. 4

67 AEC, Inertia Spot Market Rule Change Request, p. 3

68 Ring fencing separates different activities of monopoly companies (typically TNSPs, in electricity) to prevent anti-competitive behaviour, promote competition, and protect consumers' interests. This usually involves a completely separate business entity, that is treated like any other business by the NSP, operating in competitive markets.

- transparency of the power system's inertia requirements?

3.2 Alternative options

This section canvasses a range of alternative approaches to addressing the issues raised by the AEC in its rule change request.

The AEMC notes that in responding to the Joint Paper, stakeholders had mixed views on the best way to evolve the existing inertia framework — and whether the ESB's long-term vision of an inertia spot market was the right approach. Stakeholders with large synchronous generator fleets, as well as Tesla, noted their support for the AEC's inertia spot market proposal.[69] Several other stakeholders noted their in-principle support for the proposal.[70] However, other stakeholders including NSPs, large consumers, Neoen, and the AER, did not support the spot market proposal at this point in time.[71] This group all noted their preference for other procurement frameworks, most of which were similar in form to the existing framework.

The options below have been identified from the AEC's rule change request, stakeholder feedback to the Joint Paper and options raised through previous consideration of related matters. The Commission's consideration will include, but not be limited to, the options outlined in this section.

Further options may be identified based on stakeholders' feedback and/or the Commission's further consideration as part of this rule change process.

In considering the below options the Commission is particularly interested in feedback on how effectively the options would meet the problems described above with the existing inertia framework, and their pros and cons by reference to our assessment framework criteria.

3.2.1 Alternative market based mechanism (1): Ahead or close to real-time market for inertia

One alternative to an inertia spot market is a market that operates ahead of, but close to, dispatch. Under this option, AEMO could seek competitive bids from resources to provide inertia in the lead-up to dispatch. AEMO would select units that meet the system need at the lowest cost and potentially additional units if this lowered the overall cost of dispatch. Units would be scheduled close to real-time across multiple dispatch intervals for the duration of the system need.

69 [Submissions to AEMO-AEMC joint paper: Tesla, p. 1; CS Energy, p. 6; Snowy Hydro, p. 1; Energy Australia pp. 3-4; AGL, pp. 1-2; Stanwell, p. 2; Alinta, p. 1]

70 Submissions to AEMO-AEMC joint paper: ARENA, p. 1; Public Interest Advocacy Centre, p. 1; Tim George and Stephen Wallace, pp. 4-5

71 Submissions to AEMO-AEMC joint paper: Australian Aluminium Council, p. 3; Neoen, p. 3; Transgrid pp. 2-3; ENA, pp. 1-2; AER, pp. 1-2

The OSM draft determination outlined one potential design for such a market. Under this model, providers of security services (for example inertia) would make offers to provide the service.[72] A scheduling engine would run iteratively outside NEMDE to determine the optimal level of security services to procure and schedule, taking into account system security needs and any potential benefits that could be obtained in the energy and FCAS markets by scheduling additional security services. Costs would be allocated to market customers, who benefit from a secure system.

This option could help give AEMO confidence that sufficient resources would be available to deliver sufficient system security while introducing an element of competition to reduce the costs at which AEMO procures inertia in the operational timeframe.

Implementation may be relatively simpler and less costly than a spot market for inertia. In its OSM draft determination[73] the Commission noted that the implementation of the OSM would not require changes to NEMDE, and thus its implementation would likely be less costly and extensive than alternatives. The bulk of the implementation costs would be on AEMO, and it was expected that there would be relatively modest costs for participants to update systems and process in order to participate in the OSM.

Given the OSM rule change is already considering the implementation of the ahead or close to real-time market, which could include unbundled system services as they become known (such as inertia), this will not be considered in detail through this rule change. Instead, this rule change will be coordinated with consideration of the OSM.

3.2.2 Alternative market-based mechanism (2): Shadow Pricing

A shadow pricing approach would assign a value to inertia by determining the marginal cost of an inertia constraint, that is, how much money could have been saved if the constraint were relaxed by a very small amount.

The AEMC discussed a potential shadow pricing model for inertia in its 2017 System Security Market Frameworks Review (SSMF Review) [74] based around inter-regional RoCoF constraints.

Under this model, inertia providers would be paid to relieve inertia constraints where this results in economic benefits to the market. The model specifically focused on relieving inter-regional RoCoF constraints because, in the near future at least, RoCoF constraints on the mainland are most likely to be applied on an inter-regional basis, and by restricting flows between regions, these constraints are likely to have the greatest economic impacts.

In the presence of RoCoF constraints, the incremental value of inertia would be determined by an incremental increase in the flow on the constrained interconnector. When an interconnector is constrained, price separation occurs between the two regions it connects –

72 AEMC, Draft Determination - Operational Security Mechanism, available at https://www.aemc.gov.au/rule-changes/operational-security-mechanism

73 AEMC, Draft Determination - Operational Security Mechanism, available at https://www.aemc.gov.au/rule-changes/operational-security-mechanism

74 AEMC, System Security Market Frameworks Review, available at https://www.aemc.gov.au/markets-reviews-advice/system-security-market-frameworks-review

so therefore the value of inertia would relate to the difference in the regional reference prices between the two regions.

Under this model, inter-regional settlement residues that accrue as a result of RoCoF constraints would be paid to inertia providers. [75] All inertia providers would be eligible to provide the services and would receive payments from settlement. Generators dispatched in the energy market who were providing inertia would receive inertia payments in addition to energy market payments.

These payments would act as a signal to guide the enablement of inertia in the short term, and investment over the longer term. There would not be a separate inertia market, rather market participants would take expected inertia payments into account in structuring their energy market offers and making commitment decisions. By taking inertia prices into account in their energy market offers, participants would effectively co-optimise inertia provision with the energy and FCAS markets. Increases in the expected inertia price would incentivise greater provision, and this market signal would allow the costs and benefits of inertia provision to be efficiently balanced.

At times of plentiful inertia, RoCoF constraints would not bind, there would be no inter-regional price separation and, hence, the inertia price would be zero. However, when RoCoF constraints bind, there would be a positive inertia price which would signal the value of inertia and encourage participants to provide additional inertia where the expected proceeds would exceed the incremental cost involved in doing so.

Following the SSMF Review, this option was also considered as a possible solution under the Commission's consideration of the 'inertia ancillary service market' rule change (ERC0208).[76]

In this previous rule change, the Commission's final determination decided not to implement shadow pricing or any other market-based mechanism for inertia. The key reasons for this decision at the time included:

- the minimum level of inertia required to maintain the system security in a secure operating state had been addressed through a final rule on another rule change[77] which introduced the current TNSP framework for inertia;
- the minimum levels of inertia required to maintain the system in a secure operating state had yet to be determined by AEMO at the time of the final determination;
- further consideration was needed to how inertia can be accurately valued with the application of constraints to manage other system security requirements, such as system strength and system stability.

75 Inter-regional settlement residues occur when the prices between regions separate. Generators are paid at their regional spot price while retailers pay the spot price in their region. The difference between the price paid in the importing region (by retailers) and the price received in the exporting region (by generators), multiplied by the amount of flow across the interconnector, is called a settlement residue.

76 AEMC, Inertia Ancillary Service Market Rule Change, available at https://www.aemc.gov.au/rule-changes/inertia-ancillary-service-market

77 AEMC, Managing the rate of change of power system frequency (ERC0214), available at https://www.aemc.gov.au/rule-changes/managing-the-rate-of-change-of-power-system-frequency

In progressing the current rule change process, the Commission may consider to what extent these factors remain valid and relevant and is interested in stakeholder views on these points.

3.2.3 Alternative market-based mechanism (3): RoCoF Control Service

A variation on the AEC's proposed spot market option could be implementing a RoCoF control service, similar to the service implemented in the Western Australia's Wholesale Electricity Market (WEM).

The WEM will have real-time markets for five frequency-related ESS. One of these is a RoCoF control service - an inertial response provided by a facility which slows down the rate of change of frequency on the power system. The RoCoF control service will ensure RoCoF is restricted to below a certain maximum 'RoCoF limit' as defined under the WEM's Frequency Operating Standard. [78]

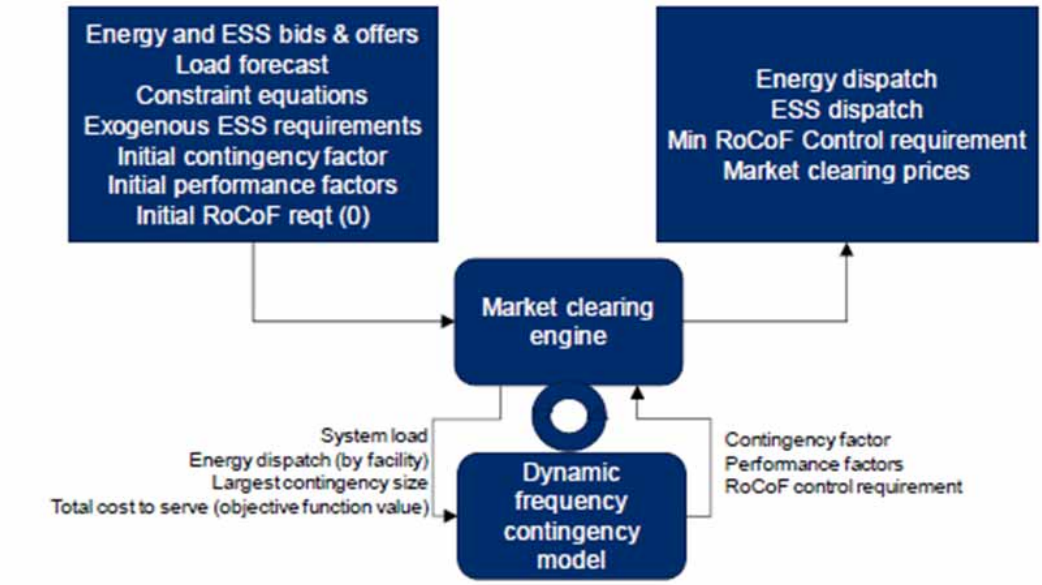
The design of this market is similar to the AEC's proposal. Under this framework, RoCoF requirements will be set dynamically as part of the dispatch process and specific to each trading interval (and can be zero if no RoCoF control service is required). Participants will make offers for their facilities to supply energy and one or more ESS, including a RoCoF control service. Participants can choose to offer into all, some or none of the markets.

The RoCoF control service will be co-optimised in real-time with energy dispatch and other frequency services. RoCoF control services will be scheduled to meet both:

- a minimum quantity required to maintain RoCoF safe limits, which are set to avoid damage to generators and load equipment, and to ensure proper operation of network components; and
- once the minimum quantity has been secured, additional RoCoF control services if these minimise overall dispatch costs by reducing the requirements for other frequency control services.

78 The WEM FOS provides the following RoCoF requirements: Safe RoCoF limit for intact system = 0.25Hz over any 500 ms period. Safe RoCoF limit for islands within the SWIS = 0.25Hz over any 500 ms (reasonable endeavours)] It has been implemented and will commence in October 2023.

Figure 3.2: Market scheduling and dispatch process for the WEM ESS framework



Source: Government - Energy Transformation Taskforce - Essential System Services Scheduling and Dispatch, available at https://www.wa.gov.au/system/files/2019-12/Information%20Paper%20-%20ESS%20Scheduling%20and%20Dispatch%20_final.pdf

The cost of procuring RoCoF control services will be recovered by applying a causer pays approach, in which costs are recovered from those facilities with a RoCoF ride-through capability[79] lower than a benchmark set by AEMO, referred to as the RoCoF Ride-Through Cost Recovery Limit.

On 8 December 2022, the Commission published a draft determination on the Frequency Operating Standard Review, which includes a recommendation for the NEM-wide RoCoF limits. This could inform the introduction of a RoCoF control service in the NEM if a limit were implemented following the review of the frequency operating standard (FOS Review).

3.2.4 Structured procurement option (1): Adjustments to the existing TNSP procurement framework

Improvements could be made to the existing TNSP inertia procurement framework to provide inertia in a more predictable way. This would involve retaining the current central planning approach: centralised forecasting of inertia requirements, then procuring services and building out capacity in a coordinated and forward-looking manner to meet these requirements. Options for improvements to ensure that the optimal mix of services and resources is procured and delivered in the most coordinated way could include:

- re-considering the required level of procurement to ensure sufficient inertia is available in operational timeframes - for example, requiring TNSPs to provide the minimum level of

79 The ability to withstand up to a specified level of frequency change over 500 milliseconds

inertia in all sub-networks regardless rather than just procuring for those where of whether AEMO identifies a shortfall. This would set the minimum level of inertia during normal operation and thus set the basis for procuring additional inertia to deliver economic benefits (AEC suggested this as an alternative option in their rule change request).

- evolving the existing framework in either:
  - a similar way to the changes implemented under the system strength framework to achieve a more secure and efficient power system and lower costs to consumers by improving the supply, demand and coordination of system strength, this could also include re-considering dispatch arrangements to ensure operational efficiency - for example, requiring inertia providers contracted by the TNSPs to bid in the energy market in line with their contractual obligations when a credible contingency event occurs (similar changes are being considered through the operational security mechanism)
  - other amendments such as TransGrid suggesting a more streamlined RIT-T process to facilitate a shorter timeframe between identification of any inertia shortfall and delivery of the solution (noting that the Transmission Planning and Investment Review are considering changes to the economic assessment framework).[80]

The Commission's Transmission Planning and Investment Review (TPIR) is also considering various options to streamline the current economic assessment process, including the RIT-T, to better support the timely delivery of strategically important network projects. In September 2022, the Commission issued the TPIR Stage 3 draft report to seek stakeholder feedback on early options to improve the timeliness of the economic assessment process while maintaining an adequate level of rigour.[81] The Commission will publish a final report in May 2023.

Some stakeholders identified enhancing the existing framework as their preferred option, noting that inertia is a fundamental aspect of a stable power system, which TNSPs may be best placed to provide, alongside system strength.[82]

The implementation cost and complexity for enhancing the existing TNSP framework for inertia may be lower than other options, depending on the nature and magnitude of the proposed refinement(s).

3.2.5 Structured procurement option (2): AEMO forward procurement

AEMO could be required to procure inertia to meet system needs through forward contracts.

Alternatively, or in conjunction with long-term contracts, AEMO could procure shorter-term inertia supply contracts through more frequent reverse auctions (for example, quarterly) to manage inertia in a more flexible, responsive way, as the AEC has suggested.[83]

80 Transgrid, Submission to the Joint Paper, p.2
81 AEMC, Transmission Planning and Investment Review - Stage 3 Draft Report, page 40
82 Submissions to the AEMO-AEMC Joint Paper, Transgrid (p.1), Australian Energy Regulator (p.2) and Neoen (p.4)
83 AEC rule change request, p.56

A longer-term model could provide greater investor certainty than shorter-term pricing. On the other hand, shorter-term contracts could have more flexibility than longer-term contracts to adapt to changing operational conditions, access economic benefits, and/or fill any unexpected gaps arising from long-term contracts. The draft determination on the OSM outlined one such way that this could occur.[84]

AEMO would need a mechanism to operationalise the contracted inertia in dispatch — either through contractual arrangements, or a new scheduling engine.[85]

This option, however, is not without risk as AEMO would likely continue to procure inertia ahead of dispatch, based on a static assessment in the planning timeframe. The AEC states this could result in over-procurement, similar to the current inertia framework.[86]

3.2.6 Maintain the current framework until technical work informs the best approach

Some stakeholders considered in submissions to the Joint Paper that there could be merit in maintaining the current inertia framework and allowing more time for further technical work to inform the appropriate design of an updated inertia framework and mitigate implementation risks.[87]

Under this approach, TNSPs would continue to be responsible for providing inertia when AEMO identifies a projected shortfall in a region at risk of islanding. AEMO would also retain the existing tools (constraints, directions and potentially the OSM) to address inertia levels if the security of the power system is threatened in the operational timeframe.

Other reforms underway could also eventually provide learnings to inform further consideration of the most efficient way to meet the frequency needs of the NEM. The OSM rule change could result in a tool for managing inertia in operational timeframes (depending on the outcomes of that rule change process); and the RoCoF limits proposed under the FOS Review's draft determination could also clarify the inertia requirements for an interconnected system under different operational conditions, including a pre-contingent volume of inertia during normal operation. The technical work discussed in section 2.2 would progress to provide a better understanding of the challenges arising from declining inertia inform the best future approach.

> QUESTION 5: ALTERNATIVE OPTIONS
>
> Do stakeholders consider that any of these options address the problems identified (see Chapter 3) more effectively than the proposed solution of an inertia spot market?
>
> Are there any additional options not identified in this consultation paper that should be

84 AEMC, Draft Determination — Operational Security Mechanism, available at https://www.aemc.gov.au/rule-changes/operational-security-mechanism
85 AEC rule change request p.55
86 AEC rule change request p.57
87 Submissions to the Joint Paper from Transgrid, ENA and Neoen.

investigated?

3.3 Implementation considerations

The AEC's proposal presents how an inertia spot market could work at a high level, however, it notes that there would be substantial issues to be worked through in implementation. The alternative options would similarly have implementation issues to consider. This subsection explores those implementation considerations.

Technical considerations

As noted in section 2.2, technical input will be essential to inform this rule change process, particularly on issues such as system need for inertia and evolving capabilities of technology to provide an emulated inertial response. These technical inputs would be essential to the implementation of revised arrangements — none of the above options can operate without a specification for how much inertia is needed and who can provide it.

The Commission is working with AEMO to explore options on how key technical questions could be answered. These options could include capitalising on a series of technical work AEMO is undertaking for the Engineering Framework. Where necessary, the AEMC may also supplement this with independent technical advice.

Implementation and ongoing costs

Implementing an evolved mechanism for inertia procurement is likely to incur some costs, as is operating the mechanism. The Commission will need to weigh up whether these costs are outweighed by the benefits of implementing the solution in assessing the most appropriate path forward.

The assessment of costs and benefits will also guide the timing of the implementation of any option. The AEC notes that if its proposed mechanism were to be implemented early, impacts would be minimal as the inertia spot price would remain near zero until there was no longer an oversupply of inertia.[88] While this may be the case, there would be costs incurred from the administration and operation of a spot market. Any market arrangement would also need to carefully consider interaction with existing markets, co-optimisation and NEMDE. As such, these costs will need to be weighed against the risk and cost of late implementation.

Interim and transitional considerations

The assessment and development of amendments to the current inertia framework may take some time. While there is an existing backstop mechanism which could serve as a transitional mechanism, it may also be useful to consider if there are any other interim or transitional arrangements that may be useful. This could include, but is not limited to:

- enhancements to the current framework to ensure it operates effectively and efficiently while a new framework is being developed

88 AEC, Inertia Spot Market Rule Change Request, p. 6

- a staged approach to implementing any new arrangements, for example, initially implementing a simplified mechanism, while the more complex version is developed.

Interactions with other essential system services frameworks

The Commission considers that how any evolution to the existing inertia framework would interact with other system security frameworks, including those currently implemented and those being considered.

To ensure that all essential system services are provided efficiently, where possible, the price signals and incentives that are provided for each should be clear and distinguishable from those for any other services provided co-incidentally. This is of particular concern for system strength, which has some characteristics in common with inertia, and is often supplied by the same plant. For example, if there are overlapping incentives that all incentivise the build-out of syncons, then it is likely that too many syncons would be built.

The Commission also notes that this rule change is progressing in the context of a suite of other essential system services reforms including those that have been implemented such as the introduction of mandatory primary frequency response and associated incentives; and evolving the existing system strength framework to be more proactive in approach. It also includes those currently under consideration, such as operational security mechanism (OSM), which is seeking to find a more efficient way of procuring, scheduling and pricing essential system services. We are cognisant of the need for these reforms to work together, to not create conflicting incentives, and not to have multiple tools seeking to do the same thing. As such will consider how this rule change should complement and be consistent with others.

QUESTION 6: IMPLEMENTATION CONSIDERATIONS

What are stakeholders' views on the implementation considerations identified?

4 MAKING OUR DECISION

When considering a rule change proposal, the Commission considers a range of factors.

This chapter outlines:

- issues the Commission must take into account
- the proposed assessment framework
- decisions the Commission can make
- rule-making for the Northern Territory

We would like your feedback on the proposed assessment framework.

4.1 The Commission must act in the long-term interests of consumers

The Commission is bound by the National Electricity Law (NEL) to 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).

The NEO is:

> To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system

4.2 We propose to assess the rule change using these five criteria

Considering the NEO and the issues raised in the rule change request, the Commission proposes to assess this rule change request using the following focus areas.

4.2.1 Power system security

Inertia has a role in maintaining a secure power system. Energy consumers do not demand inertia specifically, however, they expect that their electricity supply will be secure and reliable. Moreover, energy consumers, particularly as technology adapts, may be able to provide inertia going forward.

The operational security of the power system relates to the maintenance of the system within pre-defined limits for technical parameters such as voltage and frequency. System security underpins the operation of the energy market and the supply of electricity to consumers. It is therefore necessary to have regard to the potential benefits associated with improvements to system security brought about by the proposed rule change, weighed against the likely costs.

4.2.2 Principles of market efficiency

We propose to assess any evolved framework for inertia against whether it promotes efficiency across the investment, planning, commitment and dispatch timeframes. There are several factors that can contribute to an efficient approach to managing inertia in the system:

- **Efficient operation and allocation** — Does the solution accurately identify the needs of the power system and allocate an optimal level of inertia to meet these needs, at lowest cost? (that is, avoiding over- or under-procurement or provision). Does the solution allocate the available mix of resources in an efficient way, considering inertia alongside other services and considering the need to meet multiple system needs (for example, security, reliability and resilience)?
- **Efficient short and long term incentives** — Does the solution provide clear and effective signals to inertia providers? That is, are providers incentivised to provide the right levels of inertia in both their short-term operational decisions, and in their longer-term investment decisions to meet the future needs of the power system?
- **Transparency** — Does the solution provide transparent and adequate information on the system need, and the value of inertia to the system, to promote efficient investment in, and operation of inertia assets?
- **Competition** — Is there sufficient competition between sellers, if market approaches are used? Are there barriers to entry or exit? Is there sufficient competition between sellers in the market?

4.2.3 Costs and complexity

Options for inertia reforms have a range of cost and complexities. Potential solutions could range from options with lower implementation costs, such as making minor changes to provide more information and transparency within the existing inertia framework, to options with relatively higher cost and complexity, such as implementing an inertia spot market.

In assessing this rule change, the Commission will consider the costs and complexity of each option relative to their benefits. The Commission considers that the solution should minimise the cost and complexity of implementation and ongoing regulatory and administrative costs and maximise benefits to all market participants, consumers and market bodies.

4.2.4 Timing and uncertainty

This rule change request exists within the broader context of the energy transition and the large volume of reform that accompanies it. It is important that individual reforms fit within the wider program of reform both in terms of timing and coordination.

Different solutions will offer varying benefits at different times and create different costs at different times. The relative timing of these costs and benefits should be managed to ensure the best overall outcome while having regard for the different timeframes in which costs can arise.

Similarly, the way different reforms fit within the broader landscape of reform differently has a substantial impact on their success at achieving the NEO. A reform that is efficient in

isolation could be duplicative and inefficient if similar frameworks already exist, or if it is contrary to the direction of other reforms. The Commission also considers it is inefficient to have multiple frameworks that seek to achieve the same outcome, and so consideration of coordination between reforms and frameworks will be an important criterion to consider in assessing this rule change.

The Commission considers that it is important to ensure consideration of the right approach for inertia should be coordinated with and draw from other related ESS reform initiatives. This would ensure that the best solution is identified to achieve system security and efficiency from the whole-of-system perspective (rather than considering a solution for inertia in isolation).

4.2.5 Innovation and flexibility

Regulatory arrangements must be flexible to changing market and external conditions. They must be able to remain effective in achieving security outcomes over the long-term in a changing market environment. Solutions should be flexible enough to accommodate different circumstances in different jurisdictions. They should be effective in facilitating security outcomes where required, while not imposing undue market or compliance costs.

Frameworks should also be flexible enough to incorporate new technologies as they develop over time. Where possible, they should also provide incentives for new technologies to enter the market, as this is likely to increase competition and drive technological innovation.

> QUESTION 7: DO YOU AGREE WITH THE PROPOSED ASSESSMENT FRAMEWORK?
>
> Do you agree with the proposed assessment framework? Are there additional principles that the Commission should take into account or principles included here that are not relevant?

4.3 We have three options when making our decision

After using the assessment framework to consider the rule change request, the Commission may decide:

- to make the rule as proposed by the proponent[89]
- to make a rule that is different to the proposed rule (a more preferable rule), as discussed below, or
- not to make a rule.

The Commission may make a more preferable rule (which may be materially different to the proposed rule) if it is satisfied that, having regard to the issue or issues raised in the rule

89 The proponent describes sets out its proposed rule in pp. 2-8 of the rule change request.

change request, the more preferable rule is likely to better contribute to the achievement of the NEO.[90]

90 Section 91A of the NEL

A BACKGROUND – PREVIOUS CONSIDERATION OF APPROACHES TO INERTIA

Under various past reviews and rule change requests, the Commission has acknowledged challenges arising from declining system inertia and the need for an approach for inertia to meet the long-term needs of the power system through the energy transition.

This section outlines the Commission's past consideration of inertia and related issues.

A.1 June 2017 — System Security Market Frameworks Review

In June 2017, AEMC published a final report on its System Security Market Frameworks Review (SSMF Review), which acknowledged the need to introduce a new inertia procurement mechanism to address challenges arising from a declining level of inertia in the power system. The SSMF Review noted that the level of inertia required to be procured under a new mechanism could be divided into two components as follows:

- Minimum system threshold – The absolute minimum level of inertia that is required to maintain the secure operation of the system; and
- Additional inertia – Additional inertia above the minimum threshold to achieve further system security and cost-savings by allowing additional interconnector flows, improving reliability, and lowering the overall cost of energy provision by alleviating constraints on the system.

Based on these two components, the SSMF Review made two recommendations for the procurement of different levels of inertia. These recommendations include:

- Recommendation 3 – Place an obligation on transmission network service providers (TNSP) to provide minimum required levels of inertia, either through investment in network equipment or by contracting with third-party providers.
- Recommendation 4 – Introduce a market-based mechanism to realise the benefits that could be obtained through the provision of additional inertia above the minimum obligation on TNSPs.

A.2 September 2017 — 'Managing the rate of change of power system frequency' rule change (ERC0214)

Recommendation 3 of the SSMF Review was subsequently implemented by the AEMC's final determination on the 'Managing the rate of change of power system frequency' rule change (ERC0214), which was proposed by the South Australian Government.

A rule that places an obligation on TNSPs to procure minimum required levels of inertia then commenced on 1 July 2018. This rule provides the current inertia framework (See section 2.1 for further information).

A.3 February 2018 — 'Inertia ancillary service market' rule change (ERC0208)

Recommendation 4 of the SSMF Review was also considered as part of the 'Inertia ancillary service market' rule change proposed by AGL (ERC0208).

However, the AEMC made a final determination in February 2018 not to introduce a market-based mechanism for the procurement of additional inertia above minimum levels.

The Commission's final determination (ERC0208) noted that the minimum levels of inertia required to maintain the system security were addressed through the rule made by the South Australian Government's rule change (ERC0214), which introduced the TNSP arrangement for inertia provision.

The final determination (ERC0208) also noted more time was needed for AEMO to gather information about the minimum required levels of inertia needed in the power system as the generation mix continues to change. It also noted that a greater understanding of various complex policy and technical considerations was required to assess the extent to which there would be any residual benefits from introducing a mechanism for the procurement of additional inertia above minimum levels.

A.4 August 2021 — ESB Post-2025 Market Design Final Advice to Energy Ministers

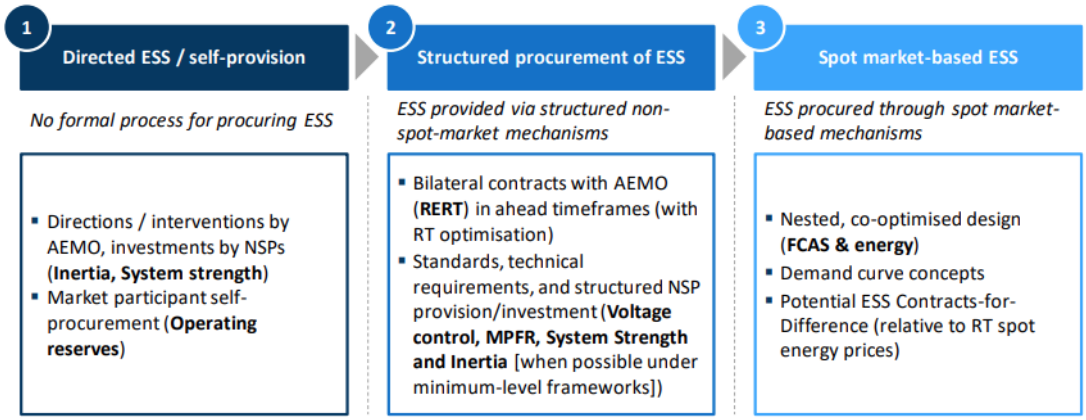
In August 2021, the ESB published market design final advice to energy ministers, which, among other reforms, recommended a spot market approach for valuing and procuring inertia as a long-term priority. It noted that in the short- and medium-term, inertia provision would continue to rely on the existing TNSP arrangement, along with the potential use of the system security mechanism to procure additional inertia when required.

The ESB recommended using AEMO's Engineering Framework to consider technical requirements for inertia, including to coordinate and draw from other related initiatives, ahead of moving towards its long-term priority vision of a spot market approach for valuing and procuring inertia.

The ESB's recommendation was informed by FTI Consulting's report, titled "Essential system services in the national electricity market", which stated that spot market arrangements, combined with co-optimisation, should be used where possible. It also noted that the NEM should progressively move towards spot market provision for services.

The FTI Consulting noted that the current NEM approach to the procurement and scheduling of ESS, including inertia may not be suitable to meet the future needs of the system. To improve the approach, the FTI Consulting noted that consideration could be given to various degrees of change over time, ranging initially from less complex adjustments to the current design (labelled "NEM Evolve"), through to more complex changes over time that may involve an explicit procurement of services through spot market or non-spot-market routes. An overview of these high-level options is provided in the figure below.

Figure A.1: FTI Consulting's ESS procurement pathway



Source: FTI Consulting, Essential System Services in the National Electricity Market: A Report for the Energy Security Board, available at https://esb-post2025-market-design.aemc.gov.au/32572/1599207219-fti-final-report-essential-system-services-in-the-nem-4-september-2020.pdf

However, FTI Consulting also noted that for some services spot market arrangement may not be appropriate (either now or ever). Accordingly, the ESB also recognised that not all system services are suited for spot market-based procurement given current technology and understanding. The ESB noted structured procurement could be used in cases where spot markets are not currently appropriate and may provide important insights on the pathway towards the incremental development of long-term ESS arrangements.

ABBREVIATIONS

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Commission	See AEMC
ESB	Energy Security Board
ESS	Essential system service
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
OSM	Operational security mechanism
Proponent	The proponent of the rule change request
RoCoF	Rate of change of frequency
SSMF review	System security market frameworks review
Syncon	Synchronous condenser
TNSP	Transmission network service provider