Australian Energy Market Commission

AEMC
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RULE

Consultation paper

National Electricity Amendment (Improving the NEM access standards - Package 2) Rule 2025

Proponents

AEMO
Rod Hughes Consulting

8 May 2025

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About the AEMC

The AEMC reports to the energy ministers. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the energy ministers.

Acknowledgement of Country

The AEMC acknowledges and shows respect for the traditional custodians of the many different lands across Australia on which we all live and work. We pay respect to all Elders past and present and the continuing connection of Aboriginal and Torres Strait Islander peoples to Country. The AEMC office is located on the land traditionally owned by the Gadigal people of the Eora nation.

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Summary

1 We are seeking your feedback on three rule change requests related to the technical requirements for connection (known as access standards) to the National Electricity Market (NEM) in the National Electricity Rules (NER). The proponents for these rule change requests are the Australian Energy Market Operator (AEMO) and Rod Hughes Consulting.[1]

2 The Australian Energy Market Commission (AEMC or the Commission) has consolidated the two rule change requests from Rod Hughes Consulting with AEMO's rule change *Improving the NEM access standards — Package 2*.[2]

3 The NEM access standards define the permissible range of technical requirements that connection applicants need to meet before being allowed to connect to the NEM. These standards need to shift and adapt as our power system evolves to meet Australia's net zero target and, in turn, ensure the secure operation of the NEM.[3]

4 AEMO's rule change (Package 2)[4] is one of two rule change requests submitted in April 2024 after completing its first review of the technical requirements for connecting to the NEM (Access Standards Review),[5] which it must complete every five years. It comprises several proposals for amending chapter 4 and schedules 5.2, 5.3, and 5.3a of the NER, to improve the NEM access standards.

5 The key driver of AEMO's rule change request is the projected increase of large loads connecting to the power system and their potential to adversely impact power system security. Examples of large loads, as noted in AEMO's rule change request, include new hydrogen electrolysers, large smelters, and large data centres to support artificial intelligence (AI) technologies, with the potential to scale up to several hundred megawatts (MW) within the next few years.[6] AEMO is particularly concerned with how large loads would behave during a power system disturbance, including whether the behaviour of these loads could act to worsen a disturbance through the impact on system frequency, voltage and stability.[7]

6 AEMO's proposals primarily relate to system strength, power system stability, protection systems, and load shedding, and are discussed in more detail below.

7 Rod Hughes Consulting's rule change requests also contain several proposals to improve the NEM access standards including:

- Correcting a drafting inconsistency in the access standards for generator protection systems.[8]
- Updating some NER definitions and adding new definitions to improve clarity in the access standards for generator protection systems.[9]

8 The Commission has commenced its consideration of the requests and this consultation paper is

1 AEMO rule change request, 4 April 2024; Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023; Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023.

2 For more information on why we have consolidated these rule change requests, see chapter 1.

3 For a more detailed description of access standards, see section 1.1, Box 1.

4 AEMO rule change request, 4 April 2024 (Package 2); AEMO's Package 1 rule change request is being considered separately to this Package 2 rule change.

5 AEMO website, Review of technical requirements for connection (NER clause 5.2.6A), April 2024.

6 AEMO rule change request overview, 4 April 2024, p 19; AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 11.

7 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3and 5.3a, Addendum to Draft Report, 4 April 2023, p 10.

8 Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023.

9 Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023.

the first stage of our rule change process.

9 We are seeking your feedback on:

- the problems raised in the rule change requests
- the proposed solutions and any alternative solutions
- our proposed assessment criteria for the rule change requests.

We are seeking your views on the issues and solutions proposed in the rule change requests

10 Throughout this consultation paper, the Commission has posed several questions to stakeholders for their feedback (listed below). These questions are also found throughout the corresponding chapters, which are summarised as follows:

11 **Chapter 2 — Amending the NER to support the projected increase of large loads**: This chapter considers one of the key drivers for AEMO's rule change proposal, which is the projected increase of large loads connecting to the power system. Throughout AEMO's Access Standards Review, they observed that this projected growth could pose potential risks to the secure operation of the power system.[10] Accordingly, AEMO's package 2 rule change request suggests that the existing customer access standards in schedule 5.3 of the NER are not adequate to address these risks.[11] AEMO has, therefore, proposed several amendments to schedule 5.3, intended to facilitate the planning and design of large loads in a way that will support secure power system operation into the future and mitigate any potential adverse power system impacts.

12 In this chapter, the Commission considers how 'large loads' are defined, addresses the increase of these large load customers seeking connection to the NEM, and considers how these large loads have the potential to adversely impact power system security.

13 **Chapter 3 — System strength**: This chapter considers two proposals made by AEMO in its rule change request that relate to system strength, which are:

- A proposal to allow high-voltage direct current (HVDC) link owners to procure system strength services from a third party to meet short circuit ratio requirements.
- A proposal to limit the application of short circuit ratio requirements for customer loads to large inverter-based loads (IBL), and allow flexibility to agree to larger short circuit ratio thresholds for those loads.

14 **Chapter 4 — Power system stability and protection**: This chapter discusses a number of changes proposed by AEMO and Rod Hughes Consulting relating to protection systems and power system stability, being:

- Rod Hughes Consulting's proposals to clarify the requirements for generator protection systems.
- AEMO's proposals to allow greater visibility of loads' ride-through capability and maximise ride-through capability where possible.
- AEMO's proposal to create a new access standard for detection and response to instability for loads.

15 **Chapter 5 — Further proposals from AEMO's rule change request**: AEMO's rule change request contains several further proposals for improving the NEM access standards contained within the

10 AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 76.
11 AEMO rule change request overview, 4 April 2024, p 19.

NER. This includes:

- The proposal to allow for the ramp down of loads to facilitate under-frequency load shedding.
- The proposal to clarify and restrict the scope of credible contingency events in relation to the automatic and minimum access standards for disturbance ride-through capability of schedule 5.2 plant.
- The proposal for testing and commissioning of non-registered schedule 5 participants.
- The proposal for an extension of time for complex issues in future access standard reviews.

We propose three assessment criteria for this rule change request

16 The Commission is guided by the National Electricity Objective (NEO)[12] in making a decision as to the proponents' rule change requests. A draft or final rule will be made only if we are satisfied that the rule will, or is likely to, contribute to the achievement of the NEO.

17 To assist us in determining whether a rule will, or is likely to, contribute to the achievement of the NEO, we consider certain criteria in our decision-making. Considering the issues raised in the rule change requests, the Commission proposes to assess the rule change request against three NEO assessment criteria.

- **Safety, security and reliability** — This criterion was selected to consider the safe, reliable, and secure operation of the power system at least cost. The operational security of the power system depends on whether the connecting plant and equipment can operate within the technical access standards contained in the NER and not present significant system security risks. Improving access standards can ensure alignment with safe, secure and reliable system performance and improve power system resilience.
- **Innovation and flexibility** — This criterion was selected because innovation and flexibility are important principles to utilise when improving the NEM access standards contained in the NER. This is true both from the perspective of process innovations and innovations in finding solutions to system security issues uncovered through the application of the access standards to network user customers.
- **Implementation considerations** — This criterion was selected to assess what implementation considerations may arise from the proposals. This includes timing, interrelationships with other reforms and processes, as well as benefits or adverse consequences to industry and consumers. Further, we consider that the cost and complexity of implementation and ongoing regulatory and administrative costs to all market bodies, participants and consumers must be balanced. This includes being clear on the roles of market bodies and participants, supporting efficient investment and operational decisions, and promoting transparency and predictability.

Next steps

18 Submissions to our consultation paper must be lodged with the Commission by 19 June 2025. For more details, see the next section on 'how to make a submission'.

19 The Commission intends to publish a draft determination, which factors in feedback from stakeholders, in late August 2025.

12 Section 7 of the NEL.

Full list of consultation questions

Question 1: Defining large loads in the context of this rule change request

In the context of this rule change request and AEMO's ongoing consideration of the definition for large loads through its Large Loads Review:

1. Are stakeholders supportive of AEMO's ongoing process to address the system security implications and performance standards for large loads, including how large loads ought to be defined in the NER?
2. To what extent do stakeholders think that the Commission should consider the definition of 'large loads' in the context of this rule change?
3. If it is considered, should large loads be defined based on the relevant access standard, or should a large load be more holistically defined in the NER?
4. Alternatively, should we consider whether to apply guiding principles and timing for AEMO to produce a proposed definition, which is currently being considered in AEMO's Large Loads Review?

Question 2: Amending the NER to address the influx of large loads

1. Do stakeholders have any reflections or data and information they wish to share with the AEMC regarding the prospective growth of large loads connecting to the NEM, including from international experience?
2. Do stakeholders agree with AEMO that the expected growth of large loads may present a risk to power system security?

Question 3: HVDC links to procure system strength services from third parties

In relation to AEMO's proposal to amend NER clause S5.3a.7 to allow all HVDC links to procure system strength services to meet the short circuit ratio requirement of 3.0:

1. Do stakeholders agree that the NER should be amended to allow HVDC link owners to procure system strength services from third parties? Is the current inability to do so a material problem, or will it become a material problem?
2. Do stakeholders consider the proposed rule should replicate the corresponding NER clause S5.2.5.15 for generating systems and IRS to promote consistency?
3. Do stakeholders consider that procurement should be subject to agreement between the HVDC link owner, NSP, system strength provider, and AEMO? Do stakeholders have any views as to how involvement from AEMO in such an agreement would operate?
4. Are there alternative solutions stakeholders consider would be more effective?
5. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 4: Limiting short circuit ratio requirements for customer loads to IBR, and introducing flexibility to the access standard

In relation to AEMO's proposal to limit the application of short circuit ratio requirements under clause S5.3.11 to large inverter-based resources that is IBL:

1. Do stakeholders consider it an issue that the short circuit ratio requirements under clause S5.3.11 apply to all IBR plant without any size threshold?
   a. Should it only apply to large inverter-based resources as defined in AEMO's SSIAG?
   b. Is the definition of a large inverter-based resource in the SSIAG sufficient for the purposes of this proposal?
2. Are there alternative solutions stakeholders consider would be more effective?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

In relation to AEMO's proposal to amend the NER to introduce flexibility in clause S5.3.11 to allow the NSP and AEMO discretion to agree to a minimum short circuit ratio requirement above the minimum requirement of 3.0:

1. Do stakeholders agree there should be flexibility to agree to higher short circuit ratio requirements? Could there be unintended consequences?
2. Are there alternative solutions stakeholders consider would be more effective?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 5: New definitions for protection systems

In relation to Rod Hughes Consulting's *Definitions of protection system requirements* rule change request:

1. Do stakeholders agree that the requirements for generator protection systems are currently unclear? If so, what are the impacts of this lack of clarity?
   a. Similarly, do stakeholders consider the requirements for loads' and HVDC links' protection systems are currently unclear?
2. Do stakeholders support the proposal to update and add new NER definitions for types of protection systems?
   a. Do stakeholders have feedback on the proposed new definitions themselves?
3. Do stakeholders have any concerns or suggestions in relation to this element of Rod Hughes Consulting's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 6: Conditions for generator protection systems

These questions relate to Rod Hughes Consulting's *Conditions for generator protection systems*

rule change request.

1. Regarding the proposal to remove paragraph (b) of clause S5.2.5.9:
   a. Do stakeholders agree that paragraph (b) is redundant and/or misleading, or do stakeholders have a different interpretation?
   b. Do stakeholders support Rod Hughes Consulting's proposal to remove paragraph (b)?
2. Regarding the proposal to add a new provision in the minimum access standard:
   a. Do stakeholders agree that the minimum access standard may create risks to power system security because it does not require additional redundancy in protection systems?
   b. Do stakeholders support Rod Hughes Consulting's proposal to give AEMO and the NSP discretion to increase redundancy requirements in the minimum access standard if required to prevent adverse impacts on power system security?
3. Do stakeholders have any concerns or suggestions in relation to this element of Rod Hughes Consulting's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 7: Provision of information on ride-through capability

In relation to AEMO's proposed changes to enable NSPs to request information on loads' ride-through capability:

1. Do stakeholders agree that NSPs and AEMO lack visibility of loads' ride-through capability and that this creates a challenge for system security?
2. Do stakeholders support AEMO's proposed rule to require network users to provide information about connecting load's ride-through capability to the NSP on request?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule?

Question 8: Protection settings to maximise ride-through performance

In relation to AEMO's proposed changes to amend clause S5.3.3(c) of the NER to encourage protection settings that maximise loads' ride-through capability:

1. Do stakeholders agree that the current arrangements allow conservative load protection settings that may unnecessarily reduce loads' ride-through capability?
2. Do stakeholders support AEMO's proposed rule requiring cooperation between the NSP and the network user in the design of protection systems and settings to maximise ride-through capability?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 9: New access standard for detection and response to instability

In relation to AEMO's proposed new access standard for detection and response to instability that would apply to large inverter-based loads:

1. Do stakeholders agree that there is an emerging need for large inverter-based loads to play a role in managing instability in the NEM?
2. Do stakeholders support AEMO's proposed new access standard for instability detection and response by loads as set out in Box 4?
   a. Which parts of the proposal do stakeholders support, or oppose?
   b. Do stakeholders agree with the materiality thresholds for application of the automatic access standard and minimum access standard (see Table 4.2)?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 10: Under-frequency ramp down of large loads

In relation to AEMO's proposed changes to amend the NER to facilitate the ability for loads to ramp down:

1. Do stakeholders agree some loads may be more flexible with the ability to ramp down their load in an emergency rather than disconnecting in blocks?
2. Do stakeholders agree that the NER should be amended to allow for the provision of interruptible load by way of fast ramp down?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 11: Clarification of credible contingency definition for disturbance ride-through

In relation to AEMO's proposed changes to amend clause S5.2.5.5 of the NER to clarify the scope of contingency events that a schedule 5.2 plant must be able to ride through:

1. Do stakeholders agree that the current definition for the types of credible contingencies in relation to disturbance ride-through requirements for schedule 5.2 plant is unbounded/implied to be unbounded and that this presents an issue?
2. Do stakeholders agree that arrangements poorly define the types of credible contingencies in relation to disturbance ride-through requirements for schedule 5.2 plant?
3. Do stakeholders support AEMO's proposed rule to clarify the types of contingency events that a schedule 5.2 plant must be able to ride through?
4. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 12: Testing and commissioning

1. Do stakeholders support AEMO's proposed amendments to clause 5.7.3 to refer to schedule 5 plant in respect of AEMO's ability to request compliance tests for registered plant?
2. Do stakeholders support AEMO's proposed changes to clauses 5.7.2 and 5.7.3 to extend the rights for testing of power system plant to apply to non-registered schedule 5 plant?
3. Do stakeholders support AEMO's proposed changes to the NER to extend the requirement for coordinating commissioning procedures for non-registered schedule 5 plants with a maximum capacity equal to or greater than 30MW of 30MVA?
4. Should the Commission consider extending enforceability and compliance requirements under rules 4.14 and 4.15 to all 'schedule 5 participants', which includes non-registered participants?
5. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Question 13: Extension of time for complex issues in future access standards reviews

In relation to AEMO's proposal to amend clause 5.2.6A of the NER to allow flexibility for extending the time limit for completing each review:

1. Do stakeholders agree that the requirement to complete each review within 12 months of the approach paper being published is too inflexible or may inhibit proper analysis and consultation?
2. Do stakeholders consider that AEMO should be responsible for setting a new date for publication of the final report? Is there an alternative approach that would better address the issue?
3. Do stakeholders agree that AEMO should publish a notice when an extension is needed, outlining the reasons as they may relate to complexity/difficulty, or a material change in circumstances?
4. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning?

Question 14: Assessment framework

Do you agree with the proposed assessment criteria? Are there additional criteria that the Commission should consider or criteria 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 questions in each chapter to guide feedback, and the full list of questions is above. However, you are welcome to provide feedback on any additional matters that may assist the Commission in making its decision.

Submissions are due by 19 June 2025 with other engagement opportunities to follow

Due date: Written submissions responding to this consultation paper must be lodged with the Commission by 19 June 2025.

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 ERC0394.[13]

You may, but are not required to, use the stakeholder submission form published with this consultation paper.

Tips for making submissions are available on our website.[14]

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).[15]

Other opportunities for engagement

There are other opportunities for you to engage with us, such as one-on-one discussions or industry briefing sessions.

13 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.

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

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

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This consultation paper seeks stakeholder feedback on the three rule change requests related to the technical requirements for connection (known as access standards) to the National Electricity Market (NEM) in the National Electricity Rules (NER).[16] The proponents for these rule change requests are the Australian Energy Market Operator (AEMO) and Rod Hughes Consulting.

AEMO's rule change requests

AEMO's rule change is one of two rule change requests submitted in April 2024 after completing its first five-year review of the technical requirements for connecting to the NEM (Access Standards Review). AEMO lodged two rule change requests:

1. **Improving the NEM access standards — Request for a fast-tracked rule (Package 1 rule change)** — The Commission has progressed AEMO's Package 1 rule change separately through our fast-track rule change process as AEMO had undertaken extensive public consultation on these measures. On 5 December 2024, we made a draft determination and more preferable draft rule that would improve the NER access standards.[17] We expect to publish the final determination and final rule on 22 May 2025.
2. **Improving the NEM access standards — Request for a standard rule (Package 2 rule change, focus of this consultation paper)** — This consultation paper relates to AEMO's second request for changes to the NEM access standards. AEMO suggested that this be considered through the standard rule change process as the issues would benefit from additional consultation by the AEMC. An overview of AEMO's Package 2 rule change request is set out in section 1.2.

Rod Hughes Consulting rule change requests

The two rule change requests from Rod Hughes Consulting relate to the conditions for generator protection systems, submitted in January 2023, and definitions of protection system requirements, submitted in March 2023.[18]

This chapter provides context for the rule change requests, and information on the rule change consultation and assessment process:

- Section 1.1 — provides context for AEMO's requirement to review the access standards every five years.
- Section 1.2 — provides an overview of the key drivers for AEMO's Package 2 which is the subject of this consultation paper.
- Section 1.3 — provides an overview of the two rule change requests from Rod Hughes Consulting.
- Section 1.4 — explains that we have consolidated Package 2 with two rule change requests from Rod Hughes Consulting.
- Section 1.6 — highlights there are several related work streams to Package 2 that we will monitor.
- Section 1.7 — explains that we have started the rule change process.

16 See Box 1 for a description of access standards.

17 For more information on Package 1, see our website.

18 Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023; Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023.

1.1 AEMO is required to review the access standards every five years

At least once every five years, AEMO must review some or all of the technical requirements set out in schedules 5.2, 5.3, and 5.3a of the NER to assess whether they should be amended.[19] Each of those NER schedules applies to different connecting parties as follows:

- Schedule 5.2 — sets out connection requirements for registered (and some exempt) generators and integrated resource providers (IRP).
- Schedule 5.3 — sets out connection requirements for market customers at their market connection points, registered and potentially unregistered customers connecting load facilities to a network, and distribution network service providers (DNSPs) connecting to other networks.
- Schedule 5.3a — sets out connection requirements for market network service providers (MNSPs) connecting to a transmission or distribution network.

The requirement to review these schedules was introduced through the Commission's *Generator technical performance standards* final determination and rule in 2018 following the *Independent review into the future security of the national electricity market* led by Dr Alan Finkel AO in 2016,[20] which recommended regular and comprehensive reviews of the connection standards. Our final determination recognised that:[21]

> The power system is experiencing a period of change as traditional forms of large-scale, synchronous generation are retiring and being replaced by intermittent, asynchronous and increasingly distributed generation. This shift presents challenges for the secure operation of the power system. In particular, it is becoming more difficult to effectively control frequency and voltage, which could lead to significant power system disturbances and potentially blackouts.

As such, connection standards for schedule 5 participants are essential for ensuring that their capabilities and settings are appropriate for meeting system needs. This includes technical requirements such as frequency control, voltage control, and response to power system disturbances.

When conducting the reviews, AEMO must have regard to:[22]

- the National Electricity Objective (NEO)
- the need to achieve and maintain power system security
- changes in power system conditions
- changes in technology capabilities of facilities and plant.

In December 2023, AEMO completed its first review of the technical requirements for connecting to the NEM and identified numerous opportunities to improve the NER access standards and their application. They then submitted two rule change requests to the AEMC in April 2024 to give effect to the final recommendations from the Access Standards Review.

19 NER clause 5.2.6A.

20 AEMC, *Generator technical performance standards*, Final determination, 27 September 2018; Dr Alan Finkel AO, Chief Scientist, Chair of the Expert Panel, *Independent review into the future of the National Electricity Market*, June 2017, Recommendation 2.1.

21 AEMC, *Generator technical performance standards*, Final determination, 27 September 2018, p i.

22 NER clause 5.2.6A(a)(1)-(4).

AEMO's final report for the 2023 Access standard review identified the need for further review in relation to the following issues, which require further stakeholder consultation and analysis by AEMO:[23]

- Load technical requirements.
- Connection of grid-forming (GFM) technology.
- AEMO's role in smaller connections.

Section 1.6 provides an overview of AEMO's ongoing review of load technical requirements, as this relates to the issues raised in this rule change and provides important context.

Box 1: Access standards play an increasingly important role in the NEM

To establish a new connection under chapter 5 of the NER (following the process in rule 5.3 or 5.3A), a connection applicant and the connecting network service provider (NSP) must agree on a set of performance standards for the connecting plant within the parameters set by the access standards in the applicable schedule (schedules 5.2, 5.3 or 5.3a). Each access standard relates to a technical requirement for the performance of the connecting plant, regarding its impact on the broader power system. Most (but not all) access standards have two components:

- **Automatic access standard (AAS)** — a connection application cannot be refused if it meets this standard.
- **Minimum access standard (MAS)** — a connection application must be refused if the plant does not meet this.

This format with a permissible range of access standards was established after a 2001 review by the then National Electricity Code Administrator (NECA), which found that mandatory fixed access standards were inefficient. NECA noted that the cost of meeting those standards will vary dramatically for different types of plants. Some could significantly overachieve against a mandatory standard at low cost, while others may only be able to achieve that standard at prohibitive costs. In addition, the need for plant to meet a mandatory level of technical performance was likely to vary between different locations within the NEM. In light of this, NECA introduced flexibility in access standards by specifying a negotiating range, subject to a mandated minimum.

Once the proposed access standards are agreed upon (with AEMO approval where required), they become the performance standards for the relevant plant and are included in the binding connection agreement between the connection applicant and the NSP. Where applicants are (or will be) registered participants, the performance standards must be registered with AEMO, and an ongoing compliance regime will apply under rule 4.15.

This format of access standards has largely been preserved since this time.

Source: AEMO rule change request overview, 4 April 2024, p 10.

1.2 AEMO's Package 2 rule change request proposes changes to the NER access standards

AEMO's rule change request comprises several proposals for amending chapter 4 and schedules 5.2, 5.3, and 5.3a of the NER, to improve the NEM access standards. The types of plant captured

23 AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, pp 13-14.

by these proposals would include generating systems and IRP, market customers and non-registered customers, and MNSPs connecting to a transmission or distribution network.[24]

There are a multitude of drivers for the proposals in AEMO's rule change request that are important to highlight.

There is an influx of large customers seeking to connect to the NEM

Over the next 10 years, the NEM is facing an influx of 'large load' projects, such as hydrogen electrolysers, smelters, and very large data centres between 100 MW and 600 MW, which are at various stages of planning and development. AEMO's view is that the existing technical customer access standards in schedule 5.3 of the NER are not adequate to address this anticipated growth and maintain or support power system security. This is a key driver for this rule change and AEMO's proposals may be considered as a first step toward establishing appropriate access standards for large loads, to be supplemented by further targeted review and consultation by AEMO as these technologies and our understanding thereof rapidly evolve.[25]

In chapter 2, we further explore the anticipated growth, identify the risks this growth may pose to the power system, and examine potential gaps in the NER in clearly defining a 'large load' within the context of this rule change.

The power system's resilience needs to be enhanced

As larger customers increasingly seek to connect to the NEM, ensuring the resilience of the power system is paramount. This involves updating the technical requirements to strengthen the grid's ability to withstand and recover from disturbances through adequate protection systems for loads, thereby maintaining system security. Accordingly, AEMO is seeking flexibility to monitor and manage any material adverse impacts that may come from these connections through information sharing and utilising them for the provision of system security services.

AEMO also proposes enhancing system strength frameworks for power system resilience by:

- improving the application of short circuit ratio requirements for loads[26]
- allowing high-voltage direct current (HVDC) link owners to procure system strength services from third parties to meet short circuit ratio requirements for system strength.[27]

The NER needs to accommodate new and evolving technologies

AEMO's rule change request acknowledges there are new and evolving technologies that have varying impacts on the power system or could support its resilience. As such, AEMO proposes:

- allowing load shedding by way of ramping down as some loads have this technological capability, and this approach could better meet the needs of the power system during emergency under-frequency events[28]
- allowing for testing of non-registered plant that are schedule 5 participants under the NER, because similar to registered plant, it can adversely impact the operation of other power system equipment.[29]

The NER needs to promote transparency and flexibility

24 The Commission notes that the draft rule for Package 1 makes several changes and clarifications to the types of plant for which schedules 5.2, 5.3 and 5.3a apply. If the final rule is made, schedule 5.2 would apply to synchronous condensers, and schedule 5.3a would apply beyond market network service providers to an HVDC link to all HVDC link owners. See appendix A for further details on that draft rule.

25 AEMO rule change request overview, 4 April 2024, p 19.

26 Ibid., pp 71-72.

27 Ibid., p 67.

28 Ibid., p 71.

29 Ibid., p 25.

AEMO's rule change request acknowledges the importance of promoting transparency and flexibility in the NER and has identified potential improvements to support these principles.

- Generators and integrated resource systems (IRS) are required under the NER to remain in continuous uninterrupted operation for credible contingency events. However, AEMO's rule change request observes that what constitutes a credible contingency can be different at any point in time. This creates uncertainty and potential compliance risk for connection applicants under schedule 5.2 of the NER, whilst reducing the transparency of power system operation. As such, AEMO proposes amending the NER to qualify what constitutes a credible contingency event, thereby promoting transparency and clarity.[30]
- AEMO proposes allowing flexibility to extend the time limit for completing future access standards reviews. This is in recognition of such reviews requiring evaluation of complex technical matters and intensive stakeholder consultation.[31]

The table below provides a more detailed summary of the proposals in AEMO's rule change request.

Table 1.1: Summary of AEMO's Package 2 proposals

Topic	Sub-topic	NER clause(s)	Description of AEMO proposal
System strength	Loads: Short circuit ratio	S5.3.11	• Limit the application of short-circuit ratio requirements to large inverter-based loads, as defined in AEMO's System Strength Impact Assessment Guidelines. • Allow flexibility for AEMO and NSPs to agree to a higher short circuit ratio where appropriate.
	HVDC links: Short circuit ratio	S5.3a.7	• Allow HVDC link owners to procure system strength services from third parties to meet short circuit ratio requirements.
Protection systems for loads	Ride through capability	S5.3.1; New S5.3.4A	• Include in the information provisions of clause S5.3.1 the ability for the NSP, in consultation with AEMO, to request information about the ride-through capability of a load intending to connect to its network. • Add a new clause S5.3.4A providing discretion for the NSP to require the ride-through capability to be recorded in the performance standards, with a copy to be provided to AEMO.
	Cooperation	S5.3.3	• Amend the general requirements in clause S5.3.3(c) to require cooperation between the NSP and the S5.3 Participant on the design and implementation of protection system and settings so as to maintain operation in accordance with the performance standards, and also to maximise capability to remain in operation for disturbances where the plant is not otherwise required to disconnect, subject to the

30 Ibid., p 45.
31 Ibid., p 75.

Topic	Sub-topic	NER clause(s)	Description of AEMO proposal
			technical capabilities of the plant, safe operation, and safety margins consistent with good electricity industry practice.
	New access standard	New S5.3.12	• Specify an AAS and MAS for detection and response to instability for loads.
Further AEMO proposals	Load shedding	S5.3.10	• Amend clause S.5.3.10 to allow for provision of interruptible load by way of fast ramp down, in addition to the capability to disconnect load blocks during an under-frequency event, with the performance standards to record the nature of the capability and quantities and rates of fast ramp down capability where applicable. • Amend clause 4.3.5 and the definitions of interruptible load and load shedding to be consistent with the potential for fast ramp-down capability as well as disconnection and to make those provisions consistent with each other.
	Testing non-registered S5 participants	5.7.2; 5.7.3; 5.8.2; 5.8.4; 5.8.5; New clause 5.8.1A	• Amend clause 5.7.2 to extend mutual rights to request testing to non-registered schedule 5 Participants, and require them to comply with a request for testing on plant. • Extend clause 5.7.3 to any category of registered participants. • Amend clause 5.7.3(d) to (f) permitting AEMO to request testing of compliance with AEMO advisory performance standards for both registered and non-registered schedule 5 participants, on the same conditions. • Extend the commissioning requirements of clauses 5.8.2, 5.8.4 and 5.8.5 to schedule 5 Participants that are not registered participants, by the addition of a new clause 5.8.1A.
	Re-classified contingency events	S5.2.5.5	For the purposes of the access standards, limit the scope of a credible contingency event to: • Credible contingency events used by the NSP for its network planning under clause S5.1.2.1. • Non-credible contingency events specified by AEMO that are routinely expected to be reclassified as credible contingency events under clause 4.2.3A in reasonably anticipated abnormal conditions, and are likely to cause a significant disturbance at the schedule 5.2 plant's connection point.
	Extension of	5.2.6A	Include a provision allowing AEMO to extend the timeframe for review of certain matters under clause

Topic	Sub-topic	NER clause(s)	Description of AEMO proposal
	time		5.2.6A by publishing a notice with reasons, where the 12-month timeframe is insufficient given the complexity or difficulty of the matters under consideration or a material change in circumstances.

Source: This is a summary of AEMO's rule change request and does not exhaustively reflect all proposed NER amendments. See AEMO's rule change request for all the details of these proposals.

1.3 Rod Hughes Consulting's two rule change requests proposed amendments to the generator access standards

This section provides an overview of the two proposals for changes to the generator access standards that the Commission has received from Rod Hughes Consulting.

1.3.1 Rule change proposal for conditions for generator protection systems

Rod Hughes Consulting submitted the *Conditions for generator protection systems* rule change request (ERC0355) in January 2023.[32] This rule change request suggests that there is a drafting inconsistency in the access standards for generator protection systems.

Clause S5.2.5.9 sets out the requirements that apply to generators for protection systems that impact on power system security. Specifically, clause S5.2.5.9(b) contains a provision for AEMO or the NSP to require certain additional redundancy in a generator's protection systems as part of the AAS, if necessary to maintain power system security. However, the proponent considers this is inconsistent with the AAS because the automatic access standard includes that additional redundancy by default.[33]

The proposed solution is to delete clause S5.2.5.9(b) to remove this inconsistency. Rod Hughes Consulting considers this would clarify that the additional redundancy referred to in S5.2.5.9(b) is always part of the AAS. Streamlining the AAS in this way would support an efficient connections process and would not adversely impact power system security. Connection applicants would still be able to negotiate an access standard without the additional redundancy, subject to approval by the NSP and AEMO, since the additional redundancy is not required in the MAS.

The rule change request also proposed adding a new provision to the MAS, similar to the existing clause S5.2.5.9(b). The new provision would allow AEMO or the NSP to require the same additional redundancy currently referred to in S5.2.5.9(b) as part of the MAS, if necessary to prevent certain adverse power system security impacts. Rod Hughes Consulting considers that this change would give AEMO and the NSP greater ability to assess the impacts of proposed non-redundant protection system design. This would, in the proponent's view, allow AEMO and the NSP to enforce the need for redundant protection systems where necessary to mitigate risks to power system security.

32 Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023.
33 NER clause S5.2.5.9(b).

1.3.2 Rule change proposal for definitions of protection system requirements

Rod Hughes Consulting submitted the *Definitions of protection system requirements* rule change (ERC0361) in March 2023.[34] This rule change request seeks to update some NER definitions and add new definitions to improve clarity in the access standards for generator protection systems.

Rod Hughes Consulting considers that:

- the distinction between primary, back-up, and breaker fail protection systems is unclear because some of these terms are not explicitly defined in the NER
- provisions requiring redundancy in primary protection systems, such as clause S5.1.9(d) and clause S5.2.5.9(a)(2), lack clarity on the level of redundancy required
- as a result of these and other issues, it may be unclear to participants how much duplication of protection equipment is required across primary, back-up and/or breaker fail protection systems.

The proponent considers that this lack of clarity could result in differing interpretations or confusion amongst industry participants, and inconsistent application of the rules.

The proposed solution is to:

- add or update several NER definitions for types of protection systems and related terms
- use the term 'main protection system' instead of 'primary protection system'
- clarify the requirements for redundancy in protection systems by introducing the concept of an 'independent alternative main protection system', which would also be explicitly defined.

The proponent considers that this rule change would support power system security by clarifying the protection systems requirements and ensuring that new connections meet those requirements, without building in more redundancy than necessary. This would also help to reduce the cost of new connections, and the time and cost of negotiating performance standards.

1.4 We have consolidated the rule change requests from AEMO and Rod Hughes Consulting

The Commission has consolidated the two rule change requests from Rod Hughes Consulting with AEMO's rule change *Improving the NEM access standards — Package 2*. This section sets out how the legal test for consolidation has been met.

Under section 93 of the National Electricity Law (NEL), consolidation of two or more rule change requests is possible if the AEMC considers it necessary or desirable that those requests be dealt with together.[35] In those circumstances, the AEMC may consolidate by treating the requests as one request or by treating the later request(s) as a submission to the first request.

We consider consolidation desirable as the two rule change requests from Rod Hughes Consulting are substantially related to AEMO's rule change request. More specifically, they are targeted at providing new definitions for protection systems and remedying what are considered drafting inconsistencies for generator protection systems in schedule 5.2 of the NER. Some of the issues raised and changes proposed by Rod Hughes Consulting could also impact schedule 5.3 and schedule 5.3a of the NER, where AEMO's rule change is focused. Consolidating the rule change requests will allow the Commission to consider any potential interactions or synergies between

34 Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023.
35 Section 93 of the NEL.

the rule change requests as they arise. Consolidation will also allow stakeholders to engage with all three rule change requests more efficiently, as they will all be considered in one process.

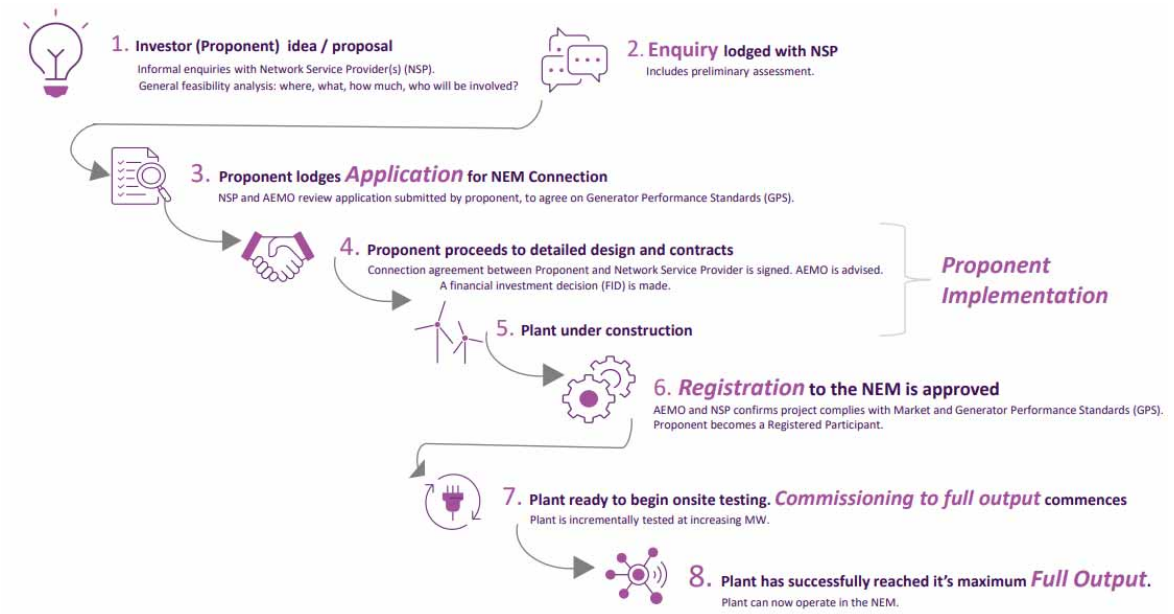
1.5 We will consider implementation considerations for any rule made

The Commission will consider implementation arrangements throughout this rule change process, including considering how any rule, if made, would apply to participants seeking connection to the NEM. The intent is that it would not apply to existing connections. Instead, the focus will be on how it applies to those currently in the connection process or those seeking connection.

While AEMO's rule change request does not contain specific implementation proposals relating to the above, the Commission has recommended 'implementation considerations' as one of the NEO assessment criteria for this the rule change. As such, the Commission proposes to assess the timing for implementation, interrelationships with other reforms and processes, as well as benefits or adverse consequences for industry and consumers that may arise from implementing any final rule. This will include how any new technical standards would apply to connecting parties that are currently in the connection process. We welcome stakeholder feedback on these considerations.

The Commission also notes that AEMO's rule change request does not seek to change the connections process, summarised in the diagram below. Rather, it considers the access standards applicable throughout that process, and how they ought to be improved.

Figure 1.1: Connections Process Overview



Source: AEMO, Connections Scorecard Guide, 12 August 2024.
Note: This is a brief overview provided for illustrative purposes. The connections process is detailed in the NER and relevant AEMO guidelines.

1.6 There are several related work streams to Package 2 that we will monitor

The Commission notes the following separate work programmes that are related to our assessment of AEMO's Package 2 rule change request. We intend to monitor these related programmes of work throughout the rule change process.

The Commission's assessment of AEMO's Package 1 rule change request

The measures proposed in Package 1 to improve the scope and application of schedules 5.2, 5.3, and 5.3a of the NER are expected to form part of the final rule, due to be published in May 2025. Given Package 2 contains measures under each of these schedules, the Commission will ensure we are clear as to which types of plant the proposed measures apply.

The Commission will also monitor other amendments to the access standards in the final rule for Package 1 that may interact with this rule change request.

AEMO's schedule 5.3 large loads access standards review

In December 2024, AEMO commenced its NER schedule 5.3 large loads access standards review (Large Loads Review), which aims to supplement the proposed measures in this rule change request.[36] AEMO is actively investigating what technical requirements will be needed in the near term to facilitate the anticipated growth of 'large loads' in the NEM. More specifically, AEMO is considering:

- applying the schedule 5.3 access standards to single facility loads above a certain size threshold, albeit irrespective of the technology type
- improving disturbance ride-through requirements for loads by developing access standards that may apply in accordance with a size threshold or by different load types
- reactive power support from 'large loads'
- frequency support from 'large loads'
- co-location of generation and 'large loads'.[37]

The Commission will continue to work closely with AEMO on these developments and how they may interact with this rule change request.

Rescheduling the generator compliance programs review

On 28 November 2024, the Commission published a final determination and final rule that requires the Reliability Panel (Panel) to commence the next review of the template for generator compliance programs (template) by 19 December 2025.[38]

The template provides registered participants with guidance in developing and designing programs to demonstrate ongoing compliance with their registered technical performance standards.[39] The NER's access standards, from which registered performance standards are derived, are critical inputs into any review of the template. It is also intended to assist the Australian Energy Regulator (AER) with the enforcement and monitoring of generators' compliance with the technical requirements under the Rules. This is because effective compliance with performance standards contributes to the delivery of reliable and secure electricity to customers in the NEM.[40]

Given the proposed amendments to the access standards in this rule change request, the Commission will work with the Panel to monitor opportunities for alignment with the Panel's review of the template.

National Consumer Energy Resources Roadmap

36 See AEMO's website for more information on the Large Loads Review.
37 AEMO, Schedule 5.3 Large Loads: Access Standards Review Kick-off, 3 December 2024.
38 AEMC, *Reschedule the generator compliance programs review*, Final determination, 28 November 2024, p i.
39 Reliability Panel AEMC, *Template for Generator Compliance Programs*, 19 December 2019.
40 Ibid., pp iv-v.

The National Consumer Energy Resources (CER) Roadmap sets out a series of actions and reforms to support full realisation of the potential benefits of integrating CER into the NEM. Among other actions, the Roadmap sets out how the market bodies and the CER Taskforce are working together to consider the roles and responsibilities for market operations (reform priority M.3) and power system operations (reform priority P.5).[41] The CER Taskforce has indicated that it will publish one or more consultation papers on redefining the roles and responsibilities for market and power system operations in Q3 2025.[42]

The Commission recognises that consideration of the technical performance requirements under the NER access standards, and the related roles for AEMO and the relevant NSP, may have some relevance to the consideration of the broader roles and responsibilities for AEMO and NSPs in the future power system dominated by dynamic and responsive generation and load connected at the distribution level. As such, the Commission will monitor and seek consistency in relation to any potential interactions between this element of the CER Roadmap and the consideration of the Package 2 access standards rule change.

1.7 We have started the rule change process

This paper is the first stage of our consultation process.

Figure 1.2: Prospective timeline for this rule change

A standard rule change request includes the following formal stages:

- a proponent submits a rule change request
- the Commission commences the rule change process by publishing a consultation paper and seeking stakeholder feedback
- stakeholders lodge submissions on the consultation paper and engage through other channels to make their views known to the AEMC project team
- the Commission publishes a draft determination and draft rule (if relevant)
- stakeholders lodge submissions on the draft determination and engage through other channels to make their views known to the AEMC project team
- the Commission publishes a final determination and final rule (if relevant).

The Commission intends to publish the final determination and final rule for Package 1 prior to the publication of this Consultation paper regarding Package 2. In light of this, we have allotted two additional weeks for providing submissions to our consultation paper, thereby allowing stakeholders to comprehensively consider the final rule for Package 1.

41 Department of Climate Change, Energy, the Environment and Water, National Consumer Energy Resources Roadmap: Powering Decarbonised Homes and Communities, 19 July 2024, p 19.

42 CER Taskforce, National Consumer Energy Resources Roadmap - Progress Report, February 2025, pp 6-7.

Information on how to provide your submission and other opportunities for engagement is set out at the front of this document.

You can find more information on the rule change process on our website.[43]

To make a decision on this proposal, we seek stakeholder feedback on how we propose to assess the request, the stated problem and the proposed solutions.

43 See our website: https://www.aemc.gov.au/our-work/changing-energy-rules.

2 Amending the NER to support the projected increase of large loads

One of the key drivers for AEMO's rule change proposal is the projected increase of large loads connecting to the power system.[44] This includes new hydrogen electrolysers and large data centres to support artificial intelligence (AI) technologies, with the potential to scale up to several hundred MW within the next few years.[45]

Throughout AEMO's Access Standards Review, it was observed that this projected growth could pose potential risks to the secure operation of the power system.[46] Accordingly, AEMO's Package 2 rule change request suggests that the existing customer access standards in schedule 5.3 of the NER are not adequate to address these risks.[47] AEMO is proposing several amendments to schedule 5.3, as a first step towards establishing appropriate detailed access standards for large load ride-through capabilities, noting that large converter-based load technologies and the sector's understanding of vulnerabilities and capabilities are rapidly evolving.

AEMO describes its rule change to be an initial step towards reforming the regulatory arrangements to address the system security risks posed by future large load connections.[48] The proposed initial measures for loads are focused on information sharing on ride-through capabilities, detection and response to instability, options for load shedding capability, protection systems and settings design, and more flexibility in the short circuit ratio standard.

AEMO is currently undertaking a '*Schedule 5.3 Large Loads Access Standards review*' (Large Loads Review) to develop more fulsome and detailed technical requirements for the connection of large loads.[49] A topic of consideration in this review is a definition for large loads or thresholds that should apply to the application of possible access standards to ride through voltage or frequency disturbances. This Review may result in future rule change requests being submitted to the AEMC, and/or certain guidelines being updated to more appropriately address potential system security risks, clarify scope and application thresholds, and potentially require large loads to actively support the grid through the provision of system security services.

This chapter addresses the projected increase in large loads:

- Section 2.1 — considers how a large load is defined with respect to the NER access standards.
- Section 2.2 — provides further information on the projected increase in large loads connections in the NEM.
- Section 2.3 — describes the potential system security risks posed by large loads including through international examples.

2.1 Defining large loads in the context of AEMO's Package 2 rule change request

Large loads are currently colloquially understood to be NEM customers who consume large amounts of electricity, such as smelters, refineries, mines and large data centres. The NER defines

44 See section 1.2 for a discussion on the key drivers behind AEMO's rule change request.
45 AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 11.
46 AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 76.
47 AEMO rule change request overview, 4 April 2024, p 19.
48 Ibid.
49 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 12; See also AEMO's website which contains the kick-off slide deck; AEMO's *Load Technical Requirements Review* is summarised in section 1.6.

load as a connection point(s) at which electrical power is delivered to a person/network. This means that the NER defines load with reference to a specific network connection. However, there is no explicit definition in the NER for a *large load* in the context of connecting plant pursuant to schedule 5.3 of the NER.

In the initial stages of its Access Standards Review, AEMO introduced a definition for a single facility load, thus having reference to a specific network connection:[50]

> A single facility load is a load that forms part of a single installation (as distinct from the connection between a transmission and distribution network).
>
> It may have one or more physical connection points, which are in electrical proximity to each other, and the plant within the facility can be described as one geographical location, so that most power system disturbances affect power delivery to the facility as a whole. A single facility load may have different types of load technologies. For the purposes of the technical requirements of Schedule 5.3, a single facility load is 5 MW or greater.

This definition recognises that a load facility may incorporate a number of smaller load connections, or units. For example, a 500MW hydrogen electrolyser facility may be comprised of 10 smaller 50MW electrolyser units, each with a separate connection to the power system. While the 50MW unit size is relevant for AEMO's assessment of credible contingency risk, the larger 500MW size is important for considering the facility response to power system faults and disturbances.[51]

Further, the AEMC notes that AEMO's System Strength Impact Assessment Guidelines (SSIAG) stipulate that a key criterion for classifying a plant as an inverter-based load (IBL) is a minimum capacity of 5MW/5MVA (and draw power through converters/inverters).[52] This threshold is relevant to AEMO's Package 2 rule change request, and is considered throughout the proceeding chapters of this consultation paper.

AEMO's Access Standards Review

During AEMO's Access Standards Review, it considered introducing a size threshold for large loads. Ultimately, AEMO did not propose a definition for large loads in the rule change proposal due to complexity, a diverse range of stakeholder feedback, and further analysis and consultation being required. This is now being considered by AEMO in the context of its Large Loads Review, which is considering a potential new voltage and frequency ride-through requirement, and could lead to future rule change requests.[53]

Application of thresholds in the NER

Most access standards for the connection of loads to the NEM are not specifically limited by reference to size or other characteristics, but are flexible in their application. Exceptions in the current schedule 5.3 include:

- The application of system strength requirements to all inverter-based loads (IBLs) under clause S5.3.11.
- Clause S5.3.10, requiring market customers with peak demands in excess of 10MW to provide automatic interruptible load.

50 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 82.
51 Ibid., p 81.
52 AEMO, System strength impact assessment guidelines V2.2, 1 July 2024.
53 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 80.

For the three substantially new schedule 5.3 requirements proposed in package 2, AEMO suggests both flexible and restricted application in different ways, without defining large loads:

- For the provision of information about ride-through capability, NSP discretion on whether to apply the requirement after considering information requested (after consulting with AEMO) in the connection process.
- For detection and response to unstable operation, a combination of threshold characteristics and the specification of automatic and minimum access standards.
- For protection systems and settings design, by reference to operation of the relevant schedule 5.3 plant consistent with good electricity industry practice.[54]

Defining large loads and applying some access standards only to loads meeting this definition would provide greater certainty for load proponents on the application of those access standards, thereby reducing scope for NSP or AEMO discretion. On the other hand, a prescriptive definition in the NER or size threshold may not suit all connection circumstances, resulting either in unnecessary application or inappropriate exclusion from the relevant requirement.

2.1.1 We are interested in hearing from stakeholders about defining large loads in the context of this rule change request

In light of AEMO's rule change request largely pertaining to large loads, the Commission considers it important to hear from stakeholders about how they ought to be considered in the context of this rule change. Stakeholder feedback will be used to support any potential draft or final rule and is intended to supplement and support AEMO's ongoing work in this space as part of the Large Loads Review.

We note that defining large loads is a complex matter, as experienced during AEMO's Access Standards Review and there is other work underway on this at this point. We are after stakeholder views on the extent they would like this to be considered in this rule change.

Question 1: Defining large loads in the context of this rule change request

In the context of this rule change request and AEMO's ongoing consideration of the definition for large loads through its Large Loads Review:

1. Are stakeholders supportive of AEMO's ongoing process to address the system security implications and performance standards for large loads, including how large loads ought to be defined in the NER?
2. To what extent do stakeholders think that the Commission should consider the definition of 'large loads' in the context of this rule change?
3. If it is considered, should large loads be defined based on the relevant access standard, or should a large load be more holistically defined in the NER?
4. Alternatively, should we consider whether to apply guiding principles and timing for AEMO to produce a proposed definition, which is currently being considered in AEMO's Large Loads Review?

54 AEMO rule change request overview, 4 April 2024, p 71.

2.2 There is an increase in the number of large load customers seeking connection to the NEM

As noted above, a key driver behind AEMO's proposed changes to the technical performance standards for large loads is the projected increase in the number and capacity of large loads connected to the NEM. This is propelled by the growth in technologies such as hydrogen electrolysers and data centres, as well as the general trend towards electrification, including for commercial and industrial applications that had previously been reliant on gas for process heating needs.

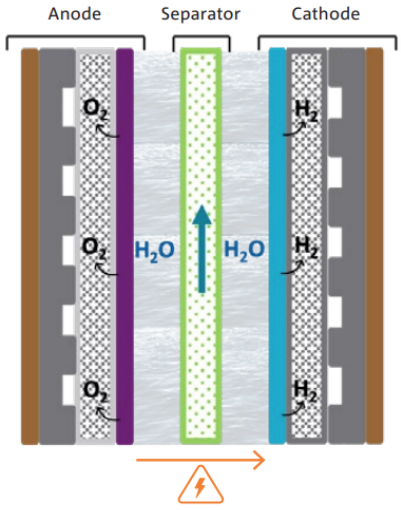
Growth in hydrogen electrolysers

The Commission recognises that the use of hydrogen electrolysers is expected to increase across Australia as this form of production presents an opportunity to decrease carbon emissions and, in turn, support Australia's net zero goals.[55]

Hydrogen manufacturing using electrolysis requires a dedicated or grid-connected electricity supply, as electrolysis is the process of using electricity to split water into hydrogen and oxygen.[56] If developed at scale, it has the potential to significantly impact the NEM, noting this depends on the specific characteristics of each connecting plant, the location, and the extent to which load is met by generation behind the connection point from the grid.

Hydrogen production is expected to scale up in alignment with supportive government policies, such as the National Hydrogen Strategy, and other state and federal initiatives.[57] Indeed, the National Hydrogen Strategy has identified a number of regional locations for Hydrogen Hubs to focus the activities of producers, users and exporters of hydrogen.[58]

Figure 2.1: Basic structure of an electrolyser cell



Source: CSIRO, *Hydrogen Electrolyser Manufacturing: A strategic guide for seizing Australia's clean-tech manufacturing opportunity*, October 2024, p 12.

55 AEMO rule change request overview, 4 April 2024, p 70; Department of Climate Change, Energy, the Environment and Water (DCCEEW), *Building regional hydrogen hubs*, website.

56 See Figure 2.1 below.

57 CSIRO, *Hydrogen Electrolyser Manufacturing: A strategic guide for seizing Australia's clean-tech manufacturing opportunity*, October 2024, p 1.

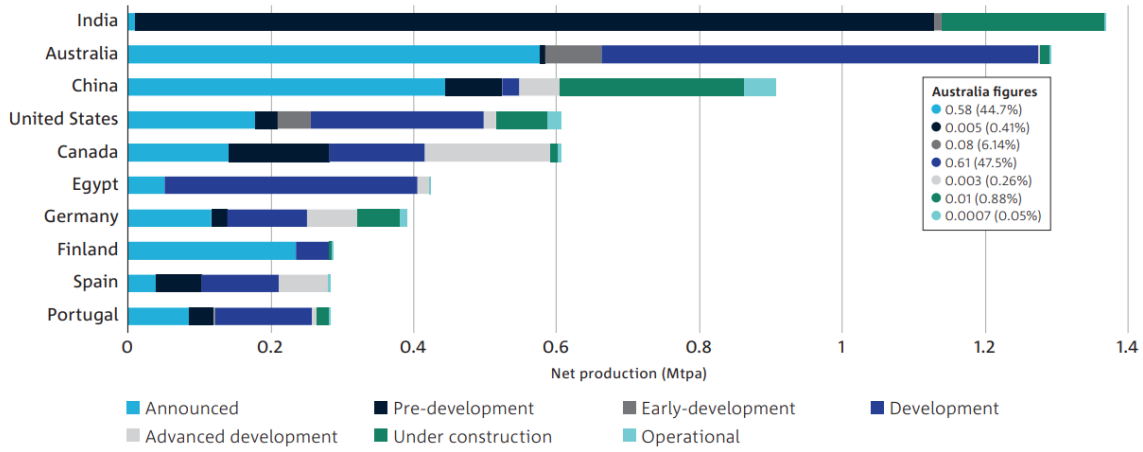
58 Department of Climate Change, Energy, the Environment and Water (DCCEEW), *Building regional hydrogen hubs*, website.

In the final report for the recent Access Standards Review AEMO noted that:[59]

> At present there are several load projects at or nearing demonstration stage, with potential to scale up to several hundred MW within the next few years. AEMO understands that the ultimate size of some individual hydrogen loads may be in the order of 1000-5000 MW in some cases. In addition, AEMO's consultation so far has identified multiple potential new data centre loads more than 100 MW in size, and up to 600 MW. Several of these projects are at connection enquiry or pre-application phase and some projects propose to connect within the next two years.

Further, a 2024 report by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) identified that Australia has a strong pipeline of projects seeking to produce renewable hydrogen. Figure 2.2 below highlights Australia's hydrogen pipeline, which is significant in contrast to some other countries.

Figure 2.2: Renewable hydrogen pipeline across the 10 largest countries by prospective net production



Source: CSIRO, *Hydrogen Electrolyser Manufacturing: A strategic guide for seizing Australia's clean-tech manufacturing opportunity*, October 2024, p 6.

Growth in data centres

Demand for data centres is increasing in Australia owing to greater data generation and storage, growing adoption of cloud computing services, and advancements in AI technology. Data centres require significant amounts of electricity that is reliable and uninterruptible,[60] in turn increasing NEM demand and potential impacts on power system security.[61]

Throughout the Access Standards Review, AEMO's consultation revealed that multiple potential new data centre loads larger than 100 MW and up to 600 MW are at the connection enquiry or pre-application phase, and some projects propose to connect within the next two years.[62] Figure 2.3 below demonstrates this expected growth over the next few years.

59 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 11.

60 We note that while data centre load generally needs to be uninterruptible, this does not necessarily mean that the grid must be uninterruptible, as there may be generation meeting load demand behind the connection point. Further, some load activities for data centres do not rely on uninterruptible supply, such as data mining.

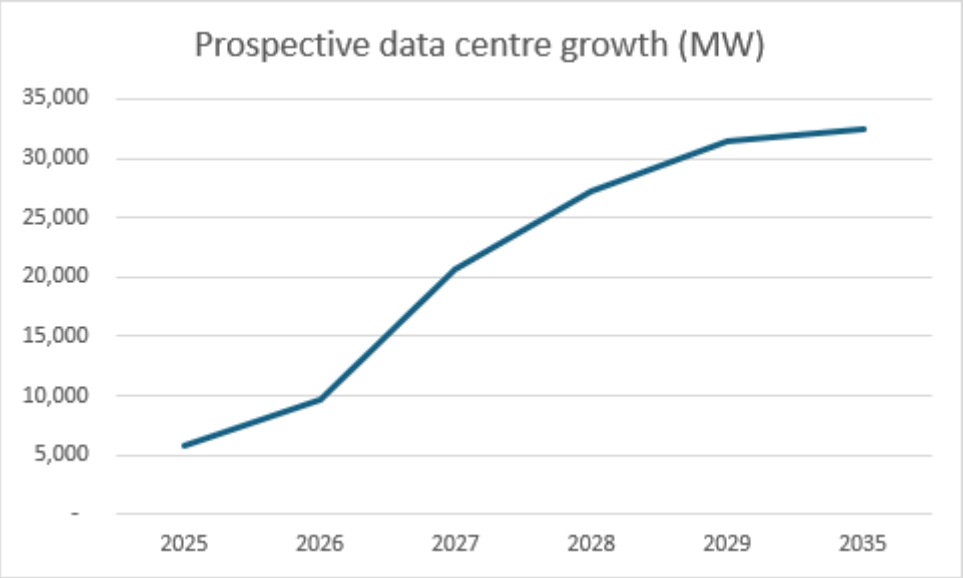
61 See section 2.3.

62 AEMO, Review of technical requirements for connection - National Electricity Rules schedules 5.2, 5.3 and 5.3a, Final report, 22 December 2023, p 11.

We also note that the Energy and Climate Change Ministerial Council (ECMC) has agreed to work with AEMO and other market bodies on the implications for Australia's energy system presented by the projected growth in data centres.[63]

Figure 2.3 below sets out data on the size of connection enquiries and connection applications for new data centres. Whilst only a subset of the connection enquiries will be connected, Figure 2.3 indicates that there is likely to be significant growth in the size of data centres connecting to the NEM.

Figure 2.3: Estimated growth of data centre loads



Source: AEMO.
Note: This data provided by AEMO is still under review by AEMO and may be subject to change.

2.3 Large loads have the potential to adversely impact the power system

AEMO's proposal to revise the technical standards for large loads is based on its view that large loads (particularly those with significant converter technology components) have the potential to have adverse impacts on the power system. AEMO considers that changes to the performance standards for these connections can help address these risks at the design stage, thereby reducing the related risks that AEMO and NSPs would need to address through network design and during power system operation.[64]

A particular focus in AEMO's rule change request is the potential consequences of not having an access standard regarding a ride-through capability for large loads.[65] Without access standards governing their capability to ride through disturbances and manage these risks, either:

- more Frequency Control Ancillary Services may need to be procured in the market, or
- constraints may need to be applied to ensure that resources within the market are dispatched within the physical limits of the power system. These constraints could impact the supply to the data centres.

63 Energy and Climate Change Ministerial Council Meeting Communique, 14 March 2025.
64 AEMO rule change request overview, 4 April 2024, p 19.
65 Ibid., pp 69-73.

AEMO is also concerned with how large loads would behave during a power system disturbance, including whether the behaviour of these loads could act to worsen a disturbance through the impact on system frequency, voltage and stability.[66] For example, if a large load of approximately >100MW were to disconnect from the power system in response to a high-frequency event, this would further destabilise system frequency, thereby worsening the disturbance and risking broader impacts on electricity supply. Further, the development and installation of converter-based loads can provide opportunities for those loads to efficiently support the energy transition if their capabilities are well-understood and appropriately utilised and managed. The Commission notes that this is being considered in more detail through AEMO's Large Loads Review.

AEMO's rule change request identifies that:[67]

> AEMO and the NSP's ability to efficiently manage system security and meet the system standards depends on understanding the ride through capability of large loads. Should such large loads trip because of a disturbance or fault in the power system, there is a risk of cascading outages of other loads and generation network failure and consequential asset damage and blackouts unless generation is significantly and quickly reduced.
>
> There are a limited number of existing very large loads connected in the NEM, typically aluminium smelters, ore refineries, mines and large data centres. To date, the impacts of these individual large loads on the operation of the power system could be considered in isolation from other loads because they have generally been electrically and geographically distant from each other.
>
> However, connection enquiries and public announcements suggest additional very large, often co-located, loads will be developed in the near future. Some new loads may have dynamic behaviours that pose challenges for operation of the power system. The location of very large loads in electrical proximity to each other or to inverter-based generation increases the risk of interactions between them or power system responses that in combination are more detrimental to the power system than the responses considered separately.

2.3.1 North American Eastern-Interconnection large load incident

While the Commission is not yet aware of a significant large load loss incident that has occurred in Australia, we have seen examples of this in international jurisdictions, such as in Virginia, North America.[68]

This large load loss incident in North America illustrates how new, emerging types of loads, such as data centres, can have common design features that are not necessarily visible to the NSP or system operator but can cause unexpected, adverse impacts on the electricity system.

A network fault led to 1.5GW of load being disconnected

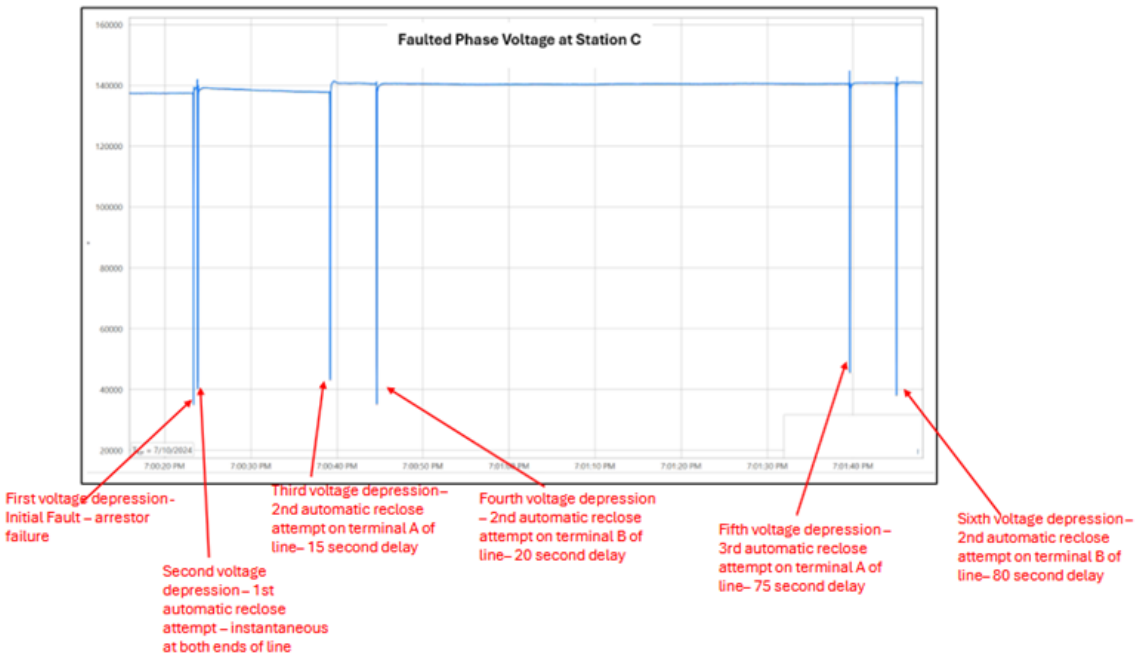
On 10 July 2024, there was a lightning arrestor failure on a 230 kV transmission line in the Eastern Interconnection of North America. An auto-recloser then attempted to reclose three times while the line was still faulted. This led to a series of deep voltage disturbances as shown in Figure 1, causing 60 data centres (with different owners) in Northern Virginia to trip.

66 AEMO, Review of technical requirements for connection - National Electricity Rules Schedules 5.2, 5.3 and 5.3a, Addendum to Draft Report, 4 April 2023, p 10.

67 AEMO rule change request overview, 4 April 2024, p 69.

68 North American Electric Reliability Corporation (NERC), *Incident Review: Considering Simultaneous Voltage-Sensitive Load Reductions*, 8 January 2025.

Figure 2.4: Faulted phase voltage



Source: NERC, *Incident Review: Considering Simultaneous Voltage-Sensitive Load Reductions*, 8 January 2025.

These faults resulted in 1,500 MW of load being disconnected from the grid. The North American Electric Reliability Corporation (NERC) report indicated that the data centres all shared a common design feature: the protection system included a function that counts the number of faults that occur within a preset duration and disconnects if the count breaches a pre-specified threshold. The system operator was unaware of this design feature prior to the event materialising.[69]

Figure 2.5: System load chart

Source: NERC, *Incident Review: Considering Simultaneous Voltage-Sensitive Load Reductions*, 8 January 2025.

Typically, a load would either ride through a fault or automatically reconnect to the grid once a fault is cleared. In this case, the loads did not successfully reconnect as they were switched to run

69 Ibid.

from their backup uninterruptible power supply (UPS) systems. The depressed demand caused a spike in frequency to 60.05Hz and a prolonged reduction in system demand until the loads were manually reconnected to the system.

Lessons learned

In its incident review, NERC identified that:[70]

> While this disturbance did not cause significant operating issues with the grid at this location and at this time, as data [centre] loads continue to grow rapidly, the risk could quickly increase.

NERC also recommended a series of actions for transmission planners to avoid significant issues in the future and has a Large Load Task Force to collaborate with industry to ensure they are resilient to system faults or failures.

Question 2: Amending the NER to address the influx of large loads

1. Do stakeholders have any reflections or data and information they wish to share with the AEMC regarding the prospective growth of large loads connecting to the NEM, including from international experience?
2. Do stakeholders agree with AEMO that the expected growth of large loads may present a risk to power system security?

70 Ibid., p 8.

3 System strength

System strength is the measure of a power system's ability to maintain a stable voltage waveform and is critical to a secure power system. It is important as it supports the ability of the power system to return to stable operating conditions following a disturbance, such as a physical fault on the power system.[71]

Short circuit ratio is a key measure of system strength, as it assesses the power system's capability to maintain stable voltage levels when there are disturbances. More specifically, it is the synchronous three-phase fault level (in MVA) divided by the rated output of an inverter-based resource (IBR) generating system (in MW or MVA) measured at the generating system's connection point.[72] Under the NER, the rated output for inverter-based load (IBL) is its maximum demand at the connection point expressed in MW, and for a market network service facility, its rated power transfer capability expressed in MW.[73]

The current access standards within chapter 5 of the NER for short circuit ratio requirements were introduced through our *Efficient management of system strength* final rule in 2021.[74] The purpose of these access standards is to manage the system strength requirements of IBR by mandating a base-level capability for each inverter connecting to the NEM.[75]

Further, AEMO provides guidance on system strength and the related access standards in its SSIAG.[76] The guidelines cover matters such as the methodology for undertaking system strength impact assessments, how AEMO assesses adverse system strength impacts, and the responsibility of NSPs to undertake system strength impact assessments and calculations of system strength locational factors and system strength quantities for connecting applicants.

As the power system evolves with the influx of IBR, including IBL, it becomes more likely that voltage waveforms will be impacted by that IBR and network disturbances. This is because grid-following inverters do not create a voltage waveform in the same way as a synchronous machine, thereby posing risks to system strength.[77]

Accordingly, AEMO considers that these access standards and the accompanying SSIAG must also evolve to address the retirement of synchronous generators and ensure they reflect current understandings and preserve the stability of the NEM.[78]

In recognition of this, AEMO has made two proposals in its rule change request that relate to system strength that we address in this chapter:[79]

- Section 3.1 — Proposal to allow HVDC link owners to procure system strength services from a third party to meet short circuit ratio requirements.

71 AEMC, *Efficient management of system strength*, final determination, 21 October 2021, p i; AEMC, *Managing power system fault levels*, final determination, 19 September 2017, p 3.

72 AEMO, System Strength Explained, March 2020, Section 2.4.

73 For the methodology used to assess the short circuit ratio, see AEMO, System strength impact assessment guidelines V2.2, 1 July 2024.

74 AEMC, *Efficient management of system strength*, final rule, 21 October 2021.

75 NER clauses S5.2.5.15; S5.3.11; S5.3a.7.

76 AEMO, System strength impact assessment guidelines V2.2, 1 July 2024.

77 AEMO, System Strength Explained, March 2020, Section 3.4.

78 NER clause 5.2.6A requires AEMO to conduct a review of the technical requirements in NER schedules 5.2, 5.3 and 5.3a at least once in every five-year period; NER clause 4.6.6 requires AEMO to publish System Strength Impact Assessment Guidelines and can amend these guidelines in accordance with the rules consultation procedures set out in NER rule 8.9.

79 AEMO rule change request overview, 4 April 2024, pp 67-68, 73-74.

- Section 3.2 — Proposal to limit the application of short circuit ratio requirements for customer loads to large IBL, and allow flexibility to agree to larger short circuit ratio thresholds for those loads.

3.1 Proposal for HVDC link operators to procure system strength from third parties

AEMO's rule change request proposes amending the NER to allow all HVDC link owners to procure system strength services from a third party when they are unable to meet the short circuit ratio access requirements themselves. This change would extend the current arrangements under the NER that allow for generating systems and IRS to procure system strength services from a third party to HVDC links. AEMO considers this will lead to more efficient solutions while reducing the cost and time it takes to connect to the NEM.

3.1.1 Current arrangements

Schedule 5.3 sets out the access standards for MNSPs, which typically operate HVDC (high-voltage direct current) transmission lines between regions, such as Basslink. Access standards for HVDC links are necessary because they can have a significant impact on the operation of the power system, comparable to bidirectional units of similar size.[80]

Pursuant to clause S5.3a.7 of the NER, MNSPs for an HVDC link must meet short circuit ratio requirements in order to be connected to the NEM. The prescribed MAS stipulates that the "electrical plant must have plant capability sufficient to operate stably and remain connected at a short circuit ratio of 3.0, assessed in accordance with the methodology prescribed in the system strength impact assessment guidelines".[81] Further, the general requirements stipulate that the performance standards in the connection agreement must record the agreed value of the short circuit ratio.[82] MNSPs and NSPs may also agree to a negotiated access standard pursuant to the procedures outlined clause 5.3.4A.[83]

Generating systems and IRS must also meet short ratio requirements in accordance with the MAS, which mandates having plant capability sufficient to operate stably and remain connected at a short circuit ratio of 3.0.[84] If this cannot be achieved, they may procure services required to meet this standard from an NSP, system strength provider, or another registered participant, provided there is agreement among those parties and AEMO.[85]

3.1.2 The issue

AEMO's rule change request highlights that presently, HVDC links that are not able to operate stably and remain connected at a short circuit ratio of 3.0 or lower cannot meet this requirement by procuring services from a system strength service provider or third party. This is in contrast to generating systems and IRS, which are permitted to procure these services under the NER.

3.1.3 The proposed solution

AEMO proposes that HVDC link owners should, like generating systems and IRS, be able to procure system strength services to meet this short circuit ratio requirement. AEMO considers

80 Ibid., p 18.
81 NER clause S5.3a.7(b).
82 NER clause S5.3a.7(c).
83 See AEMO, System Strength Impact Assessment Guidelines V2.2, 28 June 2024, pp 42-43.
84 NER clause S5.2.5.15(b).
85 NER clause S5.2.5.15(e)-(f).

that this approach would allow for more efficient solutions and reduce both the costs and the time it would take to have a connection application approved by the relevant NSP, thereby streamlining the process.

To implement this proposal, AEMO proposes to amend clause S5.3a.7 by including the wording from the comparable schedule 5.2.5.15 for generating systems and IRS, which is intended to promote consistency.[86]

3.1.4 Implications from the Package 1 rule change

Should the NER be amended to reflect AEMO's proposal, the ability to procure those services would apply to all MNSPs specified in NER clause S5.3a.1a. However, we note that the Package 1 draft rule seeks to expand the scope and application of clause S5.3a.1a so that all schedule 5.3a requirements apply to:[87]

- any person who is, or intends to be, the MNSP for an HVDC link
- any NSP (or person exempted from the requirement to register as an NSP) whose HVDC link is, or will be, interfaced only with its own AC network or connected to the AC network of another NSP

collectively known as, 'schedule 5.3a participants'.

The Commission will take into account the final rule for Package 1 to ensure that AEMO's proposed changes to clause S5.3a.7 in this rule change apply to all persons who own and operate any HVDC link.

Question 3: HVDC links to procure system strength services from third parties

In relation to AEMO's proposal to amend NER clause S5.3a.7 to allow all HVDC links to procure system strength services to meet the short circuit ratio requirement of 3.0:

1. Do stakeholders agree that the NER should be amended to allow HVDC link owners to procure system strength services from third parties? Is the current inability to do so a material problem, or will it become a material problem?
2. Do stakeholders consider the proposed rule should replicate the corresponding NER clause S5.2.5.15 for generating systems and IRS to promote consistency?
3. Do stakeholders consider that procurement should be subject to agreement between the HVDC link owner, NSP, system strength provider, and AEMO? Do stakeholders have any views as to how involvement from AEMO in such an agreement would operate?
4. Are there alternative solutions stakeholders consider would be more effective?
5. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

86 See AEMO rule change request, proposed rule drafting, pp 206-207 (proposed amended clause S5.3a.7(e)-(f)).

87 See AEMC, *Improving the NEM access standards - Package 1*, Draft determination, 5 December 2024, pp 13-15.

3.2 Proposal to limit the application of short circuit ratio requirements for loads and allow flexibility to agree to larger thresholds

AEMO's rule change request proposes amending the NER to limit the application of short circuit ratio requirements under clause S5.3.11 to IBL that is a large IBR, as defined in the SSIAG, rather than all IBRs. AEMO has also proposed introducing flexibility in clause S5.3.11 to allow the NSP and AEMO discretion to agree to a minimum short circuit ratio requirement above the minimum requirement of 3.0. They consider this would allow appropriate consideration of the connection in the context of local system requirements as our understanding of IBR system strength requirements evolves throughout the transition to net zero.

3.2.1 Current arrangements

Under clause S5.3.11, customers for the purposes of schedule 5.3 whose plant to be connected includes an IBR,[88] are required to meet short ratio requirements in order to be connected to the NEM. As with HVDC links, the prescribed MAS for customers stipulates that the "electrical plant must have plant capability sufficient to operate stably and remain connected at a short circuit ratio of 3.0, assessed in accordance with the methodology prescribed in the system strength impact assessment guidelines".[89] Further, the general requirements stipulate that the performance standards in the connection agreement must record the agreed value of the short circuit ratio.[90]

3.2.2 The issue

In its rule change request, AEMO outlines that IBL can present a risk to power system stability when there is insufficient system strength. However, the risk IBL may pose is less understood at this stage of the transition to net zero, and some IBL may require more system strength than other IBR.[91] For example, some types of hydrogen production technology employ thyristor-based converters, whereas others use insulated gate bipolar transistor-based technology. Thyristor-based technology typically requires a higher short circuit ratio to enable commutation of the thyristors. Consequently, they may not be able to operate within a short circuit ratio of 3.0, as currently required by clause S5.3.11.

Additionally, AEMO considers it an issue that clause S5.3.11 applies to plants that include IBR without any size threshold. This is because it has the potential to capture load with small IBR components for which the cost of the short circuit ratio requirements could far outweigh any system benefits.

3.2.3 Proposed solution

To address these issues, AEMO's rule change request proposes amending clause S5.3.11 so that its application is limited to IBL which is a 'large inverter-based resource' as defined in the SSIAG.[92] The SSIAG provides:[93]

> The NER define an IBR as comprising, alone or in combination, asynchronous generating unit, asynchronous bidirectional unit and IBL. An IBL is defined as a load classified as an IBL

88 NER S5.3.11(a).

89 NER S5.3.11(b).

90 NER S5.3.11(c); See AEMC, *Efficient management of system strength on the power system*, final rule, 21 October 2021, for reasoning as to why the current arrangements apply to all IBR.

91 AEMO rule change request overview, p 73.

92 See AEMO's draft rule, clause S5.3.11(a).

93 AEMO, System strength impact assessment guidelines V2.2, 1 July 2024, section 2.2.

> in accordance with [the SSIAG]. ...
>
> AEMO considers that the size of plant (other than a production unit) or IBR should be determinative of the need for a system strength impact assessment. Hence, the key criterion for classifying plant (other than a production unit) as an IBL or an IBR as [a large inverter-based resource] is a **minimum capacity of 5 MW or 5 MVA**.
>
> For clarity, it is noted that plant (other than a production unit) can only be an IBL if it also meets the criteria inherent in the NER definition of [IBL] itself. That is, the plant (other than a production unit) must be:
>
> (i) supplied by power electronics, including inverters; and
>
> (ii) potentially susceptible to inverter control instability.

AEMO also proposes providing flexibility in clause S5.3.11 to allow the NSP and AEMO discretion to agree on a higher minimum short circuit ratio.[94] As such, the proposed MAS is "electrical plant must have plant capability sufficient to operate stably and remain connected at a short circuit ratio of 3.0, or a reasonable higher value agreed with the NSP and AEMO having regard to expected three phase fault levels at the connection point, assessed in accordance with the methodology prescribed in the system strength impact assessment guidelines".[95]

Question 4: Limiting short circuit ratio requirements for customer loads to IBR, and introducing flexibility to the access standard

In relation to AEMO's proposal to limit the application of short circuit ratio requirements under clause S5.3.11 to large inverter-based resources that is IBL:

1. Do stakeholders consider it an issue that the short circuit ratio requirements under clause S5.3.11 apply to all IBR plant without any size threshold?
   a. Should it only apply to large inverter-based resources as defined in AEMO's SSIAG?
   b. Is the definition of a large inverter-based resource in the SSIAG sufficient for the purposes of this proposal?
2. Are there alternative solutions stakeholders consider would be more effective?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

In relation to AEMO's proposal to amend the NER to introduce flexibility in clause S5.3.11 to allow the NSP and AEMO discretion to agree to a minimum short circuit ratio requirement above the minimum requirement of 3.0:

1. Do stakeholders agree there should be flexibility to agree to higher short circuit ratio requirements? Could there be unintended consequences?
2. Are there alternative solutions stakeholders consider would be more effective?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

94 See AEMO rule change request, proposed rule drafting, p 192 (proposed amended clause S5.3.11(a)).
95 See AEMO rule change request, proposed rule drafting, p 192 (proposed amended clause S5.3.11(b)).

4 Power system stability and protection

Maintaining power system stability is key to providing a secure energy supply for consumers. Stability is the ability of the power system to return to a normal operating state after a disturbance, such as a fault or loss of load.[96] This capability is important to maintain a secure and reliable supply of energy to customers.

The power system is designed to withstand disruptions that are considered to be reasonably possible, defined in the NER as credible contingency events.[97] Credible contingency events could include a sudden loss of generation, load, or a network element. AEMO is responsible for maintaining the power system in a secure operating state whenever possible.[98] This includes operating the power system within its technical limits and taking into account credible contingency events, as well as returning the system to a secure operating state following any contingency event.[99] The performance standards for generators, loads and HVDC links support AEMO in coordinating the system's response to disturbances and contingency events by requiring appropriate plant responses and providing visibility of those responses.[100]

Protection systems are a connected plant's first line of defence against instability. Protection systems play two important roles:

1. **Clearing faults to protect the power system:** A fault is a defect that causes abnormal electrical current or voltage due to, for example, a damaged cable, contact with a tree or animal, or lightning. Protection systems detect faults and automatically disconnect the faulted element from the rest of the power system.[101] If a fault is not cleared quickly, the disturbance it causes in the power system could lead to power system instability or damage other equipment connected to the network.[102] The isolation of a fault may lead to a contingency event such as the loss of a generating unit.
2. **Disconnecting plant to protect it from disturbances:** Disturbances may include voltage or frequency excursions outside the normal range, or rapid changes in power, and may be triggered by a fault and/or contingency event.[103] Disturbances can risk damage to some types of plant, so some protection systems are designed to disconnect plant if disturbances or instabilities are detected.[104] Generators (including IRS) are generally expected to 'ride through' a range of disturbances without disconnecting, whereas loads are not (see section 4.2.1).[105]

The main goal of protection systems is to isolate faulted elements while leaving as much of the power system as possible intact.[106] While it is sometimes necessary for plant to trip off to protect itself, there is a trade-off between the protection of power system equipment and the system's ability to ride through disturbances. The ability for plant to remain in operation during (reasonably expected) disturbances, which is known as ride-through capability, is important for the stable and secure operation of the power system. The access standards set out the requirements for

96 AEMO, Power System Stability Guidelines, v2.0, 1 December 2022, p 5.
97 NER clause 4.2.3(b).
98 NER clause 4.2.6(a); see also NER clause 4.2.4 for the definition of *secure operating state*.
99 NER clause 4.2.6(b).
100 These performance standards are set out in NER schedules 5.2, 5.3 and 5.3a for loads, generating systems and integrated resource systems, and HVDC links, respectively.
101 S Mackay, Engineering Institute of Technology, Fundamentals of Power System Protection, pp 3-10.
102 AEMO, Power System Stability Guidelines, v2.0, 1 December 2022, p 5.
103 Ibid., pp 12-14.
104 AEMO rule change request overview, p 33.
105 NER clauses S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.6, S5.2.5.7, S5.2.5.8. See also proposed new clause S5.2.5.5A in the Package 1 draft rule.
106 S Mackay, Engineering Institute of Technology, Fundamentals of Power System Protection, pp 3-4.

connected plant to clear faults (see section 4.1.1), ride through disturbances (see section 4.2.1), and support the return to normal operation (see section 4.2.1 and section 4.3.1).

AEMO's Package 2 rule change request concerns the role of loads in maintaining power system stability. AEMO has raised these issues because it expects greater numbers of large loads, including IBL, to connect to the NEM in the near future.[107] Disconnection of a large load, for any reason, would represent a larger contingency, and AEMO considers that visibility of how these loads will behave in a disturbance would make it easier to maintain power system security. Some large loads may be particularly sensitive to disturbances and may be designed to trip off to protect themselves. However, a reasonable level of ride-through capability amongst large loads may become important to help the system maintain stable operation following a disturbance and, in particular, to avoid cascading outages.[108]

Finally, AEMO has noted that IBL may contribute to power system instability in the same way as generators.[109] This is because IBR control systems may exhibit non-linear behaviour or undesirable interactions with other plant on the network. In this context, power system instability could look like sustained variations in voltage, frequency, active power or reactive power, or oscillations that are not damped sufficiently quickly.[110] Given the expected increase in IBL as defined in the SSIAG,[111] AEMO considers there would be power system security benefits in increasing loads' capability to detect and respond to instability.[112]

This chapter discusses a number of changes proposed by AEMO and Rod Hughes Consulting relating to protection systems and power system stability.

- Section 4.1 — Rod Hughes Consulting's proposals to clarify the requirements for generator protection systems.
- Section 4.2 — AEMO's proposals to allow greater visibility of loads' ride-through capability and maximise ride-through capability where possible.
- Section 4.3 — AEMO's proposal to create a new access standard for detection and response to instability for loads.

4.1 Clarifying protection systems requirements

Rod Hughes Consulting made two rule change requests proposing amendments to clarify the protection system access standards for connecting generators. We have consolidated these requests with AEMO's Package 2 rule change request to improve the NEM access standards, as outlined in section 1.4.

- The *Definitions of protection system requirements* rule change request (March 2023) proposes new and updated definitions for different types of protection systems and related concepts. Rod Hughes Consulting considers that these definition changes would improve clarity in NER schedules 5.1 and 5.2.
- The *Conditions for generator protection systems* rule change request (January 2023) seeks to address an apparent drafting inconsistency in the AAS for generator protection systems, as well as a policy issue in the MAS.

107 AEMO rule change request overview, p 19; see also chapter 2, which details the potential future impacts of large loads.
108 Ibid., pp 69-71.
109 Ibid., p 72.
110 AEMO, Power System Stability Guidelines, v2.0, 1 December 2022, pp 12-14.
111 AEMO, System strength impact assessment guidelines V2.2, 1 July 2024.
112 AEMO rule change request overview, 4 April 2024, p 72.

This section discusses the issues raised and solutions proposed in both of the Rod Hughes Consulting rule change requests.

4.1.1 Current arrangements

There are existing requirements for protection systems that apply to generators, loads and HVDC links, as well as NSPs.[113]

Access standards for generator protection systems

Clause S5.2.5.9 sets out the AAS and MAS that apply to generators for protection systems that may impact power system security. The overall intent is that a generator (or IRS) must be fitted with sufficient protection equipment to clear any faults that occur within that plant's equipment or its protection zone.

A high level summary of the AAS for generators is as follows:[114]

1. primary *protection systems* to *disconnect* any faulted element in the *generating system* or *integrated resource system* and in protection zones that include the connection point within the applicable *fault clearance time*
2. sufficient redundancy in each primary *protection system* to ensure that point 1 is achieved even if any single protection element (including a communications facility upon which that protection system depends) is out of service
3. *breaker fail protection systems* to clear any faults that are not cleared by the primary *protection system* in the applicable *fault clearance time*.

The MAS differs from the AAS in that:[115]

- the applicable *fault clearance times* may be longer
- redundancy in the primary *protection systems* is not required
- *breaker fail protection systems* are only required where the relevant MAS *fault clearance time* for the primary *protection system* is less than 10 seconds.

The full drafting of the AAS and MAS is provided in Box 2.

Access standards for load protection systems and HVDC link protection systems

Clause S5.3.3 sets out the access standards for protection systems and settings that apply to loads. The overarching requirement, similar to clause S5.2.5.9, is that "all *connections* to the *network* are protected by protection devices which effectively and safely *disconnect* any faulty circuit automatically within a time period specified by the *Network Service Provider*".[116] The AAS and MAS are essentially the same as the AAS and MAS for generators, outlined above.[117]

The access standards for HVDC links, set out in clause S5.3a.6, are identical to those for loads.

Network Service Providers' obligations for protection systems

Clause S5.1.9 places obligations on NSPs to provide protection systems to disconnect faults that occur anywhere on the NSP's transmission or distribution system.

113 NER schedules 5.2, 5.3 and 5.3a respectively.
114 NER clause S5.2.5.9(a). Note: NER defined terms are italicised, but this is not a direct quote. See Box 2 below for an excerpt of this clause.
115 NER clause S5.2.5.9(c).
116 NER clause S5.3.3.
117 Schedules 5.3 (loads) and 5.3a (HVDC links) do not contain a provision equivalent to clause S5.2.5.9(b) (generators). Clause S5.2.5.9(b) is discussed further in section 4.1.2.

The NSP is also responsible for setting the fault clearance times for protection zones in its network, according to requirements set out in clause S5.1.9.[118]

4.1.2 The issues

This section outlines the problems or issues that Rod Hughes Consulting identified in each of the two rule change requests.

New definitions for protection systems

In the *Definitions for protection systems* rule change request, Rod Hughes Consulting raised concerns that the access standards for generator protection systems do not include clear definitions for some key terms and concepts. The proponent considers that this lack of clarity has given rise to inconsistent application of the rules and confusion amongst industry participants.

Specifically, the proponent considers that:

- the lack of NER definitions for 'primary' or 'back-up' protection systems could lead to confusion or misinterpretation
- the phrase 'must have sufficient redundancy to ensure' is unclear as used in clauses such as S5.1.9 and S5.2.5.9.

The proponent considers that clauses using these phrases are subject to multiple interpretations regarding how much duplication of protection equipment is required across primary, back-up and breaker fail protection systems. The rule change request states that the unclear requirements are leading to disagreement and debate in industry and "potential mis-application of the intent of the NER".[119]

The proponent also considers that the term 'primary protection system' is contradictory because all protection systems are considered secondary equipment. This is because 'secondary equipment' is defined in the NER as:[120]

> Those assets of a *Market Participant's facility* which do not carry the *energy* being traded, but which are required for control, **protection** or operation of assets which carry such *energy*.

Conditions for generator protection systems

In the *Conditions for generator protection systems* rule change request, Rod Hughes Consulting raises two separate issues.

First, Rod Hughes Consulting considers there is a drafting inconsistency in clause S5.2.5.9, which sets out the access standards for generator protection systems. Paragraph S5.2.5.9(a) describes the AAS, as outlined in section 4.1.1 above. Paragraph S5.2.5.9(b) appears to state that the requirements in sub-paragraphs (a)(2) and (a)(3) are part of the AAS if AEMO or the NSP consider they are necessary to prevent certain adverse impacts on the power system or other Network Users. The intent and effect of paragraph (b) are not clear since according to paragraph (a), the requirements in sub-paragraphs (a)(2) and (a)(3) are included in the AAS by default. Refer to the relevant excerpt from the NER in Box 2.

118 NER clause S5.1.9(a).

119 Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023, p 1.

120 NER chapter 10 glossary definition. Note the term 'secondary equipment' only appears twice in the NER - in Schedule 5.10 Information requirements for Primary Transmission Networks Service Providers (clause 5.2A.5) and in the chapter 10 definition of 'power system operating procedures'.

Box 2: Excerpt from NER clause S5.2.5.9 - Protection systems that impact on power system security

Automatic access standard

(a) The *automatic access standard* is:

(1) subject to clauses S5.1.9(k) and S5.1.9(l), primary *protection systems* must be provided to *disconnect* from the *power system* any faulted element in a *generating system* or *integrated resource system* and in protection zones that include the *connection point* within the applicable *fault clearance time* determined under clause S5.1.9(a)(1);

(2) each primary *protection system* must have sufficient redundancy to ensure that a faulted element within its protection zone is *disconnected* from the *power system* within the applicable *fault clearance time* with any single protection element (including any communications *facility* upon which that *protection system* depends) out of service; and

(3) *breaker fail protection systems* must be provided to clear faults that are not cleared by the circuit breakers controlled by the primary *protection system* within the applicable *fault clearance time* determined under clause S5.1.9(a)(1).

(b) In relation to an *automatic access standard* under this clause S5.2.5.9, the *Generator* or *Integrated Resource Provider* must provide redundancy in the primary *protection systems* under paragraph (a)(2) and provide *breaker fail protection systems* under paragraph (a)(3) if *AEMO* or the *Network Service Provider* consider that a lack of these *facilities* could result in:

(1) a material adverse impact on *power system security* or quality of *supply* to other *Network Users*; or

(2) a reduction in *inter-regional* or *intra-regional power transfer capability*,

through any mechanism including:

(3) consequential tripping of, or damage to, other *network* equipment or *facilities* of other *Network Users*, that would have a *power system security* impact; or

(4) instability that would not be detected by other *protection systems* in the *network*.

Minimum access standard

(c) The *minimum access standard* is:

(1) subject to clauses S5.1.9(k) and S5.1.9(l), *protection systems* must be provided to *disconnect* from the *power system* any faulted element within a *generating system* or *integrated resource system* and in protection zones that include the *connection point* within the applicable *fault clearance time* determined under clause S5.1.9(a)(2); and

(2) if a *fault clearance time* determined under clause S5.1.9(a)(2) for a protection zone is less than 10 seconds, a *breaker fail protection system* must be provided to clear from the *power system* any fault within that protection zone that is not cleared by the circuit breakers controlled by the primary *protection system* within the applicable *fault clearance time* determined under clause S5.1.9(a)(3).

Source: NER clause S5.2.5.9.

The Commission's preliminary assessment is that there are (at least) two possible interpretations of paragraphs S5.2.5.9(a) and (b) together:

1. The AAS is as set out in paragraph (a) in all cases. Paragraph (b) is redundant and could be removed without changing the meaning of the clause. The proponent takes this view.[121]

121 Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023, pp 1-2.

2. Paragraph (b) gives AEMO the discretion to relax the AAS if they consider this would not have the adverse impacts listed in sub-paragraphs (b)(1) to (b)(4). In this case, paragraphs (a) and (b) may need to be redrafted to clarify this intent.

Second, Rod Hughes Consulting notes that the MAS set out in paragraph S5.2.5.9(c) includes less onerous requirements for breaker fail protection systems and redundancy in primary protection systems, without giving AEMO any discretion as to whether the additional redundancy is needed. The proponent considers that this MAS could result in risks to grid stability and system security because:[122]

- plant connecting under the MAS may not have sufficient redundancy to ensure its protection systems clear faults as intended
- there is no obligation either on the generator, AEMO or the NSP to assess the likelihood or impact of a non-redundant primary protection system failing to clear a fault
- there is no ability for AEMO or the NSP to require redundancy in protection systems at a higher level than the MAS, if they consider it necessary.

We are interested in stakeholder views on the correct or usual interpretation of clause S5.2.5.9, and whether the issues raised by Rod Hughes Consulting have negative impacts for stakeholders.

4.1.3 The proposed solution

This section describes the changes that Rod Hughes Consulting proposes to address the issues outlined in section 4.1.2.

New definitions for protection systems

Rod Hughes Consulting proposes to add or update several NER definitions around protection systems, and adjust the wording of some of the relevant clauses to improve clarity. The changes would:[123]

- define a new term *main protection system* and use this in place of 'primary *protection system*' (to remove the contradiction with *secondary equipment*)
- define the term *back-up protection system*
- update the definition of *breaker fail protection system* to be more detailed and specific
- define a new term *independent alternative main protection system* to be used instead of the 'sufficient redundancy' phrasing
- define the terms *protection element*, *protection function*, and *control function.*

The new concept of an '*independent alternative main protection system*' would be used in the redrafting of clauses such S5.1.9 and S5.2.5.9 to clarify the requirements for redundancy in primary (or main) protection systems.[124]

Rod Hughes Consulting raises a clarity issue in schedule 5.2 (generator access standards) only, but if the proposed rule was made, the new and updated definitions would apply throughout the NER. Each of the terms proposed to be redefined is used in several places in the NER, including schedules 5.1, 5.2, 5.3 (loads), and 5.3a (HVDC links).

122 Ibid., pp 2-3.
123 Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, 23 March 2023, pp 8-9.
124 Ibid., p 10.

The Commission will consider whether updating the protection systems definitions in the NER would be appropriate for all affected clauses, and whether it would also improve clarity in those clauses.

The rule change request included proposed drafting of the new definitions as set out in Table 4.1.

Table 4.1: New protection systems definitions proposed by Rod Hughes Consulting

Term	Status	Proposed definition
back-up protection system	new definition	A *protection system* that operates in consequence of a *main protection system* having failed to clear the fault in its expected time. The back-up protection system will have time and/or measurand grading to the *main protection system*. A back-up protection system may be itself a *main protection system* for other fault scenarios. A back-up protection system is not an independent alternative main protection system as it may share common modes of failure to the main protection system (e.g. auxiliary supply) and/or may not be as sensitive and/or as fast as the main protection system so as to clear all faults in a similar time frame as expected to be cleared by the main protection system. Examples of back-up protection systems include breaker fail protection systems as well as other main protection systems located at other points in the power system with different time and/or measurand settings.
breaker fail protection system	updated definition	A *protection system* that, upon detecting failure of its monitored circuit breaker to clear the fault following operation of the *breaker fail protection system's* respective *independent alternative main protection system*, operates to directly open other required circuit breakers to clear the fault independently of any other *protection function* operation.
control function	new definition	A function associated with the normal operation in absence of a power system fault that may be required to manage, monitor or control the power system performance and/or correct an abnormal condition of the power system.
independent alternative main protection system	new definition	A *main protection system* that operates with similar measurand value sensitivity and speed of operation as another *main protection system* such that it is generally expected that both would be able to operate in approximately the same time for the same fault. Specifically there must be no credible mode of failure or out-of-service condition of any of the respective *protection elements* such as to prevent correct operation of both systems for a particular fault.
main protection system	new definition (replacing primary protection system)	A *protection system* that is the intended and preferred system to clear a fault in order to minimise the number of required circuit breakers to clear the fault as close as possible to the fault.

Term	Status	Proposed definition
protection element	new definition	Any of the facilities, equipment, physical and virtual connections of the *protection system* including: CT cores, VT windings, Trip coils, devices providing *protection functions*, Auxiliary/tripping d.c. batteries, Battery chargers, Auxiliary a.c. auxiliary supply, Wiring, Communication systems.
protection function	new definition	A function that is intended to operate on the basis of a fault or other excessive operating condition of the power system.

Source: Rod Hughes Consulting rule change request - *Definitions of protection system requirements*, pp 8-9.

Question 5: New definitions for protection systems

In relation to Rod Hughes Consulting's *Definitions of protection system requirements* rule change request:

1. Do stakeholders agree that the requirements for generator protection systems are currently unclear? If so, what are the impacts of this lack of clarity?
   a. Similarly, do stakeholders consider the requirements for loads' and HVDC links' protection systems are currently unclear?
2. Do stakeholders support the proposal to update and add new NER definitions for types of protection systems?
   a. Do stakeholders have feedback on the proposed new definitions themselves?
3. Do stakeholders have any concerns or suggestions in relation to this element of Rod Hughes Consulting's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

Conditions for generator protection systems

The rule change request also proposes solutions for each of the two issues identified.

For the first issue, the drafting inconsistency in clause S5.2.5.9, the proposed solution is to remove paragraph S5.2.5.9(b). This would clarify that the AAS is as described in paragraph S5.2.5.9(a) in all cases, which the proponent considered to be the correct interpretation.[125]

For the second issue, relating to the MAS, the proposed solution is to add a provision allowing AEMO to require additional redundancy and/or breaker fail protection systems, as part of the MAS, if it considers the absence of these systems may have adverse impacts. The proposed change would allow AEMO or the NSP to increase the redundancy requirements of the MAS to those of the AAS if necessary on a case-by-case basis.[126]

The rule change request included proposed drafting of the new provision, which would be a new paragraph S5.2.5.9(d) using similar wording to the existing paragraph S5.2.5.9(b).[127]

> (d) In relation to a minimum access standard under this clause S5.2.5.9, the Generator must provide redundancy in the primary protection systems under paragraph (a)(2) and

125 Rod Hughes Consulting rule change request - *Conditions for generator protection systems*, 10 January 2023, pp 1-2.
126 Ibid., p 2.
127 Ibid., p 2.

provide breaker fail protection systems under paragraph (a)(3) if AEMO or the Network Service Provider consider that a lack of these facilities could result in:

(1) a material adverse impact on power system security or quality of supply to other Network Users; or

(2) a reduction in inter-regional or intra-regional power transfer capability,

through any mechanism including:

(3) consequential tripping of, or damage to, other network equipment or facilities of other Network Users, that would have a power system security impact; or

(4) instability that would not be detected by other protection systems in the network.

The Commission notes that, in general, a connection agreement at the MAS or a negotiated access standard is only permitted if it does not adversely affect power system security.[128] We are seeking stakeholder feedback on whether the issues raised in this rule change request could be resolved through use of the framework for negotiated access standards.

Question 6: Conditions for generator protection systems

These questions relate to Rod Hughes Consulting's *Conditions for generator protection systems* rule change request.

1. Regarding the proposal to remove paragraph (b) of clause S5.2.5.9:
   a. Do stakeholders agree that paragraph (b) is redundant and/or misleading, or do stakeholders have a different interpretation?
   b. Do stakeholders support Rod Hughes Consulting's proposal to remove paragraph (b)?
2. Regarding the proposal to add a new provision in the minimum access standard:
   a. Do stakeholders agree that the minimum access standard may create risks to power system security because it does not require additional redundancy in protection systems?
   b. Do stakeholders support Rod Hughes Consulting's proposal to give AEMO and the NSP discretion to increase redundancy requirements in the minimum access standard if required to prevent adverse impacts on power system security?
3. Do stakeholders have any concerns or suggestions in relation to this element of Rod Hughes Consulting's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

4.2 Ride-through capability of loads

AEMO proposed two changes to schedule 5.3 relating to loads' capability to ride through faults and disturbances on the network.

- **Information provision:** Requiring network users to provide information about the ride-through capabilities of connecting loads, at the request of the NSP.
- **Settings to maximise ride-through:** Requiring network users and the NSP to cooperate to design protection systems and settings that maximise ride-through performance, subject to engineering and safety requirements.

128 NER clause 5.3.4A.

These changes would support system security by making it easier for AEMO to manage the risk of outages associated with faults and incrementally improving loads' ride-through capability at low cost.[129]

4.2.1 Current arrangements

The existing access standards require loads to have protection systems that will disconnect faulted elements when faults occur in or close to the plant itself. Section 4.1.1 describes these requirements in more detail.

In addition, the network user and the NSP are required to cooperate in the design and implementation of protection systems where there is inter-operation between the parties' protection systems or any shared use of equipment.[130] A similar requirement applies to generators (including IRS) and HVDC links.[131]

Under the NER, there are currently no specific ride-through requirements for loads, meaning loads are permitted to trip (disconnect) in any circumstance, even if the access standards do not require it. For example, a large load may be designed to trip in response to voltage disturbances in order to prevent damage to its own equipment.

By contrast, there are extensive ride-through requirements for generators.[132] The access standards require generators to remain in continuous interrupted operation during:

- frequency disturbances (clause S5.2.5.3)
- during voltage disturbances (clauses S5.2.5.4 and S5.2.5.6)
- multiple successive disturbances, provided each disturbance meets certain conditions - referred to as multiple fault ride-through (clause S5.2.5.5)
- a sudden power system load reduction, known as partial load rejection (clause S5.2.5.7).

Generators are also required to provide beneficial responses to disturbances, including:

- recovering active power to a certain level in a timely manner (clause S5.2.5.5)
- injecting or absorbing reactive current to stabilise voltages after a fault (clause S5.2.5.5)
- automatically reducing output power or disconnecting in response to an over-frequency event (clause S5.2.5.8).

Following a fault or disturbance, the ride-through and response of all plant connected to the network is critical to avoid plant tripping unnecessarily, voltage decline and power system instability.

4.2.2 The issue

AEMO's responsibility to maintain system security includes ensuring that the power system remains in a satisfactory operating state following a contingency event, and quickly returns to a secure operating state.[133] AEMO uses information about the behaviour of generators and loads following a disturbance to understand the potential impact of contingency events. However, AEMO currently lacks visibility of when loads will trip as a result of a disturbance (ride-through capability). This creates challenges for AEMO in preparing for and responding to contingency events. This issue is likely to become more material as more large loads connect in the NEM.[134]

129 AEMO rule change request overview, 4 April 2024, pp 69-71.
130 NER clause S5.3.3(c).
131 NER clauses S5.2.5.9(e) and S5.3a.6(c).
132 NER clauses S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.6, S5.2.5.7, S5.2.5.8; See also proposed new clause S5.2.5.5A in the Package 1 draft rule.
133 NER clauses 4.2.4, 4.2.5, 4.2.6.

Further, since there are no ride-through requirements for loads, new load connections may lack incentives to build in strong ride-through capability. AEMO's rule change request notes the possibility that loads' protection settings may not fully use the inherent capability of their protection systems, effectively lowering their ride-through capability. These conservative protection settings could cause loads to trip unnecessarily, contributing to the system security challenges outlined above.[135]

Specifically, AEMO considers that a risk of cascading outages may emerge as more loads connect. Future large loads could be co-located or clustered close to one another.[136] For example, if one load trips due to a fault, this could exacerbate the disturbance seen by loads that are electrically close by, causing them to trip as well. These cascading outages of multiple loads (or other plant) could impact security and reliability outcomes by disrupting the balance of supply and demand. Electricity customers (owners, operators and users of the impacted loads) would also be directly affected by downtime and the resulting loss of product or business.

4.2.3 The proposed solution

In the Package 2 rule change request, AEMO proposes two changes regarding the ability of loads to ride through disturbances.

Provision of information on ride-through capability

AEMO proposes to address the lack of visibility of loads' ride-through capability by having connecting parties provide this information to the NSP on request. The NSP could also include that information in the performance standards, with a copy to be provided to AEMO. This would apply to all load connection applications, not only large loads or IBL.[137]

Under the proposal, network users intending to connect new load would need to provide information about the load's ride-through capability if requested by the NSP in consultation with AEMO. Specifically, the NSP would be able to request 'information about the capability of the equipment to remain *connected* to the *power system* and in operation following one or more *frequency* or voltage disturbances (ride-through capability)'.[138] If the NSP requests the ride-through capability information, it would also be able to include this information in the load's performance standards, and if so, it would be required to provide AEMO with a copy.[139]

The proposed amendment would form part of the existing information provision requirements in clause S5.3.1, under which a connection applicant must provide certain information including design details and test certificates to the NSP. Consistent with these existing requirements, the proposed change would apply to all connecting loads and plant upgrades, but the NSP would have discretion on whether to request the information or not. For example, NSPs may be more likely to request ride-through information from larger loads or loads connecting in weaker areas of the grid.

The nature of ride-through information to be requested would be left up to the NSP in each case. The NSP may request information including, but not limited to, the trigger levels and operation time for plant's protection relays, and the speed and manner in which load is restored following a trip. Power system modelling is not expressly required and the Commission understands it is unlikely that NSPs or AEMO would request modelling of ride-through. The intent is to record the

134 AEMO rule change request overview, 4 April 2024, pp 69-70.
135 Ibid., pp 70-71.
136 Ibid., pp 69-70.
137 Ibid., p 70.
138 AEMO rule change request, proposed rule drafting, p 185 (proposed new sub-paragraph S5.3.1(a1)(2A)).
139 Ibid., p 189 (proposed new clause S5.3.4A).

known ride-through capability of relevant new loads without imposing unreasonable costs on the network user.[140]

AEMO considers that the provision of ride-through capability information to the NSP and AEMO would assist them in maintaining the stable operation of the network and system security. Visibility of how loads will behave following a disturbance may enable AEMO to reduce the complexity and cost of preparing for and responding to contingency events. AEMO notes it would also provide insight into the behaviour and capability of large loads to inform future work on managing large loads in the NEM.[141]

Question 7: Provision of information on ride-through capability

In relation to AEMO's proposed changes to enable NSPs to request information on loads' ride-through capability:

1. Do stakeholders agree that NSPs and AEMO lack visibility of loads' ride-through capability and that this creates a challenge for system security?
2. Do stakeholders support AEMO's proposed rule to require network users to provide information about connecting load's ride-through capability to the NSP on request?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule?

Protection settings to maximise ride-through performance

AEMO also proposes an amendment to the protection systems access standard to encourage network users to design protection systems and settings with greater ride-through capability. The proposed rule would require the NSP and the network user to cooperate to design protection systems and settings that maximise ride-through capability, subject to engineering and safety requirements.[142]

The intent is that protection settings should allow for operation beyond the requirements of the performance standard where reasonable. It is not AEMO's intention to increase the cost of protection systems for connecting plant, but to encourage protection settings that use as much of the inherent ride-through capability as is practical with little or no additional cost. AEMO's proposal also includes a caveat that safety and engineering requirements would be prioritised over maximising ride-through performance.[143] We are interested in stakeholder views as to how the proposed change may apply in practice and how it could be implemented to ensure it does not impose excessive costs on network users.

The proposed rule would be added to the existing cooperation requirements in clause S5.3.3(c), which applies regardless of whether the load connects under an automatic, minimum, or negotiated access standard. This amendment would also apply to all connecting or upgrading loads, not only large loads. AEMO has proposed the rule drafting provided in Box 3, which would appear in clause S5.3.3(c) (noting the proposed drafting uses the 'schedule 5.3 plant' and 'schedule 5.3 Participant' terminology that would be introduced by the Package 1 rule if made).[144]

140 AEMO rule change request overview, 4 April 2024, p 70.
141 Ibid., p 70.
142 Ibid., pp 70-71.
143 Ibid., p 71.
144 AEMO rule change request, proposed rule drafting, pp 187-188 (proposed amended clause S5.3.3(c)).

Box 3: Excerpt from AEMO's proposed rule drafting - proposed amended clause S5.3.3(c)

(c) The *Network Service Provider* and the *schedule 5.3 Participant* must cooperate in the design and implementation of *protection systems* to comply with this clause in a manner consistent with achieving the system standards, including cooperation with regard to:

...

(4) design and implementation of *protection systems* and settings under paragraph (a):

(1) so that the *schedule 5.3 plant* remains in operation as required by the performance standards relevant to the type of protection; and

(2) except as otherwise required by *AEMO* or the *Network Service Provider*, to maximise the *schedule 5.3 plant's* capability to remain in operation for abnormal *power system* conditions for which the *plant* is not required to *disconnect* under any *performance standard*, while maintaining safe and stable operation of the *plant* within safety margins consistent with *good electricity industry practice*.

Note

While a schedule 5.3 plant is permitted to disconnect for conditions that exceed the requirements for it to remain in operation under any individual performance standard, sub-paragraph (2) confirms that protection settings should allow for operation beyond those limits where reasonable. This does not affect other requirements to disconnect that may apply, for example, to the provision of ancillary services.

Source: AEMO rule change request, proposed rule drafting, pp 187-188 (proposed amended clause S5.3.3(c)).

We note that the Package 1 final rule, intended to be published on 22 May 2025, may make similar changes to schedule 5.2. The Package 1 draft rule proposed to introduce an analogous requirement for generators to maximise their ride-through capability. This change would appear in clause S5.2.5.8 and would require a generating system's or IRS's protection settings to be set such that the plant remains in operation as much as possible when not otherwise required to disconnect, subject to safety requirements and good engineering practice.[145] The proposal for loads differs from the draft rule for generators in that it is a requirement for cooperation between the network user and the NSP.[146]

145 AEMC, Improving the NEM access standards - Package 1, Draft determination, pp 46-47.

146 AEMO rule change request overview, 4 April 2024, p 71.

Question 8: Protection settings to maximise ride-through performance

In relation to AEMO's proposed changes to amend clause S5.3.3(c) of the NER to encourage protection settings that maximise loads' ride-through capability:

1. Do stakeholders agree that the current arrangements allow conservative load protection settings that may unnecessarily reduce loads' ride-through capability?
2. Do stakeholders support AEMO's proposed rule requiring cooperation between the NSP and the network user in the design of protection systems and settings to maximise ride-through capability?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

4.3 New access standard for instability monitoring

AEMO proposes adding a new access standard in schedule 5.3 that would require loads to detect and respond to instability. This would be similar to the requirements that AEMO proposed for asynchronous generators (including IRS) in Package 1, but would only apply to IBL that meet certain materiality thresholds.[147]

4.3.1 Current arrangements and proposed changes in Package 1

Currently, the Rules do not include any requirements for loads to detect, monitor or respond to instability in the power system.

The generator access standard for detection and response to instability is being considered in the Package 1 rule change. Currently, the AAS for generating systems and IRS requires a protection system that trips plant for unstable operation, including pole slipping in the case of synchronous generators. The Package 1 draft rule amended and expanded this access standard to require generators to have the capability to detect instability in voltage, reactive power and active power, and (for the AAS) automatically execute a hierarchy of response actions, which could include disconnecting the plant for unstable operation.[148] The Package 1 draft rule would also require generating systems and IRS over 100 MW to have the capability to send instability detection data to the NSP or AEMO and receive a remote tripping signal, if required by the NSP or AEMO.[149]

In making the Package 1 draft rule, the Commission considered that the draft rule would:[150]

- recognise that a range of responses may be preferable to tripping
- provide flexibility to use available capability for connected plant to promptly respond to instability when detected, in a manner that is likely to be proportionate and efficient, considering power system needs and plant capabilities
- allow for detection, monitoring and response of the plant's own contribution to instability as those capabilities mature

147 Ibid., pp 72-73.
148 AEMC, *Improving the NEM access standards - Package 1*, Draft determination, pp 48-49.
149 AEMC, *Improving the NEM access standards - Package 1*, Draft rule - markup, pp 158-159 (clause S5.2.5.10).
150 Ibid., p 49.

- allow for both a local and a future centralised system to identify plant contributing to the instability, for visibility and control of response, with size thresholds balancing risk and efficiency.

In submissions to the Package 1 draft determination, stakeholders supported the changes in principle and generally supported the requirement for equipment to detect instability. We note that some stakeholders provided detailed feedback on how to improve the draft rule, recognising technological limitations and suggesting clarifications.[151]

The Commission is taking stakeholders' views into account for the Package 1 final determination, which will be published on 22 May 2025.

For this rule change (Package 2), the Commission will consider the Package 1 final rule and ascertain ways to ensure consistency, where appropriate.

4.3.2 The issue

The existing requirements for generators to disconnect for unstable operation, and the new requirements in the Package 1 draft rule, are intended to protect the network from instabilities in active power, reactive power and voltage that may be caused or exacerbated by a generating system or IRS. However, disconnecting on detection of instability as required by the existing automatic access standard may make the power system less secure if the plant is damping (reducing) the instability rather than contributing to it.[152] There are currently no requirements for loads, as opposed to generators, to detect instability at the connection point or take any action as a result of instability.

Both loads and generators can potentially contribute to instability in the power system. According to AEMO, IBR, or any plant that interfaces with the power system via power electronics, may be more likely to cause or participate in instabilities.[153] Therefore, with increasing numbers of large IBL expected to connect in the NEM, the risk of instability may be increasing. Requiring such loads to detect and respond to instability could help to address that risk and support power system security.[154]

4.3.3 The proposed solution

AEMO proposes to add a new access standard in schedule 5.3 that would require loads to play a role in monitoring and responding to instability. The proposed AAS and MAS would be very similar to those for asynchronous production units in the Package 1 draft rule, but would only apply to a subset of IBL.[155] Box 4 outlines AEMO's proposed new access standard and conditions under which it would apply.[156] (See also Table 4.2.)

AEMO considers that the proposed new access standard would improve power system security by ensuring that new large IBL can detect instability, respond in a way that helps manage instability

151 Submissions to the Package 1 draft determination: Tesla, p 2; APA, p 14; Akaysha Energy, p 7; EPEC, p 4; Electranet, p 2; Transgrid, p 17; Energy Networks Australia, p 3; Windlab, p 8; Origin, p 1.

152 AEMC, Improving the NEM access standards - Package 1, draft determination, p 48; NER clause S5.2.5.10.

153 AEMO rule change request overview, p 72.
AEMO, Power System Stability Guidelines, v2.0, 1 December 2022, pp 13-14.

154 AEMO rule change request overview, 4 April 2024, p 72.

155 Ibid., pp 72-73.

156 AEMO rule change request, proposed rule drafting, pp 193-194 (proposed new clause S5.3.12).

(which may include disconnection as a last resort), and exchange information with AEMO about instability in the network.[157] This would enable loads to play a role in managing instability, helping to maintain stable operation as more large IBL are connected in the NEM.

Box 4: Proposed new access standard for instability detection and response by loads

Both the automatic access standard and minimum access standard would only apply to network users in respect of plant that:

- includes an inverter-based load component that meets the SSIAG definition of a large inverter-based resource, and
- in the view of NSP or AEMO, could reasonably contribute to instability in voltage, reactive power or active power at its connection point.

The automatic access standard would require:

- capability to detect instability in voltage, reactive power and active power
- capability to disconnect the inverter-based load for unstable behaviour, with configurable triggers and settings
- automatic and prompt execution of a configurable hierarchy of response actions on detection of instability, as agreed with the NSP and AEMO
- any action that involves disconnection to account for available automated information on the plant's contribution to the instability
- for inverter-based loads of 100 MW or larger, access to a phasor measurement unit to send data to the NSP and AEMO, and capability to receive information about contribution to oscillations from an AEMO facility where available.

The minimum access standard would require:

- where the inverter-based load can change the voltage at its connection point by more than 1%, capability to detect instability of voltage, reactive power and, where relevant, active power
- subject to the same 1% threshold, a process agreed with the NSP and AEMO to manage oscillations promptly on detection
- for inverter-based loads of 100 MW or larger, if required by the NSP or AEMO, access to a phasor measurement unit to send data to the NSP and AEMO, and capability to receive information about contribution to oscillations from an AEMO facility where available.

In addition, the proposed rule would require:

- capability to send instability detection data to the NSP or AEMO and receive a remote tripping signal, if required by the NSP or AEMO
- prioritisation of measures to eliminate the instability over disconnecting plant.

Source: AEMO rule change request, proposed rule drafting, pp. 193-194 (proposed new clause S5.3.12).

157 AEMO rule change request overview, p 73.

Table 4.2: Application of the proposed new access standard for detection and response to instability for loads

Plant includes a large IBL and AEMO or the NSP considers it could contribute to instability	IBL is 100 MW or larger	Plant can change voltage at the connection by more than 1%	Automatic access standard	Minimum access standard
No	N/A	N/A	Does not apply	Does not apply
Yes	No	No	Applies, except PMU requirement	Does not apply
Yes	Yes	No	Applies, including PMU requirement	Only PMU requirement applies, at AEMO and the NSP's discretion
Yes	No	Yes	Applies, except PMU requirement	Applies, except PMU requirement
Yes	Yes	Yes	Applies, including PMU requirement	Applies, including PMU requirement at AEMO and the NSP's discretion

Source: AEMO rule change request, proposed rule drafting, pp. 193-194 (proposed new clause S5.3.12).

Question 9: New access standard for detection and response to instability

In relation to AEMO's proposed new access standard for detection and response to instability that would apply to large inverter-based loads:

1. Do stakeholders agree that there is an emerging need for large inverter-based loads to play a role in managing instability in the NEM?
2. Do stakeholders support AEMO's proposed new access standard for instability detection and response by loads as set out in Box 4?
   a. Which parts of the proposal do stakeholders support, or oppose?
   b. Do stakeholders agree with the materiality thresholds for application of the automatic access standard and minimum access standard (see Table 4.2)?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

5 Further proposals from AEMO's rule change request

AEMO's rule change request contains several further proposals for improving the NEM access standards contained within the NER. These proposals are considered in this chapter:

- Section 5.1 addresses the proposal to allow for the ramp down of loads to facilitate under-frequency load shedding.
- Section 5.2 addresses the proposal to clarify and restrict the scope of credible contingency events in relation to the AAS and MAS for disturbance ride-through capability of schedule 5.2 plant.
- Section 5.3 addresses the proposal for testing and commissioning of non-registered schedule 5 participants.
- Section 5.4 addresses the proposal for an extension of time for complex issues in future access standard reviews.

5.1 Proposal for under-frequency ramp down of large loads

Under Frequency Load Shedding (UFLS) schemes are emergency mechanisms designed to mitigate the risk of power system collapse following multiple non-credible contingency events.

UFLS schemes typically consist of a series of relays linked to circuit breakers, which progressively disconnect load blocks in response to a frequency drop.[158] This disconnection occurs in a coordinated and automatic manner that is designed to arrest frequency drop and prevent the system from collapsing completely.[159] Due to the granularity of most load blocks, it is possible that more load will be shed than was specified by AEMO, but the transmission network service provider (TNSP) must use best endeavours to minimise any load shed in excess of the amount directed.[160]

AEMO, participating jurisdictions, and NSPs each have roles and responsibilities.

- **Jurisdictions**: Each participating jurisdiction must provide AEMO with a schedule of sensitive loads in that jurisdiction which specifies the priority of those loads. For all other loads that may be shed by AEMO, the participating jurisdiction must also set these out in a schedule.[161]
- **AEMO**: AEMO is responsible for maintaining load shedding procedures for each participating jurisdiction.[162] If required to maintain power system security, AEMO will issue a direction to a relevant TNSP to manually interrupt load, and subsequently to restore load, under sections 115 and 116 of the NEL. These directions are clause 4.8.9 instructions under the NER.[163]
- **TNSPs**: TNSPs are responsible for developing and reviewing Load Shedding Plans, which are used when shedding loads within its transmission network and connected distributed networks. These must be consistent with AEMO's load shedding procedures and Manual Load Shedding Standard, and priority schedules set by participating jurisdictions.[164] A TNSP must use its Load Shedding Plan when directed by AEMO to shed or restore load.

AEMO's rule change request proposes allowing load shedding through fast ramp down, as opposed to disconnection in blocks. They consider this can provide greater flexibility to meet

158 'Load blocks' are stipulated in each jurisdiction's schedule. For more information see AEMO, Manual Load Shedding Standard, 2 August 2019, p 6.
159 AEMO website, Under Frequency Load Shedding.
160 AEMO, Manual Load Shedding Standard, 2 August 2019, p 6.
161 NER clause 4.3.2(f).
162 NER clause 4.3.2(h).
163 AEMO, Manual Load Shedding Standard, 2 August 2019, pp 5-6.
164 AEMO, Manual Load Shedding Standard, 2 August 2019, pp 5-6.

power system needs more efficiently, potentially avoiding more widespread load shedding and providing potential benefits to those users by limiting the amount of their load reduction where feasible.[165]

5.1.1 Current arrangements

Under clause S5.3.10, market customers who are registered with AEMO and have an expected peak demand above 10MW must provide automatic interruptible load in accordance with clause 4.3.5. Interruptible load is "a load which is able to be disconnected, either manually or automatically initiated, which is provided for the restoration or control of the power system frequency by AEMO to cater for contingency events or shortages of supply".[166]

The level of automatic interruptible load must be a minimum of 60% of their expected demand, or such other minimum interruptible load level as may be periodically determined by the Panel, to be progressively automatically disconnected following the occurrence of a power system under-frequency condition described in the power system security standards.[167]

Load shedding procedures may be applied or determined in accordance with AEMO's and participating jurisdictions' procedures mentioned above.[168]

5.1.2 The issue

Although the definition of load shedding refers to the reduction or disconnection of load, the NER currently only contemplates the provision of load shedding by disconnection in blocks. Some loads may be more flexible with the ability to ramp down their load in an emergency rather than disconnection. AEMO considers this can provide greater flexibility to meet power system needs more efficiently, potentially avoiding more widespread load shedding and providing potential benefits to those users by limiting the amount of their load reduction where feasible.[169]

5.1.3 Proposed solution

To facilitate the ability to ramp down load, AEMO proposes several amendments to the NER:[170]

- Amend clause S.5.3.10 to allow for the provision of interruptible load by way of fast ramp down, in addition to the capability to disconnect load blocks during an under frequency event, with the performance standards to record the nature of the capability and quantities and rates of fast ramp down capability where applicable.
- Amend clause 4.3.5 and the definitions of interruptible load and load shedding to be consistent with the potential for fast ramp down capability as well as disconnection, and to make those provisions consistent with each other.

Collectively, AEMO suggests these amendments would allow for a ramp down response where the capability exists, and for the performance standards to record the associated parameters.

AEMO notes that disconnection capability would still be required for interruptible load that has fast ramp-down capability, as it is possible that rate of change of frequency (RoCoF) conditions may be such that ramp down is not sufficient for managing under frequency events.[171]

165 AEMO rule change request overview, 4 April 2024, p 71.
166 NER clause S5.3.10.
167 NER clause 4.3.5.
168 NER clause S5.3.10.
169 AEMO rule change request overview, 4 April 2024, p 71.
170 Ibid., pp 71-72.
171 Ibid., pp 71-72.

Question 10: Under-frequency ramp down of large loads

In relation to AEMO's proposed changes to amend the NER to facilitate the ability for loads to ramp down:

1. Do stakeholders agree some loads may be more flexible with the ability to ramp down their load in an emergency rather than disconnecting in blocks?
2. Do stakeholders agree that the NER should be amended to allow for the provision of interruptible load by way of fast ramp down?
3. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

5.2 Clarification of credible contingency definition for disturbance ride through

The ability for the power system to withstand disturbances caused by unplanned events during operational timeframes is a key component of power system security. The NER uses the concept of a 'contingency event' to refer to such unplanned events that could result in a sudden and unplanned change to the level of output, consumption or power flow as a result of the failure or removal from operational service of plant — such as network or generation assets and equipment.[172]

AEMO is required to manage the power system to remain in a secure operating state, such that it is able to withstand a single credible contingency event and return to a satisfactory operating state following such an event.[173] A 'credible contingency event' is defined as an event that AEMO considers is reasonably possible in the surrounding circumstances.[174] Further, AEMO's Power System Security Guidelines provides guidance on AEMO's contingency management.[175]

In support of AEMO's high level system security responsibility, it is important that power system equipment is able to maintain continuous uninterrupted operation as a result of disturbances caused by credible contingency events.

AEMO's rule change request proposes to amend the NER to clarify the types of contingency events that a schedule 5.2 plant — generating system and IRS — must be able to ride through. Under the proposed rule, a schedule 5.2 plant would be required to ride through any disturbance caused by:

- credible contingency events used by the NSP for its network planning purposes, or
- non-credible contingency events specified by AEMO that are routinely expected to be reclassified as credible contingency events.

AEMO proposes that the NSP would be required to provide information to the connection applicant about these contingency events which it would be required to have the capability to ride through.[176]. This outcome would be supported by the general requirement for the NSP to provide a connection applicant with technical information about "any other matters that AEMO or a Network

172 NER clause 4.2.3(a).
173 NER clause 4.2.4.
174 NER clause 4.2.3.
175 AEMO, Power System Security Guidelines v 105, 3 June 2024, Section 7.
176 AEMO rule change request overview, 4 April 2024, p.46

Service Provider may specify, nominate or require" as set out under the proposed new clause S5.2.4(e1)(1C) in the Package 1 draft rule.[177]

5.2.1 Current arrangements

Under the NER, generating systems and IRS (schedule 5.2 plant) must remain in continuous uninterrupted operation (CUO) for any disturbance caused by a credible contingency event.[178] However, the *Enhancing operational resilience in relation to indistinct events* rule expanded the definition of 'contingency event' and the scope of the reclassification criteria, giving AEMO more discretion to reclassify non-credible contingencies as credible during abnormal conditions, based on its assessment of the risks to system security.[179] Clause 4.2.3A of the NER sets out the framework for reclassifying contingency events in response to abnormal conditions such as severe weather conditions, lightning, storms and bush fire. In accordance with clause 4.2.3B, AEMO publishes the criteria for reclassifying contingency events in the Power System Security Guidelines.[180]

At the same time, clause S5.2.5.5 requires that generating systems and IRS are required to remain in CUO for any power system disturbance caused by a credible contingency event.

5.2.2 The issue

AEMO's rule change request identifies that for the purposes of establishing a performance standard, there is no fixed limit on the size of any resulting disturbance that the connected plant must ride through, as what constitutes a credible contingency can be different at any point in time. This means that the reclassification arrangements under the NER contribute to uncertainty around the types of disturbances for which a schedule 5.2 plant must remain in CUO.[181]

This is due to the difficulty in predicting all possible non-credible contingency events that may be reclassified as credible contingencies. AEMO considers that this uncertainty contributes to a potential compliance risk for connection applicants and a lack of transparency for power system operation, given that ride-through capability is not infinite.[182]

5.2.3 The proposed solution

AEMO proposes amending the NER to clarify and restrict the scope of credible contingency events in relation to the AAS and MAS for disturbance ride through capability of schedule 5.2 plant. The proposed rule would amend clause S5.2.5.5 to limit the scope of a credible contingency event to:

- Credible contingency events used by the NSP for its network planning under clause S5.1.2.1
- Non-credible contingency events specified by AEMO that are routinely expected to be reclassified as credible contingency events under clause 4.2.3A in reasonably anticipated abnormal conditions, and are likely to cause a significant disturbance at the schedule 5.2 plant's connection point.

This change would improve the transparency of what constitutes a credible contingency in relation to the disturbance ride-through capability requirement for schedule 5.2 plant.

177 See clause S5.2.4(e1)(1C) of the draft rule for AEMC, *Improving the NEM access standards - Package 1*, 5 December 2025.
178 NER clause S5.2.5.5(c)(1).
179 AEMC, *Enhancing operational resilience in relation to indistinct events*, Final determination and rule, 3 March 2022.
180 AEMO, Power System Security Guidelines SO_OP_3715, 3 June 2024, Section 7.
181 AEMO rule change request overview, 4 April 2024, p 45.
182 Ibid.

AEMO proposes that the NSP would provide a connection applicant with relevant information about credible contingency events in accordance with a new general requirement set out under clause S5.2.4(e1)(1C) of the Package 1 draft rule.[183] AEMO's view is that this would require an "NSP to provide a connection applicant with information about any other matters (which would include about reclassified events) that either it or AEMO may need to specify, nominate or require for the purposes of any access standard, sufficient to cover information about credible contingency events."[184]

Question 11: Clarification of credible contingency definition for disturbance ride-through

In relation to AEMO's proposed changes to amend clause S5.2.5.5 of the NER to clarify the scope of contingency events that a schedule 5.2 plant must be able to ride through:

1. Do stakeholders agree that the current definition for the types of credible contingencies in relation to disturbance ride-through requirements for schedule 5.2 plant is unbounded/implied to be unbounded and that this presents an issue?
2. Do stakeholders agree that arrangements poorly define the types of credible contingencies in relation to disturbance ride-through requirements for schedule 5.2 plant?
3. Do stakeholders support AEMO's proposed rule to clarify the types of contingency events that a schedule 5.2 plant must be able to ride through?
4. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

5.3 Testing and commissioning of non-registered schedule 5 participants

Under the NER, AEMO, an NSP or a registered participant may request testing of other registered equipment to verify compliance with the NER performance standards as recorded in a participant's connection agreement.[185] AEMO proposes a number of changes to the NER to reflect the revised terminology of 'schedule 5 participant' and extend this 'right of testing' to also apply to non-registered power system equipment. AEMO considers that the extension of these testing arrangements to non-registered plant addresses the potential that these plant could have an adverse impact on the power system due to non-compliance with an agreed performance standard.[186]

The Commission notes that the definition and scope of schedule 5 participants is under active consideration through the Package 1 rule change process. The Commission published a draft determination and draft rule on 5 December 2024 that would amend the access standards to apply them by plant type rather than by the registration category, which relates to the owner or operator of the plant, as is the case currently. Under the draft rule:[187]

- Schedule 5.2 would apply to all generating systems, IRS and synchronous condenser systems (collectively known as schedule 5.2 plant).

183 See clause S5.2.4(e1)(1C) of the draft rule for AEMC, *Improving the NEM access standards - Package 1*, 5 December 2025.

184 AEMO rule change request overview, 4 April 2024, p 46.

185 NER clause 5.7.2.

186 AEMO rule change request overview, 4 April 2024, p 25; The Commission also notes that non-registered plant (e.g. loads) can still be subject to performance standards as a condition for connection, per a connection between the NSP and connecting applicant.

187 AEMC, *Improving the NEM access standards - Package 1*, Draft determination, 5 December 2025, p iii.

- Schedule 5.3 would apply to all plant that consume electricity from a network, including a distribution network or a source of load within an IRS (collectively known as schedule 5.3 plant).
- Schedule 5.3a would apply to any HVDC system with a power transfer capability of 5 MW or more (known as schedule 5.3a plant).
- The persons to which the obligations apply would be captured by new definitions of Schedule 5.2 Participant, Schedule 5.3 Participant and Schedule 5.3a Participant.

A final determination and final rule for the Package 1 rule change is expected to be published on 22 May 2025.

5.3.1 Current arrangements

Under the NER, a registered participant may request testing of plant owned or operated by another registered participant if it becomes aware of an adverse impact that is believed to be caused by that plant due to a potential non-compliance with the NER or a connection agreement. [188] This is referred to as the 'right of testing'. The Commission understands that this right of testing is usually exercised by an NSP during the process for connection and commissioning of new registered schedule 5 plant, including generators and IRPs, customer load and MNSPs (HVDC transmission).

The NER also sets out that the costs of this compliance testing be borne by the requesting party where the results demonstrate that the participant's plant meets the relevant requirement and that the costs be borne by the owner of the respective equipment where the results demonstrate non-compliance.[189]

Similarly, clause 5.7.3(a) of the NER sets out the requirements for connecting parties to provide evidence to the relevant NSP and AEMO to demonstrate compliance with the performance standards set out in their connection agreement. Clause 5.7.3(d) then allows for AEMO to request testing of a generator or IRP if it believes that the relevant plant does not meet one or more of the applicable performance standards.

5.3.2 The issue

AEMO considers that registered and non-registered plant covered by schedule 5.2, 5.3, and 5.3a can, by nature, adversely impact the operation of other power system equipment. While the NER provides a framework for compliance testing of registered plant, this does not yet extend to allow for testing of non-registered plant. AEMO considers that non-registered plant have the potential to adversely impact the power system and as such, the right of testing should be extended to cover these types of plant.[190]

5.3.3 Proposed solution

AEMO proposes changes to the NER to revise the existing frameworks to reflect the proposed revised terminology referring to 'schedule 5' plant consistent with the Package 1 draft rule. AEMO also proposes changes to enable testing of non-registered schedule 5 plant to be requested in a similar manner to the approach for the right of testing of registered schedule 5 plant, including as part of commissioning. The proposed changes include amending:

188 NER clause 5.7.2.
189 NER clauses 5.7.2(d) and 5.7.3(d).
190 AEMO rule change request overview, 4 April 2024, p 25.

- Clause 5.7.2 to extend mutual rights to request testing of non-registered schedule 5 Participants, and require them to comply with a request for testing on plant. In practice, the performance standards for schedule 5 plant may include any requirements under schedule 5.2, 5.3 and 5.3a subject to the discretion of the NSP as documented in the connection agreement.[191]
- Clause 5.7.3 to revise the existing arrangements for AEMO to request compliance tests for registered participants to cover any category of schedule 5 registered participants consistent with the definition and scope of a schedule 5 participant set out in the Package 1 draft rule.
- Clause 5.7.3(d) to (f) to extend AEMO's power to request compliance testing for AEMO advisory performance standards to both registered and non-registered schedule 5 participants.

AEMO also proposes to extend the commissioning requirements set out under clauses 5.8.2, 5.8.4 and 5.8.5 to schedule 5 Participants who are not registered participants by the addition of a new clause 5.8.1A. This would mean that a non-registered schedule 5 participant with a maximum capacity equal to or greater than 30MW of 30MVA would be required to coordinate its commissioning procedures through cooperation with the relevant NSP and AEMO, unless AEMO agrees not to apply this requirement.

5.3.4 Enforceability and compliance considerations

The Commission notes there may be enforceability and compliance considerations that would stem from AEMO's proposal to extend the commissioning requirements set out under clauses 5.8.2, 5.8.4 and 5.8.5 to 'schedule 5 participants' who are not registered participants.[192]

Specifically, given the increasing number of proposed responsibilities and obligations to be placed on non-registered schedule 5 participants, it may be appropriate to expand the scope of rule 4.15 of the NER, pertaining to compliance with performance standards. Rule 4.15 currently only applies to registered participants and requires them to ensure that their plant meets or exceeds applicable performance standards, ensure the plant is not likely to cause a material adverse effect on power system security, and maintain a compliance program (among other things).[193]

Further, it may be desirable to extend rule 4.14 of the NER to all 'schedule 5 participants' who are not registered participants. This rule currently requires AEMO to establish and maintain a register of the performance standards applicable to plants as advised by registered participants. It is also noted that the AER may request AEMO to provide an up-to-date copy of this register to enable the AER to perform or exercise its compliance and enforceability functions.[194] Including non-registered participants could appropriately recognise their increasing impact on power system security and the need to mitigate any potential adverse impacts.

191 AEMC, *Improving the NEM access standards - Package 1*, Draft rule, 5 December 2024, clauses S1.2.1, S5.3.1a, S5.3a.1a.
192 This is set out in AEMC, *Improving the NEM access standards - Package 1*, Draft determination, 5 December 2025, p.iii.
193 NER clause 4.15(a)-(q).
194 NER clause 4.14(n1)-(n2).

Question 12: Testing and commissioning

1. Do stakeholders support AEMO's proposed amendments to clause 5.7.3 to refer to schedule 5 plant in respect of AEMO's ability to request compliance tests for registered plant?
2. Do stakeholders support AEMO's proposed changes to clauses 5.7.2 and 5.7.3 to extend the rights for testing of power system plant to apply to non-registered schedule 5 plant?
3. Do stakeholders support AEMO's proposed changes to the NER to extend the requirement for coordinating commissioning procedures for non-registered schedule 5 plants with a maximum capacity equal to or greater than 30MW of 30MVA?
4. Should the Commission consider extending enforceability and compliance requirements under rules 4.14 and 4.15 to all 'schedule 5 participants', which includes non-registered participants?
5. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning.

5.4 Proposal for extension of time for complex issues in future access standards reviews

As discussed in section 1.1, AEMO must periodically review some or all of the technical requirements set out in schedules 5.2, 5.3, and 5.3a of the NER to assess whether they need amending.[195] Pursuant to clause 5.2.6A of the NER, AEMO is required to complete each review within 12 months of publishing the approach paper.

While conducting their first Access Standards Review, AEMO observed that this 12-month time limit can inhibit the necessary analysis and consultation needed to develop fit-for-purpose rule change proposals that give effect to the review criteria.[196] This is because the reviews require a large volume of matters to be evaluated, many of which are highly technical and require extensive consultation. For instance, AEMO explained they were unable to develop a final position on some matters given their complexity, which will now be considered as part of AEMO's Large Loads Review.[197]

5.4.1 Proposed rule

To ensure there is sufficient time to review complex issues, AEMO proposes amending clause 5.2.6A of the NER to include a provision that allows for extending the timeframe for certain matters.[198] This would also require AEMO to publish a notice prior to the 12-month time limit coming to an end, with reasons for any such extension, noting the timeframe is insufficient given the complexity or difficulty of the matters under consideration or a material change in circumstances. Further, the notice must specify the new date for publication of the final report.[199]

AEMO considers this proposal to be in alignment with similar provisions in rule 8.9 of the NER regarding an extension of consultation timeframes under the rules consultation procedure. Clause 8.9.2 provides:

195 See section 1.1 for more information on AEMO's requirement to review the access standards once every five years.
196 AEMO rule change request overview, 4 April 2024, p 75; See NER clause 5.2.6A(a)(1)-(4) which sets out the criteria for AEMO's reviews.
197 For more information, see section 1.6.
198 AEMO rule change request overview, 4 April 2024, p 75.
199 See AEMO rule change request, proposed rule drafting, p 26 (proposed amended clause 5.2.6A(f)-(g)).

> **(d)** The consulting party may extend the time limit for publishing a draft or final report under paragraphs (b) or (c), by publishing a notice before the expiry of the relevant time limit, if the consulting party considers an extension is necessary because:
>
> > **(1)** the Proposal involves issues of sufficient complexity or difficulty; or
> >
> > **(2)** there is a material change in circumstances.
>
> **(e)** The notice under paragraph (d) must specify the new date for publication of the draft or final report (as applicable), the reasons for the extension of time, and any further consultation the consulting party proposes to undertake in accordance with clause 8.9.1(l).

By allowing for this flexibility in the NER, AEMO believes it could better consider the complexity of the issues, the pace of the transition to net zero, and the evolution of technologies and services, and also engage in more fulsome stakeholder engagement.[200]

Question 13: Extension of time for complex issues in future access standards reviews

In relation to AEMO's proposal to amend clause 5.2.6A of the NER to allow flexibility for extending the time limit for completing each review:

1. Do stakeholders agree that the requirement to complete each review within 12 months of the approach paper being published is too inflexible or may inhibit proper analysis and consultation?
2. Do stakeholders consider that AEMO should be responsible for setting a new date for publication of the final report? Is there an alternative approach that would better address the issue?
3. Do stakeholders agree that AEMO should publish a notice when an extension is needed, outlining the reasons as they may relate to complexity/difficulty, or a material change in circumstances?
4. Do stakeholders have any concerns or suggestions in relation to this element of AEMO's proposed rule? If so, please describe your concerns and any related suggestions and reasoning?

200 AEMO rule change request overview, 4 April 2024, p 75.

6 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

We would like your feedback on the proposed assessment framework.

6.1 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.[201]

The NEO is:[202]

> 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; and
>
> (c) the achievement of targets set by a participating jurisdiction—
>
> (i) for reducing Australia's greenhouse gas emissions; or
>
> (ii) that are likely to contribute to reducing Australia's greenhouse gas emissions.

The targets statement, available on the AEMC website, lists the emissions reduction targets to be considered, as a minimum, in having regard to the NEO.[203]

6.2 We propose using three criteria to assess the rule change against the NEO

6.2.1 Our regulatory impact analysis methodology

Considering the NEO and the issues raised in the rule change request, the Commission proposes to assess this rule change request against the set of criteria outlined below. These assessment criteria reflect the key potential impacts – costs and benefits – of the rule change request. We consider these impacts within the framework of the NEO.

The Commission's regulatory impact analysis may use qualitative and/or quantitative methodologies. The depth of analysis will be commensurate with the potential impacts of the proposed rule change. We may refine the regulatory impact analysis methodology as this rule change progresses, including in response to stakeholder submissions.

201 Section 88 of the NEL.
202 Section 7 of the NEL.
203 Section 32A(5) of the NEL.

Consistent with good regulatory practice, we also assess other viable policy options — including not making the proposed rule (a business-as-usual scenario) and making a more preferable rule — using the same set of assessment criteria and impact analysis methodology where feasible.

6.2.2 Assessment criteria and rationale

The proposed assessment criteria and rationale for each is as follows:

- **Safety, security and reliability** — This criterion was selected to consider the safe, reliable, and secure operation of the power system at least cost. The operational security of the power system depends on whether the connecting plant and equipment can operate within the technical access standards contained in the NER and not present significant system security risks. Improving access standards can ensure alignment with safe, secure and reliable system performance and improve power system resilience.
- **Innovation and flexibility** — This criterion was selected because innovation and flexibility are important principles to utilise when improving the NEM access standards contained in the NER. This is true both from the perspective of process innovations and innovations in finding solutions to system security issues uncovered through the application of the access standards to network user customers.
- **Implementation considerations** — This criterion was selected to assess what implementation considerations may arise from the proposals. This includes timing, interrelationships with other reforms and processes, as well as benefits or adverse consequences to industry and consumers. Further, we consider that the cost and complexity of implementation and ongoing regulatory and administrative costs to all market bodies, participants and consumers must be balanced. This includes being clear on the roles of market bodies and participants, supporting efficient investment and operational decisions, and promoting transparency and predictability.

Question 14: Assessment framework

Do you agree with the proposed assessment criteria? Are there additional criteria that the Commission should consider or criteria included here that are not relevant?

6.3 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[204]
- 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 change request, the more preferable rule is likely to better contribute to the achievement of the NEO.[205]

204 The proponent sets out its proposed rule in Attachment C of its rule change request.
205 Section 91A of the NEL.

6.4 We are considering whether the proposed rule should apply in the Northern Territory

Parts of the NER, as amended from time to time, apply in the Northern Territory, subject to modifications set out in regulations made under the Northern Territory legislation adopting the NEL.[206]

The proposed rule may apply in the Northern Territory as there may be changes to chapter 10 of the NER and consequential changes that the Commission will need to consider.[207] Consequently, the Commission will assess the proposed rule against additional elements required by the Northern Territory legislation. We welcome feedback from stakeholders to this effect.

206 National Electricity (Northern Territory) (National Uniform Legislation) Act 2015 (**NT Act**). The regulations under the NT Act are the National Electricity (Northern Territory) (National Uniform Legislation) (Modification) Regulations 2016.

207 Under the NT Act and its regulations, only certain parts of the NER have been adopted in the Northern Territory. The version of the NER that applies in the Northern Territory is available on the AEMC website at: https://energy-rules.aemc.gov.au/ntner.

Abbreviations and defined terms

AC	Alternating current
Access standards	Technical requirements for connection to the NEM contained in chapter 5 of the NER
Access Standards Review	AEMO review of technical requirements for connection (NER clause 5.2.6A), April 2024
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AI	Artificial intelligence
AAS	Automatic access standard
CER	Consumer energy resources
Commission	See AEMC
CUO	Continuous uninterrupted operation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DNSP	Distribution network service provider
ECMC	Energy and Climate Change Ministerial Council
GFM	Grid-forming
HVDC	High-voltage direct current
IBL	Inverter-based load
IBR	Inverter-based resources
IRP	Integrated resource provider
IRS	Integrated resource systems
kV	Kilovolts
Large Loads Review	AEMO's schedule 5.3 large loads access standards review
MAS	Minimum access standard
MNSP	Market network service provider
MVA	Megavolt-amperes
MW	Megawatts
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
NERC	North American Electric Reliability Corporation
NSP	Network service provider
Package 1	*Improving the NEM access standards - Package 1* (rule change request from AEMO)
Package 2	*Improving the NEM access standards - Package 2* (rule change request from AEMO)
Proponent	The proponent(s) of the rule change request, being AEMO and Rod Hughes

	Consulting
Panel	Reliability Panel
RoCoF	Rate of change of frequency
SSIAG	AEMO's System Strength Impact Assessment Guidelines
TNSP	Transmission Network Service Provider
UFLS	Under Frequency Load Shedding
UPS	Uninterruptible power supply

A Package 1 draft rule changes to scope and application relevant to this rule change request

The Commission's draft rule for Package 1 proposes several changes to the access standards application framework so that they would apply based on the type of plant that is connecting, rather than the registration status of the owner or operator. These changes, if made, would have implications which will need to be considered in this Package 2 rule change request with respect to the scope and application of the access standards framework.

AEMO's rule change request noted that the access standards in the NER are expressed as obligations on specified types of registered participant.[208] However, we recognise that the application of access standards by the type of registration category means that there can be situations where equivalent plant do not face equivalent technical requirements and obligations. Without consistent obligations, these plant could interact with the power system in a way that may cause damage to the network or to other plant, which degrades power system resilience and performance.

Accordingly, in Package 1, the Commission's draft determination agreed with AEMO's proposal to amend the access standards application framework so that they would apply based on the type of plant that is connecting rather than the registration status of the owner or operator.

Table A.1 below summarises the proposed changes to the application of each schedule under the Package 1 draft rule and explains the definition of schedule 5.2/5.3/5.3a plant and participants.

Table A.1: Proposed changes to the access standard application framework under the Package 1 draft rule

Schedule	Plant covered by the schedule	The schedule would apply to these persons
Schedule 5.2	• generating systems • integrated resource systems (loads in an integrated resource system not essential to the operation of the system would be schedule 5.3 plant instead) • synchronous condenser systems	*Schedule 5.2 Participants* — that is: • any Connection Applicant who is, or intends to be, a Registered Participant for a schedule 5.2 plant • any Connection Applicant who has appointed, or intends to appoint, an intermediary for that schedule 5.2 plant • any Connection Applicant who has received, or intends to apply for, an exemption from registering as a Generator or Integrated Resource Provider, or who is entitled to an automatic exemption (but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users) • any Connection Applicant or NSP for a stand-alone synchronous condenser that 5 MVA or more • any other Connection Applicant in respect of a standalone synchronous condenser system, but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users

208 AEMO rule change request overview, 4 April 2024, p 20.

Schedule	Plant covered by the schedule	The schedule would apply to these persons
Schedule 5.3	• loads, both standalone and part of an integrated resource system • distribution networks	*Schedule 5.3 Participants* — that is: • any Connection Applicant who is, or intends to be, a Registered Participant for a schedule 5.3 plant, or who wishes to connect to a transmission network • any Connection Applicant who has appointed, or intends to appoint, an intermediary for that schedule 5.3 plant • any other Connection Applicant for schedule 5.3 plant, but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users
Schedule 5.3a	• HVDC links	*Schedule 5.3a Participants* — that is: • any person who is, or intends to be, the MNSP for an HVDC link • any NSP (or person exempted from the requirement to register as an NSP) whose HVDC link is, or will be, interfaced only with its own AC network or connected to the AC network of another NSP

Source: AEMC, *Improving the NEM access standards - Package 1*, Draft determination, pp 14-15.

This table is provided to aid stakeholders in understanding the Package 1 draft rule. See the draft amending rule from Package 1 for more information on these definitions.

Further proposals as set out in the draft rule for *Improving the NEM access standards - Package 1* that may also be considered in this rule change request include:[209]

- **clauses S5.2.5.7, S5.2.5.8, S5.2.5.13:** Exempt smaller plant from certain requirements in these clauses
- **clause S5.2.5.4:** Allow the point of application to be at the electrically closest 66kV or more location upon agreement between the NSP and AEMO in the NAS
- **clause S5.2.5.5:** Introduce multiple fault ride-through requirements for large loads, including defining the end of a disturbance, specifying the minimum fault level for tuning and CUO exemption when fault level falls below plant tuning minimum
- **clause S5.2.5.8:** Strengthen and streamline emergency over-frequency response, including requiring a frequency drop response to be preferred over disconnection
- **clause S5.2.5.8:** Require protection settings to maximise capability to ride through disturbances
- **clause S5.2.5.10:** Require instability detection systems and the ability to send detection data to NSPs and AEMO
- **clause S5.2.5.13:** Several changes to voltage control requirements.

The Commission will take into account the potential overlaps or consequences of these proposed amendments, as they may relate to this rule change request. The Commission is considering stakeholder feedback to the Package 1 draft determination, and will publish a final determination and rule on 22 May 2025.

209 AEMC, *Improving the NEM access standards - Package 1*, Draft determination, 5 December 2025.