AEMC

RULE

Australian Energy Market Commission

RULE DETERMINATION

NATIONAL ELECTRICITY AMENDMENT (EFFICIENT MANAGEMENT OF SYSTEM STRENGTH ON THE POWER SYSTEM) RULE 2021

PROPONENT

TransGrid

21 OCTOBER 2021

INQUIRIES

Australian Energy Market Commission
GPO Box 2603
Sydney NSW 2000

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

Reference: ERC0300

CITATION

AEMC, Efficient management of system strength on the power system, Rule determination, 21 October 2021

ABOUT THE AEMC

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

SUMMARY

1 The Australian Energy Market Commission (AEMC or the Commission) has made a final determination for a more preferable rule (final rule) for the efficient provision of system strength. The final rule evolves the current system strength framework in the National Electricity Rules (NER) lowering costs to consumers of providing system strength.

2 This reform seeks to make changes to the NER that facilitate simpler, faster and more predictable connections to the grid for new generators, such as renewables and batteries. It also supports secure connections that keep the power system stable into the future so new cheaper and cleaner sources of energy can get their energy to market and costly interventions in the market are minimised.

3 The final rule is an important and enduring response to the significant transformation occurring in the power system with decarbonisation occurring at a rapid rate. This changing generation mix is increasing the demand for essential system services, such as system strength. System strength has traditionally been supplied by large, synchronous units and now these units are now operating less. In addition, there is growing demand for system strength from the increasing proportion of non-synchronous, inverter based resources (IBR) in the NEM.

4 System strength relates to the stability of the voltage waveform. Along with frequency, voltage is a core electrical quality that must be maintained for a stable power system. A smooth, consistent and predictable voltage waveform is critical to the power system's voltage remaining within the parameters required for a safe transfer of energy from generators to consumers. A strong system with a stable voltage is particularly important for supporting the decarbonisation of the power sector that is currently underway.

5 This is the context that TransGrid submitted its rule change request to Maintain adequate levels of system strength. System strength is an important component of system security which needs to be maintained in order to support the transition to these new forms of generation.

6 The Commission's *Investigation of system strength frameworks in the NEM* and TransGrid's rule change request both recognised the current framework was not keeping pace with the power system transition. The current 'do no harm' obligation requires each connection to assess its impact on the local network's system strength levels and self-remediate any adverse impacts. Through this rule change process, the Commission considered this approach was too reactive and uncoordinated and did not deliver the amounts of system strength required.

7 This is of concern because inadequate levels of system strength can lead to higher costs for consumers through delays in the generator connection process as well as the Australian Energy Market Operator (AEMO) having to regularly intervene in the National Electricity Market (NEM) to maintain system security. These delays contribute to higher wholesale energy prices and consequently higher electricity bills for consumers. The final rule looks to efficiently supply system strength to the market and to evolve the 'do no harm' arrangement,

to minimise these regular interventions and delays to connections and deliver lower costs for consumers.

8 This rule forms part of the AEMC's system security program of rule changes for designing how the power system can continue to operate securely and efficiently during and after the transition to renewables and batteries. These rule changes dovetail with the Energy Security Board's Post 2025 redesign of the national electricity market. A key aspect of this work considered how to best provide four essential services needed to keep the lights on: system strength, frequency control, inertia and operating reserves.

9 This work is transforming the way that system security is procured and charged for in the NEM. The final rule consists of a deliberate set of design choices that seek to meet the challenges of the NEM's world-leading uptake of renewables and batteries. It is an example of the way the Commission is designing frameworks that practically support the power system delivering efficient outcomes through the transition and beyond.

The final rule has three components

10 The final rule evolves the existing system strength framework by implementing three broad components relating to the supply, demand and coordination of system strength. Together these should result in a more secure power system, easier and faster connections to the grid, and lower costs for consumers.

11 The rule seeks to increase the supply of system strength, while minimising the demand that connecting parties have on system strength services. It also seeks to coordinate these through providing efficient locational and technological signals to connecting parties. This aspect of the rule ensures that the costs are shared and the risks are appropriately allocated.

Aspects of the rule that maximise supply of system strength

12 The rule introduces a new obligation on transmission networks to provide the right amount of system strength to support the connection of intverter based resources (IBR) as forecast by AEMO. The new system strength standard must be met by a subset of Transmission Network Service providers (TNSPs), known as system strength service providers (SSS Providers). It requires SSS Providers — being TasNetworks, TransGrid, Powerlink, AEMO and ElectraNet — to use reasonable endeavours to plan system strength services to meet AEMO's:[1]

- forecast of future IBR connections for each system strength node
- the three-phase fault level required for a secure system at each node.

13 SSS Providers must determine what services they need to procure to meet the standard. These services may include building new network infrastructure, such as synchronous condensers, or contracting with existing synchronous generators. It is important to note that SSS Providers cannot plan to meet the standard through the use of constraints or disconnections. However, in the operational timeframe, it may be more appropriate to apply constraints to relevant generators to maintain system security when the solutions procured by the SSS Provider under the standard are exhausted.

1 These are determined by AEMO in its system strength report in accordance with the system strength requirements methodology.

14 While the final rule requires SSS Providers to use best endeavours to meet the planning standard in the investment timeframe, the solutions they procure can be operated in accordance with the real time market conditions. For example, in the case of planned outages, it may be more efficient to use constraints than to obtain further system strength services to cover the period. Therefore, the final rule does not preclude the use of disconnections or constraints in the operational timeframe, which generators may still face going forward given real-time operational considerations, but the use of these should be less than occurs currently.

Aspects of the rule that minimise demand for system strength

15 The final rule introduces two new access standards for generators and one for market network service providers (MNSPs) and certain loads who connect under Chapter 5 of the NER. This includes large controllable loads like hydrogen electrolysers, and generators such as utility-scale solar and wind farms and batteries. The access standards provide minimum standards relating to short circuit ratio and voltage phase shift angles and provide for the maximum amount of system strength that these connecting parties can demand from the system. Essentially this helps to make sure system strength is used efficiently which reduces overall demand and minimises the costs associated with its supply.

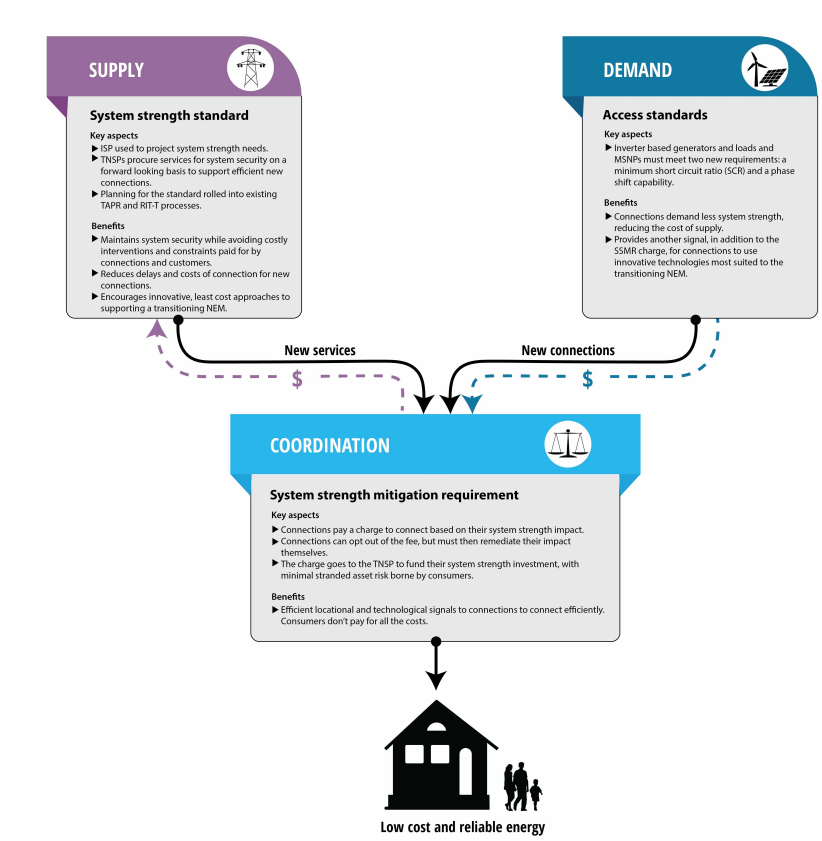
Coordination of the supply and demand side aspects of the rule

16 The final rule introduces a new way of charging for system strength, giving generators and certain large loads a choice to pay to use system strength services offered by transmission networks or to provide their own system strength. The system strength mitigation requirement (SSMR) evolves and expands the current 'do no harm' arrangements. It includes the option for new connections to pay a charge to avoid having to undergo a full impact assessment and the associated remediation obligations. This is a new and different avenue to obtaining compliance with NER clause 5.3.4B.

17 Through paying the system strength charge, connecting parties will continue to share the costs of system strength with customers. However, the final rule also helps to minimise system strength costs overall through building in incentives that limit demand for system strength services to be procured.

18 The charge is designed to reflect the system strength costs that a connecting party would impose on the system. Through the charge the connecting party is incentivised to reduce its impact. It can do that by full or partial remediation or choosing to locate in a part of the grid where it would face a lower charge, due to there being higher levels of system strength.

Figure 1: Overview of evolved system strength framework



Source: AEMC

The final rule's design has been informed by a robust and collaborative process

19 In making the final rule the Commission considered 75 stakeholder submissions arising from the consultation paper and draft determination processes, held ten technical working group sessions and a public forum and numerous stakeholder meetings.

20 The following assessment criteria have guided the design of the final rule:

- **Promoting power system security:** Having regard to the potential benefits associated with improvements to system security brought about by the proposed rule changes, weighed against the likely costs including both implementation and ongoing costs.
- **Appropriate risk allocation**: The allocation of risks and the accountability for investment and operational decisions should rest with those parties best placed to manage them.
- **Technology neutrality:** Regulatory arrangements should be designed to take into account the full range of potential market and network solutions.

- **Flexibility:** Regulatory arrangements must be flexible to changing market and external conditions.
- **Transparency, predictability and simplicity:** The market and regulatory arrangements for system strength should promote transparency and be predictable, so that connecting parties can make informed and efficient investment and operational decisions.
- **Implementation costs:** Regulatory change typically comes with some implementation costs for regulators, the market operator and/or market participants and are ultimately borne by consumers.

The final rule promotes a secure power system through both increasing supply and decreasing demand for system strength

21 Not having enough system strength can cause major issues for AEMO in managing the security of the system. If there is not enough system strength AEMO must make interventions in the market. These actions include:

- placing significant constraints on (or disconnecting) non-synchronous, IBRs
- directing synchronous coal, gas and hydro generators to keep running.

22 These interventions affect NEM dispatch outcomes and can result in higher costs for consumers.

23 Insufficient system strength can also impact how electricity is supplied because sufficient levels of system strength are also important for supporting the connection of renewable IBRs and by extension, enabling the transition to a decarbonised power system.

24 These problems will be addressed through the establishment of the new prescribed transmission standard in the NER that has SSS Providers planning and procuring the efficient level of system strength (as forecast by AEMO).

25 The final rule promotes the efficient provision of adequate levels of system strength leading to reduced costs for all consumers by:

- **Harnessing economies of scale and scope for system strength supply** through central procurement by SSS Providers which provides for greater coordination and consideration of system strength solutions in aggregate.
- **Having more practical lead times in delivering system strength solutions** where AEMO and the TNSP actively plan for the delivery of efficient levels of system strength, over the long term timeframes that apply to planning for other network services.
- **Setting limits on the demand for system strength** by introducing two new access standard for connecting parties, that set the minimum level of performance into the future. This will act together with the system strength mitigation requirement, which will incentivise connections to minimise their system strength impact efficiently.
- **Including incentives for connecting IBRs to reduce demand for system strength** through a system strength charge that reflects the connection's system

strength impact and encourages reduction of this impact by full or partial remediation or better locational decisions.

These measures promote a secure power system more effectively than the existing framework was able to, with the overall effect of reducing total system costs. Together they represent a shift from the existing emergency stopgap measures, to a forward planned approach. In the immediate horizon, these measures will provide a buffer to support the transitioning power system, and in the longer term the framework is expected to continue to deliver benefits. The centralised procurement of system strength combined with access standards and incentives for connections to minimise their demand for the services, will overtime result in innovations in the use of current technologies, as well as opportunities for new technological developments to contribute to greater system security.

The final rule delivers faster and more predicable processes for renewable generators to connect to the grid

26 The final rule improves transparency and investment certainty for generators and sets a clear direction for how transmission networks, AEMO and new energy generators like batteries and energy loads like hydrogen should work together to keep system voltage stable. Investors will be able to avoid a long, complex and potentially very costly process when negotiating connections to the network. The reform should also reduce the need for costly and market-distorting interventions in the market by the AEMO, putting investors in a better position to clearly gauge investments.

27 New parties connecting — such as renewable generators, batteries and large inverter based loads (e.g. hydrogen electrolysers) — will have a faster and more predictable connection process. The Commission expects this to result in more, lower cost energy producers entering the NEM, with the result being lower prices for consumers.

28 The final rule achieves this through evolving the existing minimum system strength and 'do no harm' frameworks and more efficiently sharing the costs with connecting parties. This is done mainly through the implementation of the SSMR.

29 The evolved the 'do no harm' arrangements will enable connecting parties to connect faster, while still managing the risk they take on. While the current framework only provides connecting parties with one option, to remediate, the SSMR provides connecting parties with the following two choices:

1. **Pay the system strength charge**, which is an amount reflecting an estimate of the forward-looking cost the connecting party would place on the SSS Provider in meeting the system strength standard (this is the cost the connecting party would have if did not undertake remediation).
2. **Remediate its general system strength impact** involving the relevant NSP undertaking a full impact assessment and the connecting party either implementing a

system strength remediation scheme or the NSP carrying out system strength connection works in order to remediate its general impact on system strength.[2]

30 The Commission has also made the deliberate design choice for SSS Providers to centrally procure system strength services to help ensure services are available to support connecting IBR. The Commission notes that over the medium term, the demand for system strength by IBR connecting to the power system is expected to continue to grow and that this has implications for the supply of system strength. Following analysis undertaken through this rule change process, the Commission considers that a slight over-procurement of the service to support connecting IBR is likely to provide greater benefits for consumers than under-procurement. This is because due to the particular characteristics of system strength, the market impacts of having a unit less of the required amount of system strength is more significant than the cost of having an extra unit procured earlier than is needed. The Commission also notes that in light of the scale of the transformation that is occurring, the risks of over-procurement are low. The final rule includes checks and balances to minimises these risks, as discussed below.

The final rule supports lower energy costs for consumers

31 The costs of system strength are currently shared between generators and customers. Customers pay either through transmission charges when TNSPs meet a declared shortfall or implicitly through higher costs from AEMO's interventions in the wholesale market. New generators pay when meeting the current 'do no harm' obligation, noting that a proportion of the costs borne by generators are ultimately passed onto consumers through higher wholesale prices.

32 Some stakeholders consider that system strength is currently being provided for free. However, the costs of providing system strength are included in other elements (e.g. the wholesale price, or the regulated cost of providing transmission) and with the changing generation mix, the amount provided as a "by-product" of synchronous generation is declining. This decline is increasing the cost of providing it. What is more, the current arrangements for providing system strength, and paying for it, do not result in the lowest cost outcomes for consumers.

33 The final rule improves the current arrangements for providing system strength which result in the lowest cost outcomes for consumers. It does this through:

- further evolving the unbundling of system strength service provision that was first introduced through the 2017 system strength rule with an explicit definition of the service that was not linked to energy provision[3]
- changing the definition of system strength so that it is technology neutral and can accommodate a broad range of system strength solutions (including those that are lower in cost)

2 This is the only option for connecting parties under the current framework's 'do no harm' obligation.

3 *National Electricity Amendment (Managing power system fault levels) Rule* in September 2017. See: https://www.aemc.gov.au/rule-changes/managing-power-system-fault-levels.

- minimising the risk of under procurement of system strength in the context of a rapid transition to IBR, that can increase costs for consumers, through the forward-looking centralised approach for system strength services
- leveraging the economies of scale and scope of centralised procurement of system strength by SSS Providers
- building in flexibility in the framework so it can cater to changing market environments, such as in the longer term where demand for system strength may change due to technological changes or where there are changes in jurisdictional policies. This flexibility is provided through:
  - AEMO's ability to reflect changing demand for system strength in its forecasts that underpin the System Strength Standard
  - The SSS Provider having flexibility explore different ways to efficiently meet the System Strength Standard
  - The AER determining the methodology for parts of the system strength charge which will contribute to lower consumer bills through allowing the most accurate price signal being send to connecting parties resulting in the lowest total system costs
- checks and balances, including an important role for the AER in testing the efficiency of the SSS Provider's approach for meeting the standard. This means that in addition to assessing whether each preferred option is the least cost solution through the RIT-T process, the AER will also assess whether the TNSP has translated the AEMO forecasts into an appropriate amount of system strength services.

34 The Commission understands there are reservations about the forward-looking nature of the standard because it may result in over procurement of system strength services. As discussed, the Commission considers the forward-looking approach to be an important response to the limitations of the current framework, which is creating delays in connections and costly interventions in the market. The approach for the standard is a practical one, that seeks to mitigate the consequences of inefficient market outcomes due to a lack of system strength. It is based on analysis and assumptions around the rapid pace of the transition, which means that the risk of having less system strength in the system would have worse outcomes for consumers than the risk of over procurement.

35 Some are concerned that over procurement could occur if technological changes caused a fall in demand for system strength services. The Commission has built in flexibility to account for technological changes that could result in less system strength being needed. Where demand falls the framework would see less system strength being procured. However, the Commission notes that the framework is underpinned by an assumption that these technological developments are unlikely to emerge in the short to medium term.

36 The Commission acknowledges that there are uncertainties with how the transition will play out and that it will be important and in light of this it will be important to closely monitor how the standard is implemented. The Commission is committed to closely monitor this the operation of the standard with the other market bodies - the AER and AEMO - to ensure that the provision of system strength continues to be done in a manner that serves the best interests of consumers.

The final rule provides clarity and flexibility for investors through quick implementation

37 The current framework has resulted in poorly coordinated system strength provision, especially in relation to the connection of new IBR plant. This piecemeal approach to the provision of system strength has added additional costs, risks and time to the connection process.

38 The final rule addresses this primarily through a coordinated and centralised approach to the provision of system strength under the new system and network standards (S5.1a and S5.1). It is also achieved through a predictable and transparent charging regime for connecting parties to use that service under the SSMR.

39 These benefits will provide clarity to the market and more broadly including investors and jurisdictional governments and will be available as quickly as possible. A quick implementation time is possible as the final rule leverages current frameworks for economic regulations and does not duplicate or create unnecessary bespoke system strength rules. This is also in the interests of promoting clarity, predictability and simplicity, and for minimising administrative costs.

40 Further the final rule sets out clear and practical transitional arrangements to support implementation that reflect the Commission's desire to implement the evolved framework as soon as practical. These include the:

- supply side arrangements commencing on 1 December 2022, from which time SSS Providers must begin planning to provide the efficient level of system strength by 2 December 2025 at the latest.
- demand side and coordination arrangements that evolve the 'do no harm' arrangements into the SSMR commencing on 15 March 2023, from which time a new connecting party may opt to pay the system strength charge rather than having to self-remediate.

CONTENTS

APPENDICES

TABLES

FIGURES

1 THE RULE CHANGE REQUEST AND RELEVANT CONTEXT

The Australian Energy Market Commission (AEMC or Commission) has decided to make a more preferable final rule (final rule) that is generally consistent with its more preferable draft rule (draft rule). It contains some clarifications and changes to improve the rule's implementation and ongoing functionality in response to stakeholder feedback on the draft determination. Importantly, the following three part approach to providing for efficient levels of system strength proposed in the draft rule has been maintained.

- **Supply side:** a new obligation on transmission networks to provide the right amount of system strength in a planning timeframe to support the connection of inverter based resources (IBR) as forecast by AEMO.
- **Demand side:** new access standards for those parties that 'demand' system strength - large controllable loads like hydrogen electrolysers, and generators such as batteries, utility-scale solar and wind farms - to make sure they use system strength efficiently, reducing demand for it and minimising costs associated with supply.
- **Coordination of supply and demand sides:** new way of charging for system strength, giving generators and certain large loads a choice to pay to use system strength services offered by transmission networks or to provide their own system strength.

The changes made in the final rule, compared to the draft rule, are set out at relevant points throughout this final determination, including in a detailed table in the appendices.

This final rule determination firstly sets out the context for the rule change request (this chapter), followed by an overview of the Commission's final decision, and summary of reasons. The appendices of the determination provide a greater level of detail on all components of the final determination, including the stakeholder feedback received throughout the process.

The structure of the determination is as follows:

- Chapter 1: Relevant context for this rule change — an overview of TransGrid's rule change request as well as the reviews and rule changes relevant to this decision
- Chapter 2: Final rule determination: an overview of the evolved system strength framework
- Chapter 3: Contribution to the NEO: why the system strength framework has been evolved
- Appendix A: Legal requirements — sets out the AEMC's rule making powers and relevant considerations of the Commission in relation to making this final rule
- Appendix B: Register of changes from the draft rule
- Appendix C: Supply side — establishing a new system strength planning standard
- Appendix D: Demand side — new access standards for generators, loads and market network service providers (MNSPs)
- Appendix E: Coordination — system strength mitigation requirement

- Appendix F: Transitional arrangements — a sequenced implementation of the evolved framework

This chapter provides an overview of:

- TransGrid's rule change request
- contextual considerations, including the power system's transition impact on system security including system strength
- the interactions with the Energy Security Board's (ESB) Post 2025 market design, the AEMC's other synchronous services rule changes and AEMO's engineering study
- the rule making process.

1.1 Overview of TransGrid's rule change request

On 27 April 2020, TransGrid (the proponent) made a request to the Commission to amend the National Electricity Rules (NER or the rules) regarding the management of system strength on the power system (rule change request).

1.1.1 Current arrangements

The Commission made the *National Electricity Amendment (Managing power system fault levels) Rule* in September 2017.[4] This rule established two new frameworks to help manage emerging issues with system strength:

1. The minimum system strength framework, which requires system strength service providers (SSS Providers) to provide system strength, where this is needed to maintain the basic levels for system security as forecast by the Australian Energy Market Operator (AEMO).
2. The 'do no harm' framework, which was designed to deliver any system strength needed to support new IBR as they connect to the system.

BOX 1: WHAT IS A SYSTEM STRENGTH SERVICE PROVIDER (SSS PROVIDER) UNDER THE FINAL RULE?

SSS Providers are now defined in clause 5.20C.3 of the NER by the final rule as either the Transmission Network Service Provider (TNSP) for the region, or where there is more than one TNSP for a region, they are the jurisdictional planning body for that region. In the instance that the jurisdictional planning body is not a TNSP, then the coordinating TNSP for that region will be the SSS Provider for the region.

The TNSP's that are currently SSS Providers are TasNetworks in Tasmania, TransGrid in NSW, Powerlink in Queensland and ElectraNet in South Australia. AEMO fulfils the role in Victoria.

4 See: https://www.aemc.gov.au/rule-changes/managing-power-system-fault-levels.

1.1.2 Rationale for the rule change request

TransGrid's rule change request identified issues similar to those identified in the March 2020 discussion paper of the Commission's *Investigation into system strength frameworks in the NEM (*the *Investigation)*.

TransGrid recognised system strength was an urgent issue to address in the NEM and identified three principal issues with the current frameworks:[5]

- difficulty coordinating solutions to address system strength issues across the 'do no harm' and minimum frameworks
- delays and increasing costs for new generation connecting to the power system due to the system strength impact modelling and remediation requirements of the 'do no harm' obligation
- increased risks of costly interventions in the operation of the energy market caused by the slow, reactive nature of the minimum system strength framework.

1.1.3 Solution proposed in the rule change request

TransGrid proposed to abolish the 'do no harm' obligation, and to amend the minimum system strength framework.[6] Specifically, it sought to evolve the minimum system strength framework by:[7]

1. AEMO setting the system strength requirement for identified fault level nodes in the system. That is, AEMO would define the level of system strength required for each sub-region in the NEM.
2. An independent body (such as the Reliability Panel) setting a probabilistic planning standard, which would define how often SSS Providers must be able to meet the required minimum levels of system strength.
3. SSS Providers being obligated to maintain these system strength levels to the standard for each node defined in their network through the ordinary planning and regulatory frameworks. So that system strength would be procured similar to existing obligations for thermal capacity and voltage control services.
4. AEMO acting as procurer of last resort for any gaps unmet by TNSPs - AEMO would be able to procure following the declaration of a network support and control ancillary service (NSCAS) gap.

TransGrid proposed replacing the 'do no harm' framework with the existing connection processes. These processes, which would still require each plant to meet generation performance standards (GPS) to connect, would send location signals to potential connections. This would see connections 'penalised' when trying to meet their GPS in weak areas of the network, through requirements to install additional plant to meet their GPS. TransGrid's rule change request proposal also considered that the risk of constraints would provide further locational signals to prospective connecting parties.

---

5 TransGrid, 2020, *Efficient management on system strength on the power system — R*ule change proposal, pp. 5-9, 27 April 2020.

6 ibid, pp. 10-11.

7 ibid, pp. 10-18.

1.1.4 Costs and benefits of TransGrid's proposed solution

TransGrid suggested its proposed rule change would yield a significant overall net benefit to system strength arrangements in the NEM.[8]

TransGrid considered that the benefits of its proposed rule change included the facilitation of more:

- coordinated, scale-efficient delivery of system strength services
- efficient balancing of costs incurred in the market
- cost-effective grid connections including reduced duplication of investments
- efficient and effective operation of transmission networks.

TransGrid considered that the costs would consist of:

- administrative and development costs incurred by:
  - AEMO in developing a new fault level standard
  - SSS Providers internal processes to implement the proposed changes.
- actual costs of procuring system strength services, incurred by SSS Providers.

1.2 Contextual considerations

The NEM is a wholesale electricity market which was designed around a generation fleet that consisted of a small number of large, synchronous, centrally located generators, such as coal, gas and hydroelectric generators.[9] However, as these generators leave the market or reduce their operations, the supply of these essential system services — including inertia, system strength and reactive support — has reduced.

Further, new IBR facilities, like generators, some loads, batteries and hydrogen facilities, can create a demand for system services, rather than supplying these services automatically as a by-product of their operation.[10]

The combination of these two trends (decreasing supply, increasing demand) means that new ways are needed to actively source these essential system services as the power system continues to transition away from traditional forms of generation.

The market bodies — AEMC, AER and AEMO — are working together through the ESB work program to develop and implement new measures to procure and operationalise these essential system services.

8 ibid, p. 19.

9 Synchronous machines (including synchronous generators, motors and condensers) are electromagnetically coupled to the AC power system. This means that some interactions of the machine with the overall power system are dictated, and determined, by the physical characteristics of the machine. This includes kinetic inertial responses to a frequency disturbance, or a reactive current response immediately after occurrence of a fault. Synchronous machines also inherently contribute to maintaining the stability of the voltage wave form.

10 Inverter based resources (IBR) refer to non-synchronous generators and loads that are connected to the power system through power electronics. A key characteristic of this form of generation is that many elements of how it interacts with the power system is related to how its digital control algorithms are programmed. This contrasts with synchronous generation, which is electromechanically connected to the grid and which tends to have a set of inherent physical interactions with the power system, based on the specific physical characteristics of each unit.

This section describes how system strength fits into the broader frameworks for system security and stability.

1.2.1 The power system transition underway and the need for system services

The power system is described as being 'secure' when certain technical parameters, centred around managing system voltage and frequency, are:

- kept within given limits during normal operation, and
- remain, or quickly return to, within those limits following a disturbance.

Historically, large synchronous generating assets played a central role in maintaining power system security. These combinations of assets provided various system services simply as a by-product of energy generation that kept system parameters of frequency and voltage — including reactive support, system strength and inertia — within their secure operating envelope. These assets interact with the power system in known ways and quantities inherently through their (electromagnetically synchronised) connection with the rest of the power system.

However, the generation mix is changing: moving away from these types of assets to more flexible, dispersed, smaller, non-synchronous and IBR plant, such as wind, solar and batteries.[11] IBR resources interact with the power system differently to synchronous generators because inverter software controls their operation.[12]

This makes it necessary to purposefully design the physical interactions between IBR plant and the power system, in order to maintain system security. This includes designing the specific services that are needed, and what innate responses to system disturbances are required.[13] It is necessary to manage the replacement of the synchronous assets as this transition occurs due to the automatic and pivotal key role synchronous generation has played in system operation.

As such, these trends are influencing the ESB's and market bodies' work programs.

Developing new ways of procuring system services

The ESB's Post 2025 Electricity Market Design project concluded that power system security should be sourced through the provision of related but separable essential system services, rather than based on the characteristics of specific assets.[14] The ESB considered that this should be done through co-optimised, market-based procurement where possible, and where that was not possible, through structured procurement approaches.

---

11 The NER use the term 'asynchronous' to refer to non-synchronous plant. The term 'asynchronous' may not be as technically accurate as non-synchronous, however the AEMC understands that, in practice, parties interpret asynchronous to mean 'non-synchronous'. The draft rule continues to use asynchronous consistent with the current NER to avoid any confusion.

12 The Commission recognises that emerging 'grid forming' may mean this changes in the future. The Commission understands that work is ongoing within AEMO to fully understand these new technologies and how they can be integrated into the NEM power system.

13 Defining the innate responses of IBR to disturbances is an issue that the AEMC began to address in the 2018 *Generator Technical Performance Standards* rule change. It is likely that further work will be required here, as IBR generation technology develops — particularly if grid forming IBR emerges as a dominant technology.

14 See https://esb-post2025-market-design.aemc.gov.au/final-advice-july-2021 for more information.

Establishing clear procurement mechanisms for the essential system services is considered necessary for managing system security and supporting innovation and competition in the provision of these services.[15] A services-based model encourages greater diversity of supply, delivering a more resilient and flexible power system. Increased options for supply of these services will also help to reduce the cost compared to the traditional asset based approach.

This shift to a service-based model will be iterative as it requires continuous learning about what needs to be done to keep the system secure and operable. This learning may allow refinement in existing service definitions, and / or definition of new services. Further, it may still be necessary to retain certain elements of the asset based model in the interim to ensure power system security through the transition.

This final determination, which defines system strength as a specific service, is consistent with this shift towards a services-based model.

Shifting to this model requires the specification of requirements and product characterisation. This is challenging from an engineering knowledge perspective because it is difficult to precisely define the power system requirements. Some service specification requires a degree of approximation. An example of this is fault level provision being a proxy for system strength. Due to these difficulties a services based model may not be able to take into account all the needs of operating a secure power system.

To date, AEMO has been able to identify and develop specific secure system configurations that represent a secure technical operating envelope. It will continue to progress its thinking in these areas through its work on the Engineering Framework, which is discussed further in section 1.3.3. Given the trends occurring and the need to keep the system secure through the early stages of the transition, it may be necessary to procure specific system configurations, when and where they are needed, to maintain system stability and provide operational flexibility through the transition.

1.2.2 What is system strength and why is it important?

System strength is a key system security parameter that needs to be carefully managed through the transition of the power system.

Electricity coming out of your power point has two key components: current and voltage. Current is like the amount of water running down a pipe, while voltage is the water pressure inside the pipe. It's important that pressure doesn't get too high, or too low, or change too quickly. A strong, stable voltage means generators can push power around the system in a steady, controlled manner.

15 Innovation in this space is already occurring. Examples include many projects supported by ARENA's work on security services like the 'Stability enhancing measure for weak grids study' and 'Gullen Range wind farm field study'.

Our power system is an alternating current (AC) system.[16] This means both current and voltage constantly "move" back and forth, in a manner that can be represented as a regular sine wave.

A strong, stable voltage means this voltage sine wave is very smooth in shape, doesn't deform too much when there is a disturbance on the system, and typically doesn't get too big or too small. The system is strong if the voltage wave form meets these conditions; it exhibits high system strength. As such, system strength is a difficult concept to define as it is an umbrella term that refers to outcomes that stem from various complex issues.

Like other system services, system strength was historically provided as a "by-product" of synchronous generator production. IBR resources — such as large scale batteries, wind and solar generation — don't produce system strength as a by-product due to the fact they are physically coupled to the grid, by what is known as "grid following" inverters. These inverters also require system strength in order to operate properly.

When there isn't enough system strength, the inverters' electronics and control systems in these IBR plant can negatively interact with each other, leading to small disturbances getting out of control quickly. These phenomena are exacerbated in the NEM by our "long and stringy" power system, meaning that many of the new IBR are connecting in peripheral, "weak" parts of the power system.

The more system strength provided, the easier it is to stop these feed-back processes from leading to instabilities. As such, greater system strength provision allows more IBR plant to safely and securely connect to the power system.

These trends and understanding have helped influence the thinking on what system strength is. In our *Investigation*, the Commission defined system strength as a quality of the power system that is related to the overall stability of the voltage waveform as discussed in Box 2.

BOX 2: EVOLVING THE UNDERSTANDING OF SYSTEM STRENGTH: VOLTAGE WAVEFORM STABILITY

The *Investigation* final report evolved the regulatory thinking around system strength to define it as fundamentally related to the stability of the power system's voltage waveform.

There are three key concepts relevant to the overall stability of the voltage waveform:

1. **Voltage waveform provision:** This is the *supply* or source of a 'strong' voltage waveform into the power system. It has historically been provided by synchronous machines (like coal, hydro and gas generators, or synchronous condensers) but can be provided by various technologies, potentially including grid forming inverters in the near future.

16 The NEM's power system operates at various alternative current (AC) voltage levels, and includes a dedicated DC interconnection between Victoria and Tasmania, as well as both AC and DC connections between the mainland regions of Victoria, South Australia, NSW and Queensland. The transmission network used for the bulk transfer of power operates at higher voltages than the distribution network.

2. **Inverter driven stability:** Disturbances in the power system need to be 'positively damped', which means they are settled quickly, and the system returned towards a stable, steady state. Whether stabilisation occurs can be due to the response of IBR's control systems and if they are effectively 'tuned' to their local network conditions. This means their interactions with other inverters and the rest of the power system are stable, and effectively contribute to the stability of the voltage waveform by damping or removing any instabilities. However, low system strength levels can make it harder to manage these inverter interactions that can result in an unstable system.
3. **Network stability management:** Network and generation plant includes equipment designed to protect the individual plant from disturbances on the system, such as mechanisms for clearing faults on a transmission line. These 'protection systems' are critical to the safe operation of the power system and require adequately damped voltage waveforms to operate effectively.

These three concepts can be further grouped as they relate to the *supply* and *demand* for system strength. The first concept of *voltage waveform provision*, being the *supply* of system strength, then the second two concepts of *inverter driven stability* and *network stability management* being the *demand* for system strength.

Source: AEMC, *Investigation into system strength frameworks in the NEM,* Final report pp. 130-140, October 2020.

1.3 Interactions with ongoing work

The evolution of system strength frameworks forms part of the ESB work, and is related to the AEMC's broader system security work program. This is discussed further below.

1.3.1 ESB's Post 2025 market design reforms — providing the long-term future vision of the NEM

The ESB was tasked by the Energy Ministers Meeting (formerly Council of Australian Governments Energy Council) to advise on a long-term, fit for purpose market framework, termed the Post 2025 market design reforms work program. The final advice to Energy Ministers was published on 26 August 2021.[17]

The essential system services workstream is a key part of the reform package. One of its outcomes was the recommendation for an evolved system strength framework as an immediate priority area for reform required for the future power system.

This rule change actions this recommendation for urgent system strength reform and has been done so consistent with the analysis and conclusions from the ESB's Post 2025 work. Additionally, this rule change process has incorporated relevant stakeholder feedback provided through the ESB's consultation processes.

17 Resources associated with the Post 2025 Market design reforms final report can be found here: https://energyministers.gov.au/energy-security-board/post-2025.

1.3.2 AEMC's Synchronous services rule changes — helping implement the long-term future vision of the NEM

This rule change is inter-related with two other rule changes being progressed by the Commission:

- *Capacity commitment mechanism for system security and reliability services* Delta rule.[18]
- *Synchronous services market* rule change request from Hydro Tasmania.[19]

These rule changes relate to the ESB's recommendation to consider operational and short-term procurement mechanisms allowing AEMO to value, procure and schedule specific services and resources to help keep the system secure. The Commission released a joint Directions paper for these rule changes on 9 September 2021.[20] This paper sets out the Commission's thinking regarding the core issues of these rule changes. Importantly, given the state of engineering knowledge, the different approaches being explored would procure secure system configurations as a transitional measure. The long term vision remains to have unbundled essential system services which are separately valued and co-optimised where possible.

This final rule enables the more efficient procurement of system strength in the planning timeframe. The Delta and Hydro Tasmania rule change requests would provide a mechanism that could:

- create an optimal schedule for contracted resources to provide system strength in the operational timeframe, and
- procure and pay for additional system strength in the operational timeframe, that may be needed due to a difference in the planning forecast need versus the real-time need.

Importantly, the rule changes will explore how system strength service contracts are scheduled efficiently to host IBR such that a net market benefit can be realised to meet the second limb of the system strength standard - being the voltage waveform stability element.[21]

1.3.3 AEMO's Engineering Framework

AEMO is currently developing an Engineering Framework, which has been used as an input into this final determination. This framework will also support the implementation and function of this evolved framework, and the power system as a whole, into the future.[22]

The Engineering Framework is the next step in a multi-year plan to deliver an integrated roadmap for the NEM. It builds on the renewable integration study (RIS) Stage 1 which delivered the first step. The Engineering Framework seeks to go beyond the renewable

18 See: https://www.aemc.gov.au/rule-changes/capacity-commitment-mechanism-system-security-and-reliability-services.

19 See: https://www.aemc.gov.au/rule-changes/synchronous-services-markets.

20 See: https://www.aemc.gov.au/sites/default/files/2021-09/ERC0306%20%26%20ERC0290%20Directions%20paper%20-%209%20September%202021.pdf.

21 S5.1.14(b)(2) of the Final Rule. This notes SSS Provider must provide services such that the voltage waveform is stable given the forecast amount of inverter based generators, loads and MNSPs that AEMO has forecasted to connect at that system strength node. See Appendix C for more information on the new system strength planning standard.

22 See: https://aemo.com.au/en/initiatives/major-programs/engineering-framework for more information on AEMO's Engineering Study.

integration alone, by taking a broader perspective, and acknowledging the various activities that are already happening across industry.

The Engineering Framework aims to:

1. Facilitate a discussion to identify possible **future operational conditions** for the NEM power system.
2. Consolidate a common view of the **current work underway** to adapt the system and existing avenues for **engagement**.
3. Collaborate on **identifying where increased industry focus is needed** to bridge the gap between current work and future operational conditions.

Application of advanced grid-scale inverter in the NEM white paper

AEMO released a white paper in August 2021 that focuses on the application of grid scale inverters in the NEM, with a focus on grid-forming inverters as part of its Engineering Study.[23] This paper seeks to enable grid-forming inverters to support the NEM as the existing synchronous generators exit, which is of particular interest in relation to the evolved framework implemented through this final determination.

The paper notes advanced inverters could provide capabilities to support the secure operation of a synchronous power system like the NEM. Demonstration of these at scale is critical if this technology is to replace the capabilities of synchronous machines, with pilot trials showing promise.[24] Such demonstrations and understanding how these capabilities will assist the ability of more technologies to provide system strength services under this framework.

The Commission is supportive of explorations, such as this white paper, of how emerging technologies can be successfully integrated into the NEM in a timely manner.[25] The final rule has been deliberately designed to provide flexibility in the technologies that can be used under it. This is achieved in the evolved framework through the:

- broadening the definition of system strength from being focused on fault current provision
- incentives to innovate:
  - provided to SSS Providers through the new system strength planning standard
  - connecting parties through the new system strength access standards and charging mechanism.

1.4 The rule making process

This section details the rule making process involved in making this final rule determination.

23 Available at: https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/application-of-advanced-grid-scale-inverters-in-the-nem.pdf?la=en&hash=B4E20D68B23F66090ADA5FD47A50D904.

24 ibid, Appendix A1.3 and A1.4 on the Dalrymple BESS and at the 69 MW Dersalloch wind farm in Scotland respectively.

25 Since that time a subsequent white paper has been published, on the enduring primary frequency response arrangements in the NEM. See: https://aemo.com.au/initiatives/major-programs/engineering-framework/reports-and-resources

1.4.1 Initiation and consultation paper

On 2 July 2020, the Commission published a consultation paper covering multiple rule change requests that all related to system services, including this rule change request.[26] First round submissions closed on 13 August 2020. The Commission received 43 submissions to this paper. All the issues relevant to this rule change request that were raised in submissions were discussed and responded to throughout the draft rule determination. These submissions are available on our website.

1.4.2 Extension of time for the draft determination

On 10 December 2020, the Commission extended the period of time for making the draft determination to 29 April 2021.[27] This followed an earlier extension decision on 24 September 2020. The Commission considered this extension to be necessary due to issues of complexity raised in the rule change request and in stakeholders' first round submissions.

The extension saw us undertake further stakeholder consultation and analysis of the issues raised as well as further collaboration with the other market bodies, and dovetailing with the ESB processes.

1.4.3 Draft rule determination

On 29 April 2021, the Commission published a draft rule determination and more preferable draft rule.[28] The Commission held a webinar briefing on 6 May 2021 to assist stakeholders understand the content and rationale for the draft decision.

Second round submissions closed on 17 June 2021. The Commission received 32 submissions to the draft rule determination. All the issues relevant to this rule change request that were raised in submissions are discussed and responded to throughout this final rule determination. These submissions are available on our website.

1.4.4 Extension of time for the final determination

On 15 July 2021, the Commission extended the period of time for making the final determination to 21 October 2021.[29] This extension was made to allow the Commission sufficient time to analyse and consult on stakeholder submissions made to the draft rule determination, reflecting the complexity of the issues involved.

1.4.5 Technical working group

The Commission also formed a technical working group of experts from industry, network service providers, a consumer group, market bodies and government agencies. The AEMC has convened ten technical working group sessions over the course of the review and rule change process up to the draft rule determination's publication.

---

26 This notice was published under s.95 of the National Electricity Law (NEL).
27 This notice was published under section 107 of the NEL.
28 This notice was published under section 91A of the NEL.
29 This notice was published under section 107 of the NEL.

Discussion held at the technical working group sessions have also been taken into account in this final determination. The Commission also wishes to thank the members of this group for their open, honest feedback that has occurred in a positive and collaborative environment, resulting in better outcomes for consumers in the long term.

2 FINAL RULE DETERMINATION: AN OVERVIEW OF THE EVOLVED SYSTEM STRENGTH FRAMEWORK

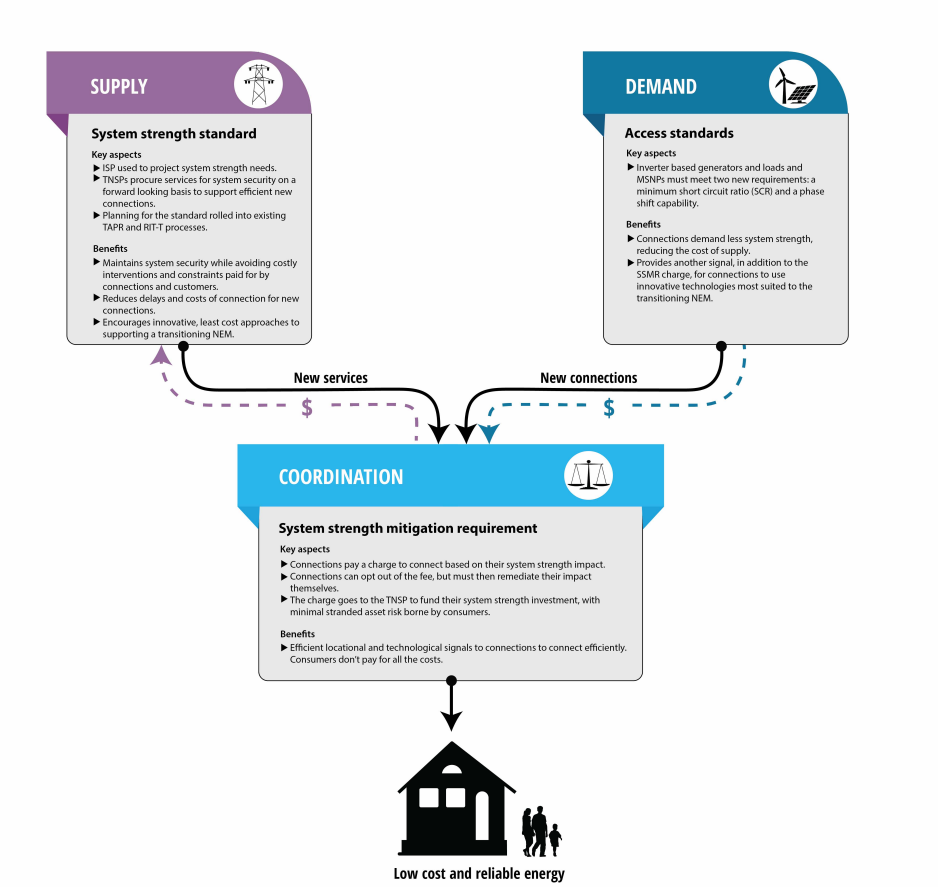
The Commission's final rule determination is to make a more preferable final rule (final rule). The final rule is attached to this determination and it is similar to the proposed draft rule with minor amendments reflecting stakeholder feedback obtained through second round submissions.

This Chapter sets out an overview of the final rule that, as illustrated in Figure 2.1, includes the following components:

- **Supply side:** Establishes a new transmission prescribed service standard for a subset of TNSPs, known as system strength service providers (SSS Providers). This evolves the existing system strength shortfall mechanism in the rules to enable greater coordination and forward looking procurement of system strength.
- **Demand side:** Introduces two new access standards that will effectively cap the system strength used by new connections contributing to the efficient use of the centrally supplied service.
- **Coordination of supply and demand sides:** Introduces the system strength mitigation requirement (SSMR) that evolves and expands the current 'do no harm' arrangements to better coordinate the supply and demand of system strength by efficiently charging the parties for their use of centrally supplied system strength.
- **Transitional arrangements:** Maps out the sequence of events for the evolved framework to be implemented as soon as possible so that the benefits of the evolved framework can be realised.

The Commission's rationale for the more preferable final rule is set out in Chapter 3. Additional details about each reform areas of the final rule, including the Commission's analysis, are provided in the appendices of this final rule determination. Appendix A sets out the legal requirements in making this final determination, Appendix B notes the changes from draft to final rule, and then Appendices C to F provide further details about the supply side, demand side, coordination, and transitional arrangements.

Figure 2.1: Overview of the evolved framework enacted through this final rule



Source: AEMC

2.1 Supply side: Establishing a new system strength standard

The final rule introduces a new system standard and transmission network standard for system strength under Schedule 5.1a and Schedule 5.1 of the NER, respectively. The standard in Schedule 5.1 requires a TNSP (who is a SSS Provider) to use reasonable endeavours to plan, design, operate and maintain its transmission network in order to meet network performance requirements at the locations on its network (known as system strength nodes) and the amounts of IBR as forecast by AEMO.

This component of the final rule builds on the proposal set out in the rule change request, but changes it to enhance its application. For example, to leverage off existing processes minimising implementation costs, the final rule has the system strength standard being determined by AEMO, rather than the Reliability Panel as was originally suggested by the proponent.

This section provides an overview of the supply side arrangements. Further detail on this aspect of the final rule, including stakeholder views on these issues, changes made following consultation on the draft rule, and the Commission's analysis is set out in Appendix C.

2.1.1 Establishing a new prescribed transmission service standard for provision of efficient levels of system strength

The supply side of the framework revolves around the system strength standard in the NER.

New system strength specific system (Schedule 5.1a) and network (Schedule 5.1) standards in the NER

Under the final rule the system strength standard is set out in two parts in the NER:

- The *system standard* of S5.1a.9 is a high level requirement that sets out the general expectation of conditions on the power system relating to system strength. That is, the system standard sets out what users of the power system should expect in relation to system strength when connected to the system.[30]
- The *network standard* of S5.1.14 then sets out the specific requirements on SSS Providers, to enable the power system to meet the general requirements defined in the *system standard* in S5.1a.

The final rule places this new standard into Schedule 5.1 of the NER – meaning that SSS Provider can procure services under a reliability corrective action RIT-T, allowing it to have negative net benefits, and still pass the test. This change was made in response to concerns that were identified with the current framework which is reactive and takes too long.

Two physical aspects of the new standards – minimum fault level requirement and stable voltage waveform

The SSS Providers' obligations under the system strength standard are further described by reference to the two key physical aspects of system strength.[31]

1. **Minimum fault level requirement:** SSS Providers must maintain the minimum three phase fault levels specified by AEMO in the system strength requirements, which are required for plant and network protection systems.
2. **Stable voltage waveforms:** SSS Providers must achieve stable voltage waveforms such that the efficient amount of IBR projected to be connected by AEMO will remain stable in steady state conditions and remain synchronised following credible contingency events. Specifically, under the final rule, the standard will require SSS Providers to plan to achieve stable voltage waveforms in their networks such that IBR:[32]
   a. do not create, amplify or reflect instabilities
   b. remain synchronised following a credible contingency event or protected event.

30 See the purpose of system standards expressed in clause S5.1a.1 of the NER.

31 Clauses 5.20C.1 and S5.1.14(b) of the Final Rule. These two physical aspects of system strength are consistent with the description of system strength first set out in the *Investigation into system strength frameworks in the NEM - final report*.

32 Clause S5.1.14(b)(2) of the Final Rule.

It is important to note that under the final rule, SSS Providers cannot *plan* to meet the standard through the use of constraints or directions given that these are operational tools. However, in the operational timeframe it may be more appropriate to apply constraints to relevant generators to maintain system security when the solutions procured by the SSS Provider under the standard are exhausted. It is important to maintain this flexibility to allow the power system to respond to the needs of the day, and to do so in a way that minimises costs for consumers.

For example, in the case of planned outages, it may be more efficient to use constraints to manage this for the length of the relatively short planned outage than to obtain further system strength services at a significantly higher cost to cover the period. Therefore, the final rule does not preclude the use of disconnections or constraints in the operational timeframe to manage system strength. Allowing such flexibility in operational timeframes is appropriate as it is AEMO who has responsibility to maintain the system in a secure state. While it requires SSS Providers to use best endeavours to meet the planning standard in the investment timeframe, these solutions have to be operated in accordance with real time market conditions and the needs of the system and consumers at that time.

Therefore, for the avoidance of doubt parties connecting to the network should not expect to face no system strength constraints. These may still arise in operational timeframes in response to real-time needs of the power system. However, due to the more forward-looking provision of system strength these constraints should be more predictable, and on the whole, should be lower than in the absence of these changes being made. [33]

The final rule also includes minor changes that respond to stakeholder submissions to the draft rule and better reflect the policy intent. These relate to the wording of the standard and clarifications to ensure consistency with the generator access standards. More details about these changes are set out in Appendix C.

2.1.2 AEMO's key role under the evolved framework

AEMO has a key role in the evolved system strength framework. It is to determine the efficient level of system strength at each system strength node that the SSS Provider must plan and procure solutions to meet over time.

First, AEMO is required to update its *system strength requirements methodology* using the rules consultation procedures and in doing so must provide a description of:[34]

- how the minimum fault level requirements will be calculated
- what is meant by stable voltage waveform(s)
- matters that may be taken into account by SSS Providers in assessing the level and type of inverter based resources projected by AEMO at each system strength nodes, and what may be required to achieve stable operation in accordance with clause S5.1.14(2).[35]

33 That is, it is not a prescribed transmission service for those connections, nor has a performance standard element that provide compensation for these connections should constraints be applied to them.

34 Clause 5.20.6 of the Final Rule.

35 The Commission expects this to include a methodology for how SSS Providers should model against these stable voltage waveform in relation to the projected IBR connections made by AEMO in its system strength report.

Following this, AEMO is required to determine the *system strength requirements* each year.[36] This includes:

- Determining *system strength nodes* where centralised and coordinated SSS Provider investment would be efficient (i.e. where the standard applies).[37]
- Projecting the *system strength standard specifications* using the *system strength requirements* methodology as required to determine the SSS Providers' obligations under S5.1.14. This includes:
    - Determining the minimum fault levels at these nodes that are required to be met in the timeframes specified in the standard,[38] and the forecasts for how they may change over the ten-year horizon.[39]
    - Projecting the amount and types of generation due to connect in an area, as informed by relevant integrated system plan (ISP) projections and other planning documents such as the electricity statement of opportunities (ESOO).[40] This will be done by determining what amount of this generation would be efficient for the SSS Provider to consider and support under the system strength standard (what SSS Providers use to determine the efficient level of system strength to procure).

Projecting the *system strength standard specifications* each year

The *system strength requirements* are projected ten years into the future to allow SSS Providers to undertake transmission planning for system strength as part of its usual planning process (which is also for ten years).

These projections are then used to set the efficient level of system strength that a SSS Provider must provide. This is achieved through AEMO's three-year system strength requirement projection, which is published annually and is known as the *system strength standard specifications*. The SSS Provider is required to meet the system strength standard specifications in three years time through the way it plans, designs, maintains and operates its network.

Setting the standard three-years into the future is intended to provide investment certainty for the SSS Provider given the ever-changing nature of forecasts. Three-years was determined to be the shortest period possible to enable SSS Providers to appropriately consider all potential solutions for providing the services to meet the system strength standard.

36 The final rule includes a new timeline that has AEMO publishing its *System strength report* on 1 December each year, with the SSS Provider being obligated to meet that forecast in three years time. Under the final rule, AEMO must publish its system strength report by 1 December. This date was amended to enable AEMO to leverage the results of their ISP and ESOO reports, and responds to feedback from AEMO.

37 Clause 5.20C.1(a) of the Final Rule.

38 Clause 5.20C.1(b) and clause S5.1.14 of the Final Rule.

39 Clause 5.20C.1(c)(2) of the Final Rule.

40 Clause 5.20C.1(c)(2) of the Final Rule.

2.1.3 SSS Provider's role under the standard

Like other network standards, SSS Providers' system strength obligations are integrated into their existing annual planning processes, which are documented in their Transmission Annual Planning Report (TAPR) publications. This requires SSS Providers to consider the long-term changes in system strength requirements, and the power system more generally when considering system strength solutions. This iterative, long term planning approach enables SSS Providers to consider a broad range of solutions to system strength, including those with long procurement lead times, and enables them to optimise the scale and scope of their portfolio of investments.

The TAPR publication is the key document that sets out how the SSS Provider will plan to meet the system strength standard over the upcoming ten years, including what investments options are available. The final rule has specified that system strength information be included in a SSS Provider's TAPR.[41] This includes the SSS Provider's forecast of the available fault level at each system strength node over the period for which AEMO has determined system strength requirements.[42]

The final rule's adjusted reporting and compliance timeline for AEMO and SSSP's is noted in the sub-section above. It will provide TNSPs adequate time to integrate their system strength obligations into their TAPR processes.

SSS Provider's revenue arrangements

The AER has oversight of TNSPs revenue in respect of their provision of prescribed transmission services through the transmission determination process. SSS Providers (other than AEMO, which is discussed below) are TNSPs that are subject to these requirements.

The final rule provides that the solutions the SSS Provider procures to meet the system strength planning standard, are a prescribed transmission service for the reasons set out in Appendix A.[43] This means that the SSS Providers forecast operating and capital expenditure needed to meet the standard as part of their revenue proposal.[44] The SSS Providers will treat the standard the same as its other regulatory obligations for which it forecasts operating expenditure and capital expenditure.

Application of the RIT-T

Where applicable, SSS Providers will apply the RIT-T to decide which investment should be pursued to meet the system strength standard. No changes to the existing RIT-T framework have been made to this process by the final rule given that this would encompass broader changes to the regulatory framework than just for system strength.

The final rule introduces an obligation on SSS Providers to meet a technical requirement in Schedule 5.1 of the NER. This enables TNSPs to undertake a reliability corrective action RIT-

41 Clause 5.20C.3(f) of the Final Rule.

42 AEMO would also be required to set out in their SSIAG how SSS Providers calculate and project available fault levels at system strength nodes for their TAPR reporting requirements. Clause 4.6.6(a)(2) of the Final Rule.

43 See the Commission's consideration of the form of regulation factors in Appendix A.

44 Part E of Chapter 6A of the NER.

T.[45] While a typical RIT-T requires that the net economic benefits associated with a project are positive, a reliability corrective action RIT-T means that the TNSP can procure a solution that provides *negative* economic benefits, if it is the solution that maximises the net market benefits. In effect, this means that the benefits can be negative if this is needed to meet a system standard, as long as the TNSP has demonstrated that they are the *least* negative of all the options considered.

As noted above, this is a planning standard. While TNSPs could include differential operational conditions in scenarios that they undertake for the RIT-T, they are not obliged to take this into account. Real time conditions may result in the need for constraints to be applied to maintain a secure power system. Where it is economically beneficial for a greater level of investment to be made above the level they are obligated to procure, a TNSP may do so to avoid these constraints being applied.

The voltage waveform stability portion of the new system strength standard allows for SSS Providers to innovate the way that system strength services are provided. It does so by allowing them to make the translation from AEMO's IBR projections to specific network investments. This is done in acknowledgement of the constantly increasing industry experience of how to provide a stable voltage waveform as well as to allow for flexibility in the assumption of the amount service required to host a connection to be outside of AEMO's system strength requirements.

The Commission also considers that as this translation allows SSS Provider's to determine the system strength need for a RIT-T, the AER has a role in verifying the basis of this translation to a network investment need to ensure that it is an appropriate and proportional approach to providing the level of system strength necessary to support the forecast connections.

2.1.4 Requirements for parties to coordinate to meet the standard

The SSS Provider is the sole planner and procurer for system strength for its region. The system strength supplied by the SSS Provider will propagate through the network, both in other networks within their region, and across regional boundaries. For these reasons, it is imperative that joint planning rules and other mechanisms for coordination between the SSS Provider, other NSPs and AEMO cover all necessary parties and function effectively within the context of the evolved framework.

The final rule leverages existing joint planning requirements in the ISP process, while adding to or amending the requirements for coordination between SSS Providers, AEMO, other TNSPs and DNSPs. The final rule updates the arrangements that were set out in the draft rule to capture the benefits of a single planner and procurer for each region, while ensuring solutions are not limited to network solutions on the SSS Provider's transmission network. It is expected however that there may be system strength solutions that may be provided by other NSPs (i.e. not the SSS Provider). The final rule allows for this possibility.

45 The definition of 'reliability corrective action' in clause 5.10.2 of the NER includes investment by a TNSP in its transmission network for the purpose of meeting the service standards linked to the technical requirements of schedule 5.1.

Changes have been made in the final rule in response to stakeholder feedback. These relate to arrangements for coordination between SSS Providers and other TNSPs and DNSPs and broadening of the SSS Provider-AEMO joint planning arrangements. More details of these have been set out in Appendix C.

2.1.5 Application of the standard in an adoptive jurisdiction — AEMO as the system strength service provider

In an adoptive jurisdiction (i.e. Victoria), AEMO would be the SSS Provider responsible for maintaining the proposed system strength standard in this region. Consistent with current arrangements, while AEMO would be the SSS Provider, AusNet Services as well as other declared transmission system operators will own and operate the assets.

There are some differences in how the Rules apply in Victoria in relation to Chapter 5 of the NER.[46] The Commission considers that, in relation to the SSS Provider's obligations to meet the system strength standard, no changes to the Rules are required as part of the final rule. The Commission also does not consider that any transitional rules specific to AEMO's role in Victoria are needed in respect of this aspect of the final rule.[47] Notwithstanding this, the Commission considers that the current NER is clear on the differences in responsibilities between AEMO and declared transmission system operators in Victoria, and that these remain clear following the amendments to evolve the system strength framework. Therefore, no additional changes have been made in this regard.

2.2 Demand side: two new access standards

The final rule introduces two new access standards as part of the technical requirements for connecting parties:

1. A minimum short circuit ratio access standard in clause S5.2.5.15, S5.3.11 and S5.3a.7 of the NER.
2. A minimum voltage phase shift access standard in clause S5.2.5.16 of the NER.

The short circuit ratio (SCR) access standard was proposed by the proponent, while the voltage phase shift access standard is additional to that proposed by the proponent. This section discusses the minimum access standards.

Further detail on this aspect of the final rule, including stakeholder views on these issues, changes made following consultation on the draft rule and the Commission's analysis is set out in Appendix D.

2.2.1 Short circuit ratio access standard (NER S5.2.5.15, S5.3.11, S5.3a.7)

The final rule introduces a minimum access standard that applies to all new IBR (i.e. those resources that 'demand' system strength), which will require the plant to have capability to meet its performance standards at a SCR of 3.0. This will apply to new connecting:

46 See, for example, clause 5.1A.1(d) and rule 5.3B of the NER.

47 Appendices C, E and F discuss other aspects of the final rule that necessitate amendments to the Rules and transitional arrangements.

- asynchronous generators[48]
- inverter based loads[49]
- market network service providers (MNSPs).[50]

The purpose of these access standards is to manage the system strength requirements of inverter based resource by mandating a base level capability for each inverter connecting in the NEM. There is no corresponding automatic access standard, as the mitigation requirement acts as a greater incentive for the connection to do better than the minimum standard.

Additionally, these standards underpin the operation of the new system strength charge as it determines the system strength quantity used by a connection. In doing so, this provides incentives to industry to develop and utilise alternative technologies, such as 'grid forming' inverters, that have a lower impact on system strength.

The SCR standard has been designed with flexibility to allow for jurisdictions to include their own lower, REZ-specific SCR requirement(s) on connection through their REZ programs.

Further, following consultation on the draft, the final rule has updated the wording of the standard to better reflect the policy intent for compliance to be assessed easily and early in the connection process. Changes have also been made in the final rule to provide flexibility for efficient connections that are unable to have an SCR of 3.0 at the connection point. The generation standard now better caters for situations where it would be more efficient for the developer to negotiate an SCR that is above 3.0 and pay the SSS Provider for the incremental provision of system strength above that level.

A further change following consultation on the draft rule that has been made to support flexibility in meeting the standard, relates to an amendment to the glossary definition of SCR. This now excludes from the calculation of the SCR any contribution to the three phase fault level from system strength improvement devices on the plant side of the connection point. This change allows connecting parties to meet the proposed minimum standard with the inclusion of appropriate local system strength mitigation facilities.

2.2.2 Voltage phase shift access standard (NER S5.2.5.16)

The final rule introduces an access standard relating to voltage phase shift which will apply only to asynchronous generators. This minimum access standard disallows any vector shift or similar relay or protective function that acts upon voltage phase angle which might operate for phase angle changes less than 20 degrees at the connection point.

This standard is a safety net standard and generators are not expected to meet a corresponding automatic access standard. An automatic standard would introduce unnecessary complexity and administration.

48 Clause S5.2.5.15 of the Final Rule.
49 Clause S5.3.11 of the Final Rule. See the new definition of 'inverter based load' introduced by the Final Rule in Chapter ten.
50 Clause S5.3a.7 of the Final Rule.

Similar with the SCR standard, the final rule has also updated the wording of this standard to better reflect the intent that compliance should be assessed easily and early in the connection process.

2.2.3 Process for renegotiation of the standards (Clause 5.3.9, 5.3.12 and 5.3.13)

Clause 5.3.9 of the NER requires generators that alter their generating systems to renegotiate their performance standards in certain circumstances. This clause has been amended in the final rule to allow generators to renegotiate technical performance in respect of the SCR requirements, which allows them to reduce their exposure to the system strength charge.

As there were no similar provisions in the NER for loads and MNSPs to alter plant and re-negotiate their registered performance standards, the final rule introduces two new clauses 5.3.12 and 5.3.13. These will allow relevant inverter based loads and MNSPs to renegotiate technical performance in respect of the SCR requirements if they alter their plant in the future and the process for how they are to be commissioned.

These clauses are critical to how connections that opt to pay the new system strength charge can reduce it (set out in section 2.3). This is because through altering connected plant the system strength impact can be reduced and hence lower the system strength charge.

2.3 Coordination of supply and demand sides: Efficiently allocating risk and costs

The final rule enables coordination of the supply and demand sides through the system strength mitigation requirement (SSMR) which evolves and expands the current 'do no harm' arrangements. It provides new connecting generator, inverter based load or MNSP an additional choice of paying a system strength charge to avoid having to undergo a full impact assessment and the associated remediation obligations. Under the final rule the following choices will be available:

- **Paying the system strength charge**, which is an amount that reflects an estimate of the forward-looking cost the connecting party imposes on a SSS Provider in meeting the system strength standard if it did not undertake any remediation; or
- **Remediating its general system strength impact** involving the relevant NSP undertaking a full impact assessment and the connecting party either implementing a system strength remediation scheme or the NSP carrying out system strength connection works in order to remediate its general impact on system strength.[51]

The coordination arrangements of the final rule build on the proposal in the rule change request to require TNSPs to charge connecting generators for the provision of system strength services in the future.[52]

---

51 General system strength impact refers to the total impact that a connection has on the power system. This is different to the adverse system strength impact of a connection that refers to the impact the connection has on the minimum level of system strength required for security. This difference is further explained in Appendix D.

52 TransGrid, *Efficient management of the power system,* rule change request, p. 11, April 2020.

The SSMR provides a new and different avenue to obtaining compliance with NER clause 5.3.4B. The inclusion of the charge means that connecting parties continue to share the costs of system strength services with consumers. However, the final rule helps to minimise system strength costs overall through building in incentives that limit demand for system strength services to be procured by the SSS Providers. The charge is designed to reflect the system strength costs that a connecting party would impose on the system. Through the charge the connecting party is incentivised to reduce its impact. It can do that by full or partial remediation or by choosing to locate in a part of the grid where it would face a lower charge due to that location having higher levels of system strength.

Further detail on this aspect of the final rule, including stakeholder views on these issues, changes made following consultation on the draft rule and the Commission's analysis is set out in Appendix E.

2.3.1 Who is liable under the SSMR — Generators, MNSPs and loads connecting under Chapter 5 of the NER

The final rule applies the system strength charge to all parties that connect under the process in Chapter 5 of the NER following the commencement of the rule (on 15 March 2023). The requirement would apply to any party that consumes system strength services as a consequence of that connection — this will be set out in AEMO's *system strength impact assessment guidelines (SSIAG)*.

This generally means those liable under the SSMR will be:

- generating systems 5MW or greater connecting to either the transmission or distribution networks
- loads that contain a large inverter based resource (as defined by AEMO in its SSIAG) for whom Schedule 5.3 of the NER applies
- MNSPs.

The Commission's inclusion of loads under the SSMR, along with generators and MNSPs who were captured under the existing framework, was to create parity and consistency between the types of connections who demand system strength.

Additionally, the final rule includes a new amendment to clarify the treatment of Designated Network Assets (DNA) final rule.[53] The changes reflect users who connect to the transmission network through a DNA should be treated in the same way as other connecting parties for the purpose of the application of the system strength rules. That is, they should have the same choices as other connecting parties to either elect to pay the system strength charge or remediate their system strength impact. To achieve this outcome, the final rule amends clause 5.2A.2(b)(1) to exclude system strength charges from the scope of that clause. This change means the system strength charge will apply to users connected to a DNA in the same way as parties that are directly connected to the TNSP's shared network.

53 See: https://www.aemc.gov.au/rule-changes/connection-dedicated-connection-assets.

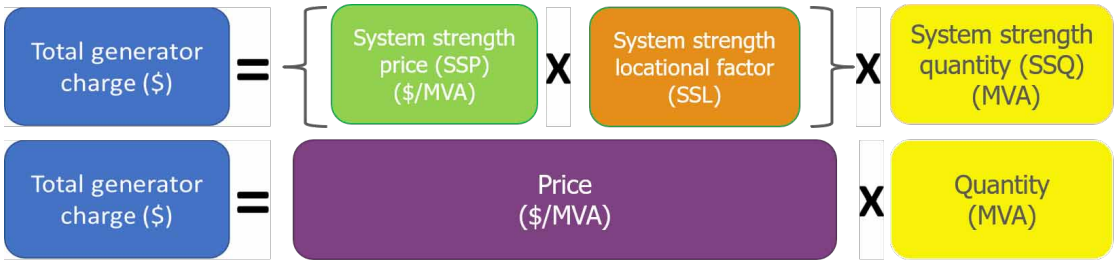
2.3.2 The SSMR charge and its three components

The charge is made up of the following three components that are multiplied together:

1. **The system strength unit price (SSUP):** this component of the system strength charge reflects the change in the **forward-looking** cost of the SSS Provider supplying system strength at each system strength node as a result of a change in demand for the service. How the SSS Provider will calculate this will be set out in its own transmission pricing methodology, which must comply with the AER's transmission pricing methodology guidelines. This would be updated by the SSS Provider every system strength charging period (every five years).
2. **The system strength locational factor (SSL):** this component reflects the localised nature of system strength. It changes the magnitude of the charge that a particular connection would face depending on its approximate electrical distance (or impedance) from the closest system strength node. How NSPs will calculate this will be set out in AEMO's SSIAG. This would be updated by the relevant NSP every system strength charging period (every five years).
3. **The system strength quantity (SSQ):** this component of the charge is important for determining the efficient allocation of the cost of the system strength provided by the SSS Provider due to the amount of the service used by the connection. The system strength quantity for the purposes of the charge is estimated from the size of the connecting party's plant in megawatts (MW) and its short circuit ratio (SCR) (MVA/MW) requirements. How NSPs will calculate this will be set out in AEMO's SSIAG. This will be fixed at connection in the generator performance standards of the plant. However, if the plant is altered to consume less of the available system strength then the amended clause 5.3.9 or new 5.3.12 and 5.3.13 processes allow for this to occur under the final rule.

These three components are illustrated below in Figure 2.2. Each component sends an important and separate price signal to the connecting parties on how their investment impacts of the demand and supply of system strength. This is why the system strength charge is seen as a key benefit to the coordination of the supply and demand sides as it incentivises efficient use of the service for the lifetime of the connection. Additionally, this is why the charge is not linked to SSS Provider expenditure or maximum allowable revenue. Rather it is a reflection of the efficient costs imposed on the SSS Providers due to the connection of an IBR.

Figure 2.2: Components of the system strength charge



Source: AEMC

2.3.3 The process when choosing to remediate general system strength impact — Full impact assessments and remediation works/schemes

The connecting party can choose not to pay the system strength charge where it considers remediation to be less costly. Remediation in relation to a full impact assessment is equivalent to reducing the SSQ to zero.[54] This could be a particularly attractive option when the connection is located further from the system strength node and the locational factor could be significantly greater.

The proponent of a connecting generator, MNSP or load could reduce its SSQ to zero where it:

- includes a system strength remediation scheme in the scope of the connecting plant, including the use of grid forming inverters where it is shown (as per AEMO's SSIAG) that they do not add to the need for system strength, or
- negotiates with the network service provider to undertake system strength connection works as part of the connection agreement.

In each case, a system strength impact assessment would need to be undertaken by the network service provider to check that the connection of the plant will not produce a general system strength impact.

BOX 3: DEFINITIONS OF 'ADVERSE SYSTEM STRENGTH IMPACT' AND 'GENERAL SYSTEM STRENGTH IMPACT'

Adverse system strength impact (previously used for size of remediation but will no longer be used for that purpose under the final rule)**:** An adverse impact, assessed in accordance with the SSIAG, on the ability under different operating conditions of:

(a) the *power system* to maintain system stability in accordance with clause S5.1a.3; or

54 Partial remediation is also an option for a new connection to reduce their SSQ and therefore their system strength charge. However, this does not require a full impact assessment to be carried out and would still involve the connection paying the charge and therefore choosing that option in its connection application.

(b) a *generating system*, *market network service facility* or *inverter-based load* forming part of the *power system* to maintain stable operation including following any *credible contingency event* or *protected event*,

so as to maintain the power system in a *secure operating state*.

General system strength impact (now used as the basis of the size of remediation required)**:** In relation to a new *connection* or an alteration to a *generating system* or other *connected plant*, the amount equal to its *adverse system strength impact* as well as any additional amount by which it reduces the *available fault level* at the *connection point* for the new *connection* or *connected plant*, assessed in accordance with the *SSIAG*.

Source: Definition of both are contained in Chapter 10 of the Final Rule.

2.3.4 The process when choosing to pay the SSMR charge

Connecting parties who pay the charge would avoid undertaking the often-lengthy full impact assessment (FIA) process. The SSS Provider however, must still confirm that the plant will operate stably under the level of system strength provided centrally. This will be done through the process set out by AEMO in the SSIAG, noting that this is a change from the draft to final rule.

The final rule makes explicit that SSS Providers are responsible for conducting wide-area modelling to verify the stability of connecting parties who pay the charge. This change from the draft to the final was made because:

- Under the approach set out in the draft rule the situation could arise where AEMO would not be confident that the connecting plant would be stable in the wider network because the NSP had not undertaken the modelling to confirm this. This could have resulted in the connection being stuck in limbo, unable to proceed until the modelling was completed.
- TNSPs noted during a workshop with the AEMC that they would be routinely undertaking wide-area EMT modelling as part of the connection process. As such they would not be incurring any additional cost as a result of making the responsibility explicit.

This clarification in the final rule acknowledges that EMT modelling is required to map inverter interactions given the complexity of these interactions. However, it does reflect that if a connection is paying the charge (and utilising the centrally provided system strength) then that connection will still need to have its stability checked but will not have to undertake remediation actions as a result. Any of these issues created by insufficient system strength would be for the SSS Provider to take reasonable endeavours to resolve, provided that the deficiency comes from the SSS Provider not meeting the standard for AEMO's forecast level of IBR connections.

2.3.5 Integration into the NSP pricing processes - system strength as a prescribed common service

The final rule includes system strength transmission services as a type of prescribed common transmission services. This approach will mean that if the SSS Provider's revenue from

system strength charges is less than its costs of providing those services in any year and the difference is recovered from transmission customers, that amount will be recovered equally from all transmission customers without any differential based on where on the network those customers are connected.

This is because system strength transmission services will provide different benefits to generators and IBR loads based on their location. However, from the perspective of most transmission customers who pay charges for prescribed transmission services (e.g. non-IBR load customers), system strength transmission services do not provide any locational benefit. It therefore would not be appropriate for some customers to pay higher transmission charges because they are located near a location where a TNSP makes investments to provide system strength transmission service.[55]

To enact this position, the final rule includes amendments to the transmission pricing provisions in:

- Clause 6A.23.2, 6A.23.3 and 6A.23.3A to reflect that system strength transmission services are a prescribed common transmission service;
- Clause 6A.22.1(2) and 6A.23.3(h) so that system strength service payments are treated in the same way as operating and maintenance costs expected to be incurred in the provision of prescribed common transmission services in relation to the adjustments that are made as part of the pricing process.

A new provision has also been added into the final rule following consultation on the draft that requires DNSPs to explain in their annual pricing proposals and how they will pass through system strength charges to customers connected to their distribution networks.[56]

2.3.6 Application of the SSMR in Victoria

The application of the SSMR in Victoria requires explanation due to the transmission arrangements in that jurisdiction. That is, Schedule 6A.4 of the NER sets out how Chapter 6A is modified in its application to AEMO in its capacity as a TNSP providing shared transmission services. These modifications give effect to the key difference from other TNSPs, which is that AEMO does not have an AER approved revenue determination, but instead, AEMO consults on and publishes a revenue methodology setting out the method for calculating its maximum allowed revenue.[57] However, like other TNSPs, AEMO has a pricing methodology approved by the AER.[58] AEMO has consulted on its proposed pricing methodology for the period 1 July 2022 to 30 June 2027 and is expected to submit this to the AER soon.[59]

55 Under the draft rule, the SSMR was integrated into the current NSP pricing process by creating a new system strength transmission service that is a type of prescribed TUOS service. Under the final rule, the system strength transmission service is a prescribed common transmission service. This change, and related consequential changes, avoids unintended price distortions for customers that could have arisen if it was a prescribed TUOS service.

56 Clause 6.18.2(b)(6C) of the Final Rule.

57 Clause S6A.4.2(c) of the NER.

58 Clause S6.A.4.2(K) of the NER.

59 Available here: https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/tuos-pricing-methodology/pricing-methodology-2022-2027.pdf?la=en

Schedule 6A.4 makes some minor modifications to how Part J of Chapter 6A applies to AEMO. The final rule makes minor amendments to Schedule 6A.4 to clarify the application of the draft rule to AEMO, so that it remains consistent with the performance of AEMO's declared network functions.[60] The final rule is consistent with AEMO's declared network functions because AEMO is responsible for allocating the annual service revenue requirement (ASRR) for prescribed common transmission services, and the new system strength transmission service forms part of prescribed common transmission services.[61]

2.4 Transitional arrangements: A sequenced approach to evolving the framework quickly

The Commission recognises the feedback from stakeholders that there is a need to evolve the system strength framework as soon as possible in order to mitigate against the avoidable costs and delays that are currently being experienced through the existing framework. Evolving the framework as quickly as possible would promote the long term interest of consumers. However, the final rule requires an inter-related sequence of events to occur for proper implementation.

The Commission considers the final rule strikes the right balance between the time needed for parties to prepare to meet their obligations under the evolved framework with enabling the new system strength framework to be implemented as soon as possible to realise the benefits. The transitional arrangements can be grouped into three sections — supply side implementation, pricing and revenue arrangements, and demand side and SSMR implementation.

Further detail on this aspect of the final rule, including stakeholder views on these issues, changes made following consultation on the draft rule and the Commission's analysis is set out in Appendix F.

2.4.1 Supply side implementation — new system strength planning commence on 1 December 2022

Materials required for the standard to begin, namely AEMO's update to the system strength requirements methodology through the rules consultation procedures and publication of the first system strength report under the evolved framework, are due by 1 December 2022.[62]

It is on this date that the new provisions required to implement the standard would commence. As such, SSS Providers would begin start their planning and designing processes to meet the standard from 2 December 2022.

However, to ensure that system security is maintained until the SSS Providers have had sufficient time to plan and design their networks to the new standard, the existing

60 See clause S6A.4.2(k) item 2 of the Final Rule.

61 Clause S6A.4.2(k) item 1 modification to paragraph (g) in Clause 6A.23.3. See the amended definition of 'prescribed TUOS service' in the Final Rule.

62 This date was selected in response to AEMO's addendum submission noting the additional costs associated with a September report compared to a December report due to the modelling required to determine the system strength requirements. This is as a consequence of moving the first system strength compliance date for SSS Providers to 2 December 2025.

arrangements will be maintained in the Rules until 1 December 2025. This means that in the interim SSS Providers must address any system strength shortfalls declared by AEMO. After the 1 December 2025 the new standard will be relied on to deliver adequate levels of system strength for the NEM.

Additionally, because of the time required to plan and design their networks from the first System strength report, SSS Providers would not be required to comply with the new reporting requirements under the final rule until its 2023 TAPR. Similarly, DNSPs and TNSPs would not be required to report on locational factors until their 2023 TAPRs and DAPRs.

2.4.2 Pricing and revenue arrangements for NSPs

The Commission's final decision is broadly in line with the draft rule with some additional transitional rules in relation to cost pass through arrangements and contingent projects. Additionally, some clarifications have been made to the transitional arrangements for how NSPs have to update their pricing methodologies.

Revenue arrangements

The final rule includes provisions on cost pass through arrangements and contingent projects will provide greater certainty to SSS Providers and the AER in relation to how SSS Providers can recover their efficient costs of providing system strength services in their current regulatory control period and the next regulatory control period.

As such, the final rule include a new transitional rule that:

- extends the deadline for submitting a cost pass though application until the earlier of:
  - the end of the SSS Provider's current regulatory control period; and
  - the second anniversary of the effective date of the final rule.
- deems a system strength project proposed to be undertaken by a SSS Provider in its next regulatory control period to be a contingent project for the purposes of its revenue determination for that period. In doing so it:
  - sets out deemed 'trigger events' for that contingent project;
  - provides that the SSS Provider is not required to include the proposed contingent capital expenditure for this contingent project in its revenue proposal and the AER is not required to make a determination under clause 6A.8.1(b) of the NER in relation to this contingent project.

Pricing methodology updates

The transitional arrangements in the final rule require an amended pricing methodology to be submitted by 30 November 2022 by every SSS Provider (ie TransGrid, ElectraNet, Powerlink, TasNetworks and AEMO) and every other TNSP who may have system strength connection points on its network (ie AusNet and Ausgrid).

Additionally, DNSPs are not required to itemise system strength charges for individual customers in their annual pricing proposals. However, in their pricing proposals that are due in April or May 2023 (as applicable), DNSPs must explain how they will pass through system

strength charges in accordance with Clause 6.20.3A of the NER, i.e. explain how they will replicate the amount, structure and timing of the SSS Provider's system strength charge as far as is reasonably practicable.

2.4.3 Demand side and system strength mitigation requirement implementation commencing 15 March 2023

Under the final rule, the access standards and SSMR commence on 15 March 2023. This is the date that the SSUP will be first published by SSS Providers. As such, this is the first date that all the required information will be available to prospective connection applicants to allow a connection to negotiate its new access standards as well as make a fully informed decision regarding how it will undergo the SSMR.

To achieve this, the transitional arrangements specify:

- AEMO updating its SSIAG by 1 December 2022, which includes:[63]
  - a methodology for the relevant NSP to calculate the:
    - — SSQ and SSL factor for the SSMR.
    - — SCR for assessing the new SCR access standards — Clauses S5.2.5.15(b), S5.3.11(b) and S5.3a.7(b) — which form the basis of the system strength quantity of the system strength charge.
  - guidance about the circumstances in which a system strength locational factor is not reasonably able to be determined or would be manifestly excessive.
  - guidance and specified information on how a preliminary and full impact assessment should be carried out to determine the general system strength impact of a new connection (or alternation to an existing plant).
- SSS Providers updating their transmission pricing methodologies such that these can be used to calculate the SSUP for publication as part of their prices for the first time on 15 March 2023 - as discussed in section 2.4.2.
- TNSPs who are not SSS Providers as well as DNSPs updating their transmission pricing methodology or distribution pricing proposals to allow for the pass through of the system strength charge and reflect the system strength unit price - as discussed in section 2.4.2.

As such, on this date, the existing 'do no harm' obligation with be evolved into the SSMR as well as the introduction of the new access standards.

Which ongoing connections fall under the new SSMR obligation?

The following transitional arrangements apply to connections applications:

1. Applicants who submitted a connection enquiry by 15 March 2023, but not an application to connect, will come under the new SSMR and access standard arrangements.
2. Applicants who submitted an application to connect by 15 March 2023 but have not received an offer to connect will by default, come under the existing arrangements (i.e.

63 The final rule specifies that AEMO is to publish the revised SSIAG by 1 December 2022 rather than 15 March 2023 to provide sufficient time for NSPs to implement the changes made to the guideline as a consequence of this rule change.

required to comply with 'do no harm' and not need to meet the new access standards). However, these applicants can ask the NSP to allow them to connect under the new framework.

3 CONTRIBUTING TO THE NEO: WHY WE HAVE EVOLVED THE SYSTEM STRENGTH FRAMEWORK

This Chapter discusses:

- how the final rule meets the rule making test for changes to the NER, including:
  - how it contributes to achieving the national electricity objective (NEO)
  - the more preferable and differential rule tests
  - other requirements under the NEL
  - declared network functions.
- the assessment framework for considering the rule change request
- the summary of reasons for making the rule.

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

3.1 Rule making test — Contributing to the achievement of the NEO

Under the NEL the Commission may only make a rule if it is satisfied that the rule will, or is likely to, contribute to the achievement of the NEO.[64] This is the decision-making framework that the Commission must apply.

The NEO is:[65]

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

The relevant aspects of the NEO that apply to this rule change are the price and security of supply of electricity, and the security of the national electricity system. The Commission agrees with the rule change proponent in stating that the rule change "relates specifically to achieving an appropriate balance between the security of the power system and the price consumers pay for that security".[66]

3.1.1 Making a more preferable rule

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

64 Section 88 of the NEL.
65 Section 7 of thence.
66 TransGrid, *Efficient management of system strength on the power system* rule change request, p. 21.

In this instance, the Commission has made a more preferable rule. The reasons are summarised below in section 3.3.

3.1.2 Making a differential rule

The Commission has determined not to make a differential rule. See section A.2.4 for the definition of a differential rule and the Commission's ability to make a differential rule.

As the proposed rule related to parts of the NER that apply in the Northern Territory, the Commission has assessed the final rule against additional elements required by the Northern Territory legislation.[67] The Northern Territory modification regulations modify the application of some of the chapters in the NER that have been amended by the final rule. Therefore, further changes may be required to those regulations as a result of this rule change. The Commission will continue to engage with the Northern Territory government in this regard as required.

3.1.3 Other requirements under the NEL

In making this final determination, the Commission has also had regard to the:

- **Form of regulation factors:** Under section 88A of the NEL, the Commission must take into account the form of regulation factors when making a Rule that specifies an 'electricity network service' as a 'direct control network service'.[68] On balance, the Commission considers that the system strength transmission service should be a prescribed transmission service, as opposed to a negotiated transmission service or an unregulated transmission service. The Commission's full consideration of the form of regulation factors is set out in Appendix A.2.1.
- **Revenue and pricing principles:** Under section 88B of the NEL, the Commission must take into account the revenue and pricing principles if the Rule being made relates to transmission system revenue and pricing.[69] In general, the Commission has sought in the development of the final rule to meet the revenue and pricing principles by applying the existing economic regulatory framework to the greatest extent possible. The Commission's full consideration of the revenue and pricing principles is set out in Appendix A.2.2.

3.1.4 Declared network functions

The Commission may only make a rule that has effect with respect to an adoptive jurisdiction if satisfied that the proposed rule is compatible with the proper performance of Australian Energy Market Operator (AEMO)'s declared network functions.[70]

---

67 From 1 July 2016, the NER, as amended from time to time, apply in the NT, subject to derogations set out in regulations made under the NT legislation adopting the NEL. Under those regulations, only certain parts of the NER have been adopted in the NT. (See the AEMC website for the NER that applies in the NT.) National Electricity (Northern Territory) (National Uniform Legislation) Act 2015.

68 The form of regulation factors are set out in section 2F of the NEL.

69 That is, items 15 to 24 of Schedule 1 to the NEL.

70 Section 91(8) of the NEL.

The more preferable final rule is compatible with AEMO's declared network functions because it is consistent with those functions. The final rule is capable of working in harmony with AEMO's performance of those functions. While the final rule requires AEMO to perform additional functions, those are consistent with, and are able to be integrated with, AEMO's declared network functions. The Commission's full consideration of this is set out in Appendix A.2.3.

3.2 NEO assessment framework

In assessing the rule change request against the NEO the Commission has considered the following principles, which are consistent with those set out in the consultation paper for the initiation of this rule change request:[71]

- **Promoting power system security:**[72] Having regard to the potential benefits associated with improvements to system security brought about by the proposed rule changes, weighed against the likely costs including both implementation and ongoing costs.
- **Appropriate risk allocation**: The allocation of risks and the accountability for investment and operational decisions should rest with those parties best placed to manage them. Where practical, operational and investment risks should be borne by connecting parties, such as businesses, who are better able to manage them.
- **Technology neutral**: Regulatory arrangements should be designed to take into account the full range of potential market and network solutions. Technologies are changing rapidly, and, to the extent possible, a change in technology should not require a change in regulatory arrangements.
- **Flexibility:** Regulatory arrangements must be flexible to changing market and external conditions. They must be able to remain effective in achieving security outcomes over the long-term in a changing market environment.
- **Transparency, predictability and simplicity:** The market and regulatory arrangements for system strength should promote transparency and be predictable, so that connecting parties can make informed and efficient investment and operational decisions.
- **Implementation costs:** Regulatory change typically comes with some implementation costs for regulators, the market operator and/or market participants. These costs are ultimately borne by consumers. The cost of implementation should be factored into the overall assessment of any change.

71 Stakeholders largely agreed with these principles in response to the *System Services* Consultation paper, including Engie, pp. 1-2; Neoen, p. 1; and CleanCo, p. 3. In addition to these supporting principles, some stakeholders also suggested additional considerations. The Commission agrees with the importance of these suggested considerations and has accounted for them as sub-components in the Commission's assessment of the rule against the relevant overarching principles listed here and the NEO itself.

72 System security underpins the operation of the energy market and the supply of electricity to consumers.

3.3 Summary of reasons

The Commission has assessed the rule change request against the above principles and has had regard to the issues raised in the rule change request. In doing so, the Commission considers the final rule will, or is likely to contribute to the achievement of the NEO better than the:

- current arrangements
- proposed rule or alternatives suggested by the proponent or other stakeholders
- the draft rule.

The reasons the Commission considers the final rule better achieves the NEO than the proposed rule are that the final rule:

- promotes power system security at least cost
- more effectively allocates risk
- is technology neutral
- is sufficiently flexible to cater for a changing market environment
- provides for greater clarity, predictability and simplicity.

The following sections explain each reason in turn.

3.3.1 The final rule promotes power system security at least cost

To maintain a secure and stable power system, a number of core power system requirements always need to be met, through the provision of certain technical capabilities, which can be described as "essential system services". One of these services is system strength.

As detailed in Chapter 1, not having enough system strength can cause major problems - all increasing costs to consumers. These problems include:

- Managing the security of the system: without adequate amounts of system strength, AEMO must place significant constraints on (or disconnect) non-synchronous, IBRs or intervene in the market and direct synchronous coal, gas and hydro generators to keep running, or both. These interventions affect NEM dispatch outcomes resulting in higher costs for consumers.
- How electricity is supplied: Sufficient levels of system strength are also important for supporting the connection of renewable IBRs and batteries, and by extension, enabling the transition to a decarbonised power system.

The final rule promotes the efficient provision of adequate levels of system strength by:

- harnessing economies of scale and scope for its supply by TNSPs
- having more practical lead times in delivering system strength solutions
- efficiently reducing demand for system strength.

Harnessing economies of scale and scope of the TNSP

The more preferable final rule harnesses economies of scale through the coordinated and centralised approach to the provision of system strength by the SSS Provider. The existing

framework does not facilitate a coordinated delivery of system strength, at least to the levels needed to facilitate effective IBR operation.

The current 'do no harm' framework has resulted in IBR generators installing small, individually tailored assets to meet their own obligations. [73] The Commission considers this lack of coordination of system strength schemes is likely to be inefficient.

These inefficiencies arise in the power system's operation due to private assets being operated to maximise their own benefit, rather than to benefit the system. System strength is considered in isolation by these parties, stopping them from considering adjacent power system security needs. For example building a synchronous condenser with a fly wheel to provide both system strength and inertia services from a single asset. The proliferation of individual system strength remediation schemes (including synchronous condensers owned by third parties as well as tripping schemes) creates:

- additional power system operation complexity for both NSPs and AEMO and
- system security risks, rather than mitigating them like the scheme is designed to do.

The final rule seeks to address these issues through harnessing economies of scale in having the TNSP centrally procuring system strength solutions at lowest cost, as proposed by TransGrid. Under the rule TNSPs will be required to plan, design, operate and maintain their transmission network in order to meet network performance requirements at the locations on their network that AEMO has declared to be system strength nodes.[74]

The Commission considers that TNSPs are best placed to consider what mix of solutions will maximise operational efficiency. This will enable greater coordination, such as consideration of what solutions can be used to provide system strength in aggregate. For example:

- pursuing a smaller number of larger assets which may be cheaper than a larger number of smaller assets,
- providing system strength through means other than building assets, for example through contracting with existing synchronous generators to provide system strength, or
- coordinating asset design and build to provide multiple system security services as well as gain efficiencies by accounting for interactions with other obligations under the NER and ongoing network infrastructure projects.

Additionally, the technologies that provide system strength — such as synchronous condensers and generators, and potentially grid-forming inverters in the future — also provide other system services such as inertia and reactive power that TNSP's are currently responsible for. Coordinating the provision of these services by a single TNSP may help unlock scope economies and drive beneficial outcomes for customers.

Through the rule change request process, the Commission considered an alternative approach for system strength provision based on workably competitive markets. However, this was not considered appropriate due to the characteristics of system strength services,

73 A typical example is several solar farms connecting within a region and each installing a small synchronous condenser - an asset used to provide system strength. In such examples the solar farms tend to operate those assets only when needed to facilitate their own export.

74 Clause S5.1a.9 and clause S5.1.14 of the Final Rule.

specifically its scope of competition and measurability, given the current technology mix and understanding of the service at this time. It is noted that the ESB's Post 2025 work and the AEMC's *Investigation* and the draft determination of this rule all noted a preference for a structured procurement approach, as opposed to workably competitive markets, for system strength.[75]

The Commission also considered whether it is more appropriate for AEMO (in its role as system operator) or for a subset of TNSPs to be provided obligations to act as the procurer of system strength in the planning timeframe.[76] The Commission prefers the provision of system strength as a regulatory obligation on the coordinating TNSPs - known as SSS Providers - because, consistent with the existing framework (outside of Victoria), the evolved framework utilises the transmission economic regulatory framework to efficiently meet the standard. That is, this framework is designed around having a single monopoly provider of a service, which is considered fit-for-purpose when procuring system strength. The incentives it provides to that single buyer, in turn, creates efficiencies in service provision from which the benefits flow to consumers. In contrast, AEMO has no such oversight or incentive structure, and typically only handles short term service procurement.

By integrating SSS Providers' obligations into existing TAPR planning processes, TNSPs will be able to co-optimise all their system service obligations and resultant network investments with their obligations under the system strength standard. This promotes the SSS Provider's ability to maximise economies of scope. This is particularly important when planning to meet minimum fault levels, as TNSPs will be able to co-optimise system strength solutions with other power system stability services, such as reactive power control or inertia.

Within Victoria, AEMO has declared network functions where it effectively acts as a TNSP in the investment timeframe. Consistent with the approach within Victoria for transmission planning and investment more generally, AEMO will run competitive tenders when a solution (or portfolio of solutions) is identified. However, the planning of the network is undertaken in a centrally coordinated manner by AEMO as the Victorian TNSP. Therefore, the benefits of economies of scope and scale will still eventuate in Victoria.

There will be one SSS Provider per region, in order to promote the central coordination efficiencies. However, recognising that there is a need to coordinate with other networks, under the final rule, with SSS Providers are obligated to consult closely with other TNSPs and DNSPs about the most optimal solutions when undertaking planning to meet the obligations under the new system strength standard.

Hence, the final rule will promote greater efficiency of the power system's operation by centralising the delivery of these services through a single procurer and operator - the TNSP. This will improve economies of scale and scope in the provision of system strength and other services, noting that AEMO and the market as a whole is still learning how to operate the

75 AEMC, *Efficient management of system strength on the power system* - Draft determination, April 2021, pp. 9-10. AEMC, *Investigation into system strength frameworks in the NEM*, October 2020, pp. 19-20. ESB, Post 2025 market design final advice - Part A, August 2021, Chapter 4.

76 In Victoria, AEMO has declared network functions and so will be obligated to plan to provide system strength.

system through the use of services rather than using a known combination of system configurations.

Importantly, the approach leverages the SSS Providers' and AEMO's existing skills and experience in the delivery of the minimum system strength requirements. This also assists to reduce implementation costs and timeframes.

More practical lead times for delivering system strength solutions

Reactivity of the current framework is another issue which concerned the Commission.

The reactive nature of the current arrangements is due to AEMO only being required to forecast shortfalls in the availability of system strength, and SSS Providers to procure services to meet these shortfalls. These forecasts must be based around expectations of future patterns of generation dispatch, which is complex and require a number of assumptions to be made. AEMO has found it difficult to identify these shortfalls sufficiently far in advance to allow SSS Providers to undertake timely planning processes. While AEMO's modelling and forecasting future shortfalls is steadily improving, the rapid rate of change in the power system means it is likely to make this process increasingly difficult.

The Commission is concerned that maintaining the current reactive approach would see consequences such as:

- the continuation of the under-procurement that are already occurring under the current frameworks, resulting in AEMO interventions and IBR constraints
- an increased risk of not enough system strength being supplied in time, which would result in bottlenecks in new connections, and the curtailment of existing IBR generation
- rising energy prices for consumers due to a reduction in output from current and future IBR which could increase wholesale market price outcomes.

The final rule therefore requires AEMO and the SSS Providers to actively plan for the delivery of efficient levels of system strength, over the long term timeframes that are considered in the current planning processes for other network services. It makes AEMO's forecasting role more workable by no longer requiring it to consider 'typical dispatch patterns' when forecasting likely minimum fault levels. Instead, AEMO will project the minimum fault levels required, and this will form the basis of the SSS Providers' obligation under the standard.

Under the standard SSS Providers will be required to use reasonable endeavours to maintain the minimum three-phase fault level as determined by AEMO, and to achieve stable voltage waveforms for the level and type of IBR projected by AEMO in steady state conditions and following credible contingency.[77] The first part represents the minimum level of system strength required for system security, and the second represents an estimation of the efficient level of the service for future grid connections (i.e. that which maximises the net benefits to consumers, inclusive of the costs, of system strength in the system).

The solutions that SSS Providers include in their plans to meet the standard can include building network infrastructure, such as a synchronous condenser, or contracting with

77 Clause S5.1.14(b) of the Final Rule.

synchronous generation. These planned solutions under the standard cannot include constraining or disconnecting parties. However, the Commission considers that these strategies should be available to use in the operational timeframe, where it will be efficient for maintaining system security. While it is acknowledged that one of the objectives of this final rule is to minimise these system security interventions by AEMO, the Commission considers that it will be inefficient to eliminate them completely. The costs of SSS Providers providing system strength services so that IBR could have unconstrained access will in all likelihood exceed the benefits of the reduced generation costs.

The Commission considers the final rule's approach for the system strength standard best promotes the NEO given the magnitude of the transition to renewable IBRs and batteries and the associated importance of ensuring there is adequate system strength. How the Commission views stakeholder concerns about the potential risk of creating stranded assets is discussed below in Section 3.3.2.

Minimising demand of system strength into the future

As well delivering a more efficient supply of system strength, the final rule seeks to efficiently reduce demand for it. It does this by introducing:

- two new access standards for connecting parties that act as a floor to ensure a minimum level of performance into the future
- the system strength mitigation requirement, including the system strength charge, that provides an incentive for connecting parties to make efficient locational decisions and install equipment that reduces demand for system strength in circumstances that reduce overall system costs.

Combined these measures puts a stronger downward pressure on demand for system strength compared to the current framework, with the overall effect of reducing total system costs.

Access standards

The new access standards require:

- connecting IBR loads, Market network service providers (MNSPs) and IBR generators to demonstrate that they can operate stably down to a minimum short circuit ratio (SCR) of 3.0.[78]
- asynchronous generators to continue to operate stably during sudden changes in voltage (which is related to system strength).[79]

These standards have the effect of reducing the plant's demand for system strength on the system. Having these minimum technical requirements avoids placing undue reliance on price signals which are only ever meant to be approximate. Absent of this safety net, substantial costs, or even system security related issues, may arise. This cost minimisation rationale is

78 Clause S5.2.5.15, S5.3.11, and S5.3a.7 of the Final Rule.

79 Clause S5.2.5.16 of the Final Rule. The minimum access standard is to not include any vector shift or similar relay or protective function that acts upon voltage phase angle which might operate for phase angle changes less than 20 degrees at the connection point.

the basis for the Commission's selection of the minimum SCR of 3.0. It is considered to reduce system costs without acting as a barrier to connection to the most projects. The addition of negotiation principles in the standard is to allow those to still connect for those that may struggle to meet an SCR of 3.0 without adding further cost onto consumers.

The short circuit ratio access standard was proposed by the proponent while the voltage phase shift access standard is additional to that proposed by the proponent. Further detail on this aspect of the preferable final rule, including stakeholder views on these issues and the Commission's analysis is set out in Appendix D.

System strength mitigation requirement

This effect of the access standards in efficiently reducing demand for system strength is strengthened by the signals being sent by the system strength mitigation requirement (SSMR). The SSMR evolves and expands the current 'do no harm' arrangements and will allow a new connecting generator, IBR load or MNSP to choose between:

- paying the system strength charge (to make use of the system strength provided by the SSS Provider); or
- remediating its *general system strength impact*.

This component of the final rule builds on the proposal in the rule change request to require TNSPs to charge connecting generators for the provision of system strength services in the future.[80] It has done this through designing the charge so that it sends ongoing efficient signals to connecting parties. If they elect to pay the charge, the final rule allows connected parties to subsequently reduce their exposure to the system strength charge at any time after connection by altering their plant to consume less system strength service. The Commission sees this as a key benefit, as it incentivises efficient use of system strength services for the lifetime of the connection asset. This includes incentives for industry to develop and deploy advanced inverter technology as soon as it is effective and efficient to do so. In the future, (subject to AEMO's system strength impact assessment guidelines) 'grid forming' or 'virtual synchronous machine' inverter technology may be able to avoid the charge entirely.

The Commission considers that the final rule will have the effect of reducing demand for system strength to efficient levels, and incentivise its efficient use, thus the rule promotes power system security and is consistent with the NEO.

Further detail on this aspect of the final rule, including stakeholder views on these issues and the Commission's analysis is set out in Appendix E.

3.3.2 The final rule more efficiently allocates risk

The final rule more effectively allocates risk through:

- evolving the existing minimum system strength and 'do no harm' frameworks and more efficiently sharing the costs with connecting parties; and

80 TransGrid, *Efficient management of the power system - rule change request*, April 2020, p. 11.

- the forward-looking approach, where the benefits of avoiding under-procurement outweigh the risks of over-procurement and stranded assets.

Evolving the existing frameworks to effectively share costs between parties

The costs of system strength are currently shared between generators and customers. Customers pay for system strength given that TNSPs have obligations to provide minimum levels of system strength in a region if a shortfall has been declared, with this paid for by consumers explicitly through the usual TUOS arrangements. In addition, to the extent that there is not enough system strength in a region and AEMO has to either constrain or direct on generators, consumers pay for the provision of system strength implicitly through higher costs in the wholesale market, given the provision of this has been bundled in with the supply of electricity. Generators who connect to the network pay for system strength in order to 'do no harm' as they connect.

Because the provision of system strength - and the associated costs - is included in other components of consumers' bills (e.g. the wholesale price, or the regulated cost of providing transmission) this has led to some parties seeing it being provided for 'free'. However, with the changing generation mix, the amount of system strength that is automatically provided in the system as a "by-product" of synchronous generation is declining, with the costs of providing it through this means increasing. In addition, more shortfalls of system strength are being declared requiring TNSPs to procure more system strength. The current arrangements for providing system strength, and paying for it, do not result in the lowest cost outcomes for consumers.

Therefore, consistent with the ESB's post-2025 market design advice, unbundling the service, paying those providing it, and providing price signals for innovation in the service are all now appropriate measures. This begun with the 2017 rule change with introduced the sharing of the unbundled system strength service between generators and customers through the 'do no harm' framework as set out above. This approach is evolved by this final rule with the ultimate vision, as set out by the ESB, being a co-optimised market-driven framework for system strength provision.

The Commission did not agree with the proponent that the 'do no harm' obligations should be completely removed and to rely only on access standards to provide sufficient investment and locational signals.[81] This is because the locational signals provided by the negotiation of generator performance standards is a complex process and is bilateral between the connecting party and the relevant NSP. A specific charge delivers the most accurate reflection of actual costs resultant from the connection of new IBR, incentivising efficient behaviour by connecting parties, and allows for these costs to offset those required for the centrally coordinated provision of the service.

The Commission has made a more preferable rule that evolves the 'do no harm' obligation into the SSMR. Charging connecting IBR the forward looking cost of the provision of system strength incentivises the efficient use of the service by connecting parties. The charge sends

81 TransGrid, *Efficient management of system strength on the power system — rule change request*, April 2020, p. 3.

clearer investment and locational signals through its three components (system strength quantity, price and locational factor) which are each designed to signal to new connections a certain aspect of the impact on system strength. As such, this should result in more efficient decisions being made by new connecting parties, being in the long term interest of consumers who gain the result of lower total system costs.

Further detail about the system strength mitigation requirement and the charge, including stakeholder views on these issues and the Commission's analysis is set out in Appendix E.

Forward-looking approach to procurement to deliver net benefits to customers

The Commission considers that there are significant benefits associated with a purposefully forward-looking approach for the provision of system strength.[82] These benefits stem from the systemic under-procurement the existing arrangements are providing to the market and as such the evolved framework this final rule puts in place is providing more system strength to the NEM. This will reduce constraints placed on the system as well as allow more lower cost generation to be connected and dispatched; which all lead to lower cost for consumers in the long run.

This forward-looking approach is a shift in the way transmission investments can be made by TNSPs. This is due to the nature of system strength investments; i.e. that they have an asymmetry of total costs towards over-procurement being more beneficial than under procurement. This point is illustrated in Box 4. However, the Commission notes this approach could result in instances of over-procurement and stranded assets, as noted by some stakeholders throughout the rule change process.

Over time, it is possible and preferable that a workably competitive market could emerge to efficiently deliver solutions for system strength. This approach will be consistent with the ESB's Post 2025 work. However, as previously noted, analysis considered by the Commission strongly suggests that a system strength ancillary-style market is not possible at the current time. The Commission's use of a supply and demand side approach to evolving the framework is a deliberate step to enable a market to emerge, and regulatory arrangements shift, if market and technology changes allowed for it to occur.

Additionally, it has been three years since the 2017 rule change and no merchant market to support the coordination of 'do no harm' remediation assets has developed. As such, the Commission is concerned that continuing to wait for such a merchant market solution to emerge and coordinate the 'do no harm' remediation solutions of individual connections risks further increasing the costs and inefficiencies in the connection process. The risk of these costs increasing is significant given expectations of future investments in IBR technologies.

Fundamental to the Commission's final determination is its analysis of risk asymmetry of total costs. The Commission compared under and over procurement of the service, using a

82 Forward-looking approach of the final rule is achieved through AEMO forecasting the system strength standard specification three years in advance of the SSS Provider having to meet them. Three years is considered sufficient time for the SSS Provider to plan and procure the necessary solutions as required under the standard. These obligations are reflected in Clause S5.1.14, 5.20.6 and 5.20.7 of the Final Rule.

simplified model, through the Investigation final report. A summary of this analysis is set out in the Box below.

BOX 4: ASYMMETRY OF TOTAL COSTS OF UNDER AND OVER SERVICE PROCUREMENT

A critical challenge is how to determine the optimal solution(s) to meet future system strength needs. Forecasts of future needs will necessarily never be right, and so there is always the possibility that there may be too much or too little system strength actually provided.

There will be some optimal level of system strength for which the total system costs are minimised, noting there is always the prospect that forecast errors and unexpected changes that result with more or less system strength than is optimal. So, an important question is how total system costs change if we procure too much or too little system strength.

For simplicity the below analysis assumes that synchronous condensers are used to fill gaps in system strength requirements, noting that the Commission expects and encourages a portfolio approach to the procurement of system strength solutions under the evolved framework. Therefore, the analysis considers what are the relative risks associated with procuring too many versus too few synchronous condensers by using modelling of how total system costs change depending on whether we deliver too many or too few synchronous condensers. The modelling approach is summarised in the note of this Box.

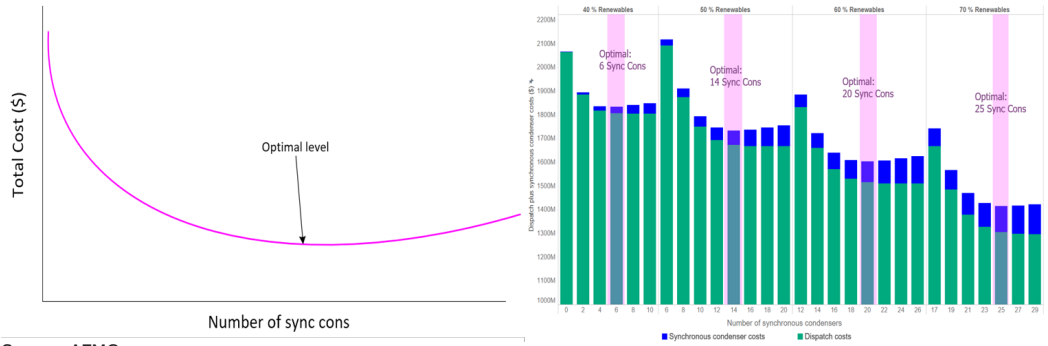
There are two key observations from the modelling.

1. Synchronous condensers provide diminishing marginal benefits: the reduction in total costs arising from the second synchronous condenser installed is less than the first synchronous condenser installed. The benefit comes in the form of lower dispatch costs. But as the number of synchronous condensers is increased, eventually costs flatten out and more synchronous condensers provide no additional value.

2. Synchronous condensers have constant marginal costs: Although the benefits of synchronous condensers vary depending on how many synchronous condensers are in the system, the costs are constant. Put simply, the next synchronous condenser costs the same as the last synchronous condenser.

This is an obvious but important observation, because when the cost curves for dispatch costs and synchronous condenser costs are combined, it yields the total cost curve shown in Figure 3.1. The total cost curve falls sharply as the optimal level is approached – ie, the point on the curve where total costs are minimised – and then slowly start to rise again.

Figure 3.1: Illustration of constant marginal cost of synchronous condensers



Source: AEMC

The important feature of Figure 1.1 is the asymmetry between having too few synchronous condensers and having too many. Meaning that it is less costly to have an additional synchronous condenser than have one less than the optimal level of the service. This is the result that is borne out by our modelling shown in the right-hand side graph where the results of our modelling and the clear asymmetry in costs between having too few synchronous condensers and too many, for different assumed levels of IBR plant penetration.

Note: The modelling has involved examining outcomes in a single, simplified region. The first stage of the model is to determine the optimal combination of existing generation, new renewable and thermal plant, as well as synchronous condensers to: meet all standard dispatch constraints (eg, supply-demand balance, minimum and maximum generation constraints etc); satisfy minimum system strength constraints for sub-regions of the region; allow hosting of renewable generation capacity, subject to limits arising from the amount of system strength in each sub-region. Having determined the optimal level of synchronous condensers, the second stage of the modelling involved assessing how total system costs change when we alter the number of synchronous condensers in the system. In particular, we have modelled how total system costs are altered when we build fewer and more synchronous condensers than optimal.

In consideration of the assessment principles discussed in section 3.2, the Commission recognises that the approach taken in this final determination means the allocation of costs will still be between consumers and generators as they are currently, but that they will be split more appropriately and transparently. That is, new connecting plants who utilise the system strength service will be required to contribute to cost of SSS Provider's system strength provision, while the stranded asset risk (and potentially some small residual costs) is allocated to consumers. This means to the extent that investments are made to meet the system strength standard that are ultimately not required with the benefit of hindsight, or are made earlier than efficient, or made too late, the costs associated with these decisions will be recovered from consumers. There are checks and balances in place - both specific to system strength and in the transmission economic regulatory framework more generally which has the AER overseeing approval of efficient expenditure - to minimise the stranded asset risk such that consumers do no bear unnecessary costs.

In theory, the most efficient outcome would be to deliver exactly the right amount of system strength, at precisely the right time and locations, to satisfy demand. However, due to the complexities of forecasting system strength shortfalls in time to allow for solutions to be in place, this is unlikely to occur in practice. Further, the asymmetries of risk and cost associated with the coordinated provision of system strength means that the magnitude of any stranded asset risk will be outweighed by the benefits of operational and investment

efficiencies, which is in turn likely to outweigh any stranded asset risk costs. Additionally, the regulation of TNSP's expenditure to meet the standard by the AER adds extra rigour to limit stranded asset risk to customers.

The Commission considers that supplying system strength where demand is expected but may not yet have arrived — means that it is very likely that there will be sufficient system strength in the system and this will decrease costs to the system of providing a secure supply of energy. It is of higher importance to avoid under procuring system strength services due to the risks this has for customers, which are significant in the context of the scale of the transition.

Further, the Commission considered that the demand of system strength by IBR in the power system is expected to continue to grow, out to the medium term. As such, while the Commission considers that the final rule's forward-looking approach appropriately allocates risk, it notes that the final determination implements the new standard based on analysis and assumptions around the rapid pace of the transition. Its approach for the final rule is a practical one, that seeks to mitigates the consequences of inefficient market outcomes increasing consumer bills due to a lack of system strength. However, the transformation underway is complex, which means that there are uncertainties about how it will play out, including the technological developments that may be around the corner.

The Commission is satisfied that the framework builds in flexibility to account for technological changes resulting in less system strength being needed; where demand for the service is reduced the framework will see less system strength being procured. However, any reduction in demand for the service will be dependent on whether technology changes are realised in the short-term, and there is uncertainty over this. In light of this it is important that how this standard is implemented is closely monitored and whether today's assumptions continue to hold true.

To do this, the Commission is committed to closely monitor the operation of the standard with the other market bodies - the AER and AEMO - to ensure that the provision of system strength continues to be done in a manner that serves the best interests of consumers.

3.3.3 The final rule is technology neutral

The final rule is technology neutral. Its definition of system strength allows for a broad range of system strength solutions and it takes and takes a technology neutral approach to resources looking to connect to the system by also applying obligations to loads.

Supporting a diverse range of system strength solutions

Consistent with the draft rule and the final Investigation Report, the final rule evolves the definition of system strength to be broader than just fault current to allow for a range of solutions. Through this the final rule supports both emerging and existing technologies in the supply of system strength. It does by expanding the regulatory focus of the evolved

framework to looking at the outcome of providing the service - i.e. provision of services that lead to a stable voltage waveform.[83]

This allows services that do not necessarily provide (much) fault current to be included in the SSS Provider's portfolio of solutions to provide system strength. Examples of such solutions include batteries with grid forming batteries and retuning of inverters. Both of these examples have had some success in past trials, and further investigation to their deployment in the NEM is occurring allowing for them to be allowed more easily.

These solutions are supported by the demand side and SSMR reforms, which incentivise the development and deployment of these technologies as soon as it is efficient and effective to do. It does so by charging new connections for the system strength quantity they require to connect and operate stably (as linked to the new SCR standards), and in doing so provides as incentive to use inverter (and other) technology that minimises that amount.

Diverse technological solutions are also supported through the SSS Providers role in translating the system strength technical requirements at the nodes into system strength solutions. The SSS Providers are not constrained by the rule in pursuing any new and innovative technological solutions that may emerge. These solutions could involve innovations in the way existing technologies are used to support system strength as well as enabling and supporting innovative new technologies. This promotes the NEO as service innovation is expected to lead to more competition for providing the services, which in turn leads to lower cost provision of system strength and lower cost to consumers.

Taking a technology neutral approach to loads

The more preferable final rule is also technology neutral in the way it treats loads.[84] When connecting under Chapter 5 of the NER, certain inverter based loads will face the same incentives under the SSMR as generators and MNSPs. This is because all three (inverter based loads, inverter based generators, inverter based batteries and MNSPs) create demand for system strength services in the same way. As such, these loads face similar decisions regarding their use of system strength as generators will and therefore can be appropriately captured under the SSMR. The Commission considers that this approach promotes consistency and can be considered technology neutral — it targets the charge on those parties' effects on the system, that is, those that demand system strength, regardless of the resource type.

The Commission's decision to expand the arrangements to include load is technology neutral because all resources that 'demand' system strength are incentivised in the same way. It is also consistent with the direction of the ESB's effective integration of distributed energy resources (DER) and flexible demand workstream under the Post 2025 market design project, which includes steps towards a two-sided market and a trader services model. The trader services model would seek to make the Rules more focused on services as opposed to being

83 Clause S5.1.14(b) of the Final Rule.

84 This is achieved through appropriate loads (as determined by AEMO in the SSIAG, clause 4.6.6(a)(5) and (6) of the Final Rule) having to comply with the new short circuit ratio access standard (clause S5.3.11 of the Final Rule) and the SSMR (clause 5.3.4B of the Final Rule).

based on assets. This would include providing for greater regulatory flexibility to supporting innovation by attaching obligations to services at connection points as opposed to attaching them to registration categories and assets. The final rule is consistent with this policy direction as it places similar obligations on loads, that require system strength, to generators and MNSPs. This is done through the inclusion of a new access standard that applies to inverter based loads that consume system strength.

3.3.4 The final rule is sufficiently flexible to cater for a changing market environment

The final rule preparing the power system for the future through providing greater certainty that efficient levels of system strength will be available, and promoting flexibility to cater for changing system needs. The final rule is sufficiently flexible to cater for changing market environments. It caters for this by enabling:

- AEMO to set the standard and maintain documents to reflect changing market conditions
- the TNSP (SSS Provider) to determine the most efficient solutions
- the AER to determine the methodology for parts of the system strength charge
- flexibility for connecting parties to self-remediate or pay the system strength charge
- coordination with jurisdictional policies.

Providing AEMO with ongoing role in setting the standard and maintaining documents to reflect changing market conditions

The final rule continues AEMO's responsibility to forecast the NEM's system strength needs. It does so by providing AEMO with the flexibility to outline how to do so in the *system strength requirements* methodology how it will set the system strength standard specifications.[85] These specifications change the magnitude of the new standard, but not its intention, which is set out in the NER, and is to reflect the efficient level of system strength given the changing market conditions. These specifications are determined by AEMO each year in its system strength report.[86] The Commission considers that enabling the specifications to be adjusted from year to year will provide sufficient flexibility to cater for changing conditions.

The final rule also continues AEMO's role is updating and maintaining the *system strength impact assessment* guidelines as well as the *methodology*. In doing so, the rule gives AEMO scope to amend these documents with industry consultation to best reflect the market conditions of the time without the need for a rule change. This includes:

- how technology advancements change the way inverters 'demand' system strength
- the reliance on synchronous generator combinations in modelling the system's needs and minimum fault levels
- changes in the connection process
- changes in the ability to forecast IBR connections.

85 Clause 5.20.6 of the Final Rule.
86 Clause 5.20.7 of the Final Rule.

That is, it allows AEMO to provide for the integration of 'grid forming inverters effectively and efficiently once they are comfortable with the parameters around their performance. Additionally, this flexibility in the final rule also allows AEMO to decide on how it treats issues such as planned outages through its *system strength requirements methodology.*

Allowing flexibility for the SSS Provider to determine the most efficient solutions

Another key aspect of the final rule is the flexibility it provides for the SSS Provider to translate IBR forecasts set out in AEMO's system strength report into the system strength solutions for meeting the standard at each node.[87] It allows for, and incentivises SSS Providers to consider a full range of solutions in order to determine what is the most efficient. The final rule also envisages SSS Providers being collaborative in their approach to meeting the standard through joint planning with AEMO, neighbouring TNSPs and DNSPs. The Commission considers that having multiple players contributing to planning (but not procuring) for the standard will help promote flexibility and adaptability which is important in the context of changing market needs.

Flexibility for the AER in determining the methodology for parts of the system strength charge

The final rule gives flexibility to the AER to determine how a critical aspect of the system strength charge will be derived. That component relates to whether the TNSP incremental costs will be derived using long-run marginal costs (LRMC) or long-run average costs (LRAC). The Commission notes that marginal costing should be considered as a way to achieve economically efficient outcomes while noting that other aspects also need to be taken into account in determining the basis for cost recovery.

However, rather than prescribe that the charge should reflect marginal costs, this flexibility is provided in the final rule because determining LRMC can be more challenging and costly than LRAC, which may in any event be a good approximation of the LRMC.

Allowing the AER to have the flexibility to change the methodology for the SSUP, being the forward-looking costs of the TNSP, results in the framework being future proofed without the need for a rule change if TNSP investment conditions change.

Flexibility for the connecting parties to choose to self remediate or pay the system strength charge

Under the final rule, any connecting party could choose to remediate their own system strength requirements in order to avoid the SSMR, in a manner similar to the existing arrangements. In practice, the Commission expects that this approach is likely to occur where a connecting party connects in areas of the grid which are electrically remote from a designated system strength node, because they will be likely to face a very high system strength remediation charge for the use of the system strength service provided by the SSS Provider.

87 Clause S5.1.14(b) of the Final Rule.

This approach will allow for connecting parties not to pay the charge where they are able to innovate and therefore provide the service themselves at a cost lower than the charge reflecting the forward-looking costs of the SSS Provider. This is in recognition that the circumstances of connections can greatly vary, as well as to maintain discipline on SSS Providers to keep pace with the expected innovation in the provision of system strength to drive down costs.

The requirement will apply across the entire NEM, with connecting parties having the choice to remediate or pay the charge wherever they connect, with the charge varying between locations.[88]

Flexibility to coordinate with jurisdictional policies

The final rule maintains the use of (system strength, previously fault level in the draft determination) nodes to represent the surrounding network topography. This approach allows integration of this framework into that of jurisdictional renewable energy zone (REZ) programs. That is, the evolved framework has been designed to efficiently and effectively provide system strength to support significant renewable and battery connection in a particular area, such as a REZ.

This will be done through AEMO's declaration of system strength node(s) in the REZ, resulting in the SSS Provider investing in, or procuring, the required solutions to facilitate the connection of the IBR in that area. AEMO is also required to make its system strength forecasts based off its ISP and ESOO reports, which are in turn required to account for jurisdictional policies.[89]

Additionally, the SCR standard allows for jurisdictions to include their own lower SCR requirement on connections, specific to their REZ programs. These lower, REZ-specific SCRs, which will result in less centrally provided system strength services to have to be funded by jurisdiction but are more difficult for the generator to meet, will then be registered in that connections GPS. This registration of the SCR in the GPS will then capture that generator under the system strength charge and allow the recouperation of system strength provision costs under the NER framework.

The Commission is working with jurisdictions as how to best leverage this final rule in their jurisdictional policies.

3.3.5 The final rule provides for greater clarity, predictability and simplicity

The final rule:

- provides greater transparency and certainty about the costs that connecting parties will bear earlier in the connection process
- clearer and simpler system strength investment price signals for new connections

88 The Commission has moved away from the idea proposed in the Investigation final report that the system strength mitigation requirement would only apply in 'system strength zones'. The rationale for this is to avoid potential issues arising from administratively delineating between areas in which the charge would apply, and areas where the existing 'do no harm'arrangements' would largely be retained.

89 Clause 5.20.6(f)(3)(i) of the Final Rule and Clause 5.22.3(b) of the NER respectively.

- avoids unnecessary complexity in the rules
- provides clear transitional arrangements.

Greater certainty for connecting parties

The current framework has resulted in poorly coordinated system strength provision, especially in relation to the connection of new IBR plant. This piecemeal approach to the provision of system strength has added additional costs, risks and time to the connection process. The remediation requirements and costs of one generator depends on, among many other things, its own system strength impact, as well as how its impact relates to recent connections of other generators. This has led to a situation where given the significant amounts of generators connecting to the NEM, requirements for individual plants may change as they progress through the connection process, adding administrative costs and time to understand the impact of the individual generator, as well as to determine (and re-determine) the appropriate remediation approach.[9091]

At the extreme, in some areas of the NEM connections have needed to be assessed on a case by case basis, in the order in which they connect. This has also led to delays in parties connecting to the network, potentially in excess of a year.

This approach has also meant that the cost of remediation changes from original estimates, the prospect of which represents a risk for connecting generators, particularly if finances have been agreed. To the extent this is occurring, generators or their financiers may seek to manage this risk through a higher cost of capital, which is ultimately recovered from consumers.

Information asymmetries also exist due to the difficulty that connecting generators face in accessing the models required to assess their own system strength impact during the connection process. These asymmetries exist due to the power system modelling required to understand the full impact that a particular generator has on the system, and therefore the cost of the remediation required to connect, which involves confidential information that only AEMO is able to possess. Therefore, potential connection applicants are not able to access the information required to assess their potential impact prior to undergoing the connection process.

The final rule addresses these issues primarily through a coordinated and centralised approach to the provision of system strength under the new system and network standard (Schedules 5.1a and 5.1 of the final rule) for system strength that the SSS Provider must meet. It is also achieved through a predictable and transparent charging regime for connecting parties to use that service under the system strength mitigation requirement.[92]

Under the final rule, the price of the system strength services paid by connecting parties will be relatively stable over time at any given location, and unaffected over short timeframes by the connection of other parties. This means that connecting parties connecting in a part of

90 Submissions to the Investigation into system strength frameworks - Discussion paper: Innogy, p. 2; ElectraNet, p. 6; AGL p. 1; Enel Green Power, p. 3; CEC, pp. 3-4; CEIG p. 2; Infigen, p. 1.

91 Submissions to the draft determination: Terrain Solar, p. 1; Tilt Renewables, p. 1; AER, p.1; CEC, p.4.

92 Clause 4.6.6 and 5.3.4B of the Final Rule.

the network where system strength is being provided by the SSS Provider will be able to more confidently understand at an early stage in their connection process the likely costs of connection relating to system strength via the transparent formula for the system strength charge.[9394]

Under the final rule, the system strength charge will apply for the system strength charging period (typically five years), and during this period, the system strength unit price and the locational factor cannot change.[9596] However, these components of the charge may change in the subsequent periods, reflecting changes in the estimate of the forward-looking cost of its provision, which could see either an increase or decrease.

The evolved framework strikes an appropriate balance between the extent of variability of the charge changing (resulting in risks for investors) and the accuracy of the price signals sent by the charge under the SSMR.

The burden on connecting parties to model their system strength impact, and various remediation options, will also be reduced because a connecting party can choose to pay the charge early in the connection process. This is done at the preliminary impact assessment stage in response to a connection enquiry and will be carried out using simple, isolated modelling — being a single machine infinite bus model. Should a connecting party elect to remediate its impact (perhaps because the charge is very high because the connecting party's location is electrically remote from a system strength node), then the more complex and lengthy full impact assessment process — as per the current arrangements— is required to determine the remediation requirement. In this case, the connecting party has selected this route in full knowledge that it has these necessary, lengthy processes. In turn, these effects should speed up the connection process and reduce the administrative burden and uncertainty associated with the costs and risks of connection to the power system for connecting parties.

Each NSP will also be required to publish the SSL factors for each system strength connection point for which it is the relevant NSP, and the corresponding system strength node. This will be published in the DNSP and TNSP's annual planning reports, promoting transparency for connecting parties to form estimates of the charge and to inform their locational decisions.[97]

---

93 The final rule differs from the draft rule in that it adds a negotiation principle to clause S5.2.5.5(r1), which clarifies that where a generator has elected to pay the charge, the fault ride through response should not be set at a level that requires a greater amount of system strength than will be provided by the SSS Provider.

94 The final rule also provides greater clarity for AEMO, TNSPs and connecting generators through specifying that the SSIAG will set out the responsibility for conducting wide-area EMT modelling to ensure that connecting generators who pay the charge will be able to operate stably.

95 Based on the current duration of transmission regulatory control periods, this will be a five-year period. The five-year period runs from the second year of a regulatory control period until the first year of the subsequent regulatory control period. See clause 6A.23.5(b) of the Final Rule. The period does not align with the regulatory control period because if the system strength charge is determined in the first regulatory year, it will be based on estimated costs.

96 Clauses 6A.23.5(f) and (i) of the Final Rule. However, the AER may provide for indexation of the unit price in the Pricing methodology guidelines.

97 Clause 5.12.2(c)(13) and Schedule 5.8(g) of the Final Rule.

Clearer and simpler system strength investment price signals for new connections

The changes made under this final rule look to improve transparency and investment certainty for generators and set a clear direction for how transmission networks, AEMO and new energy generators such as batteries, and energy loads like hydrogen electrolysers should work together to keep system voltage stable. The expected outcome from this is that investors will be able to avoid a long, complex and potentially costly process when a new generator is negotiating to connect to the network. Additionally, the reforms should also reduce the need for costly and market-distorting interventions in the market by AEMO, putting investors in a better position to clearly gauge investments.

The final rule promotes clearer and simpler investment price signals to new connections through the evolution from the 'do no harm' obligation to the SSMR as well as the supply and demand side arrangements.

The evolution of 'do no harm' into the SSMR includes the option for new connections to pay a charge to avoid having to undergo a full impact assessment and the associated remediation obligations. This is a new and different avenue to obtaining compliance with clause 5.3.4B of the NER. This allows them to better account for their impact on system strength and the associated costs. This in turn creates a simpler, faster and more predictable renewables and battery connection process and promotes investor confidence.

The Commission has taken a balanced approach to the provision of greater certainty to connecting parties. This is reflected in the approach to constraints. As noted earlier in section 3.3.1, the Commission considers that it would be inefficient to provide IBR with unconstrained access. This means that while the final rule provides greater certainty through the connections process, this does not extend to generators being guaranteed to physical or financial access in exchange for paying the charge.

The final rule also makes additions to the TAPR requirements for SSS Providers that look to support this creation of clearer and simpler system strength investment price signals. Specifically, the intent of these clauses are to:

- provide transparent information on available system strength to guide investment decisions by generator developers
- give an early indication of opportunities for market participants to offer non-network solutions prior to RIT-T commencement
- allow for the AER to assess whether an SSS Provider is meeting the obligations of the system strength standard.

Avoids unnecessary complexity in the rules through leveraging existing frameworks

The final rule leverages current frameworks for economic regulations and does not duplicate or create unnecessary bespoke system strength rules. This is in the interests of promoting clarity, predictability and simplicity, and for minimising administrative costs.

To support this the final rule classifies the provision of system strength by the TNSP as a prescribed transmission service, with the TNSP required to meet a system strength standard at certain locations (i.e. nodes) on its transmission network.[98] Making system strength service a prescribed transmission service means that it will be subject to the same forms of economic regulation as any other prescribed transmission service. TNSPs are incentivised, via the existing economic regulatory framework, to provide the service efficiently. The AER has regulatory oversight of these costs through the revenue determination process.

In making the decision the Commission has considered the proponent's proposal that AEMO should have a reserve obligation to declare a system strength shortfall as a Network Support and Control Ancillary Service (NSCAS) gap.[99] The Commission views the decision to exclude system strength from the NSCAS framework remains appropriate and should be maintained for this final rule. This is on the basis of the various structural limitations associated with the NSCAS framework, including its reactive, ad hoc nature and the significant time delays associated with its implementation. This stems from an ability for the TNSP to be able to wait and rely on AEMO to act as a procurer of last resort for 'an NSCAS need' rather than acting in a timely manner. Therefore, such an approach is undesirable as the system strength framework is looking to provide timely procurement of system strength solutions to facilitate the transition of the power system.

It is noted that the final rule differs from the draft in that it no longer sets the service as part of prescribed TUOS services but rather as prescribed common services. As the customer benefits relating to the provision system are not locational, the service will be set as part of the prescribed common services will mean it has fully postage stamped prices (being the same regardless of the customer's location) and therefore does not affect some customers based on their location. This is discussed further in Appendix E.

Clear transitional arrangements

The final rule sets out clear and practical transitional arrangements to support implementation that reflect the Commissions desire to implement the evolved framework as soon as practical.

Importantly the final rule makes clear that the new access standards and charge are not applied retrospectively. The system strength charge and new technical access standards will only apply to new connecting plant. The Commission considered that applying the new access standards to existing parties will require renegotiation of performance standards and therefore, reopening an existing connection agreement. Negotiating a new set of performance standards and the required physical changes to equipment may involve significant costs for a connecting party, and therefore, is not considered appropriate. In addition, the final rule is not intended to alter the terms or contractual rights or obligations of the parties to existing connection agreements.

98 The Commission considered which form of regulation would be appropriate for the system strength service. For example, the service could be provided as a prescribed transmission service or negotiated transmission service. There are a range of reasons that lead to the conclusion on which of these could be appropriate, as discussed in Appendix A.2.1 in the form of regulation factors.

99 TransGrid, Efficient management of system strength on the power system — rule change request, April 2020.

There are also minor changes to the final rule compared to the draft to provide the clarity and certainty needed for implementation. This includes the date that AEMO is required to publish its system strength report.

The transitional arrangements and changes made following stakeholder feedback on the draft rule are explained out in Appendix F.

ABBREVIATIONS

AC	alternating current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ASRR	Annual service revenue requirement
Commission	See AEMC
DNSP	Distribution network planning report
EMT modelling	electromagnectic transient modelling
ESB	Energy Security Board
ESOO	Economic statement of opportunities
ESS	essential system services
FIA	Final impact assessment
GPS	Generator performance standards
IBR	Inverter based resource
ISP	Integration system plan
LRAC	Long-run average costs
LRMC	Long-run marginal costs
MCE	Ministerial Council on Energy
MNSP	Market network service provider
MVA	Megavolt amperes
MW	megawatt
NEL	National Electricity Law
NEO	National electricity objective
NSCAS	Network support and control ancillary services
NSP	Network service provider
PIA	Preliminary impact assessment
PLL	phase locked loop
RIS	Renewable integration study
RIT-T	Regulatory investment test for transmission
SCR	short circuit ratio
SMIB model	single machine infinite bus model
SSC	System strength charge
SSL	System strength locational factor
SSM	System security mechanism
SSMR	System strength mitigation requirement
SSQ	System strength quantity

SSS Providers	System strength service providers
SSUP	System strength unit price
TAPR	Transmission annual planning report
TNSP	Transmission network service provider
TUOS	Transmission use of services
UCS	Unit Commitment Scheduler

A LEGAL REQUIREMENTS UNDER THE NEL

This appendix sets out the relevant legal requirements under the NEL for the Commission to make this final rule determination, which includes:

- the Commission's power to make this more preferable final rule determination
- the Commission's considerations in making this final rule determination, including:
  - form of regulation factors
  - revenue and pricing principles
  - declared network functions
  - application to the Northern Territory
- civil penalties
- conduct provisions.

A.1 Final rule determination

In accordance with s. 102 and 103 of the NEL the Commission has made this final rule determination in relation to the rule proposed by TransGrid.

The Commission's summary of reasons for making this final rule determination are set out in Chapter 3 and in further detail in appendices B to F.

A copy of the more preferable final rule is attached to and published with this final rule determination. Its key features are described in Chapter 3 and in more detail in appendices B to E.

A.1.1 More preferable rule

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

In this instance, the Commission has made a more preferable final rule. The Commission's reasons for making a more preferable rule are summarised in Chapter 3 and set out in further detail in appendices C to F.

A.1.2 Power to make the rule

The Commission is satisfied that the more preferable final rule falls within the subject matter about which the Commission may make rules. The more preferable final rule falls within s. 34(1)(a)(ii) and (iii) of the NEL as it relates to the:

- operation of the national electricity system for the purposes of the safety, reliability and security of that system
- activities of persons (including registered participants) participating in the national electricity market or involved in the operation of the national electricity system.

In addition, the more preferable final rule falls within a number of the matters set out in Schedule 1 to the NEL, being items 11 to 13 (relating to the operation of transmission systems), 15 to 20 and 24 (relating to transmission revenue and pricing), 26K (relating to electricity network services), 30F (relating to AEMO) and 34(c) (relating to payment of money).

A.2 Commission's considerations

In assessing the rule change request, the Commission considered:

- its powers under the NEL to make the rule
- the rule change request
- submissions received during first and second rounds of consultation
- consultation undertaken during the *Investigation* and the findings of the Final report
- stakeholder feedback received during ten sessions of our technical working group as well as numerous bilateral meetings
- the Commission's analysis as to the ways in which the proposed rule will or is likely to, contribute to the NEO
- the form of regulation factors in making a rule that specifics an electricity network service as a prescribed network service[100]
- the revenue and pricing principles.[101]

There are no current Ministerial Council on Energy (MCE) statements of policy principles.[102]

A.2.1 Form of regulation factors

The AEMC must take into account the form of regulation factors in making a rule that specifies an electricity network service as a direct control network service.[103] A direct control network service includes an electricity network service that the Rules specify as a service the price for which, or the revenue to be earned from which, must be regulated under a transmission determination.[104] In its final rule, the Commission has provided for the new system strength transmission service to be a prescribed transmission service.[105]

In determining which form of economic regulation should apply there is a trade-off between the various forms of regulation, in particular between the:

- direct and indirect cost of different forms of regulation

100 Part 1, s 2F and s 88A of the NEL.

101 Part 1, s 7A and s 88B of the NEL.

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

103 Sections 88A of the National Electricity Law.

104 Section 2B of the National Electricity Law.

105 See amendment to paragraph (b) of the definition of 'prescribed transmission service' in the final Rule.

- effectiveness of each form of regulation at limiting the exercise of market power held by a network service provider in the provision of a service.

The form of regulation factors are set out in section 2F of the National Electricity Law. Their application to a service indicates the extent of likely market power the service provider has in the provision of that service. Where the prospect of market power is high, the possible scope of economic inefficiencies arising from that market power is also high. All else equal, this justifies more heavy-handed forms of regulation, despite the prospect of higher direct and indirect regulatory costs. Conversely, where the factors indicate that market power may be more modest, the economic inefficiencies arising from this market power are also likely to be lower. In turn, all else equal this justifies more light-handed regulation with lower direct and indirect regulatory costs.

On balance, and particularly due to the AEMC's analysis of form of regulation factors (a) and (b) relating to barriers to entry and economies of scale and scope, the Commission considers that the system strength transmission service should be a prescribed transmission service, as opposed to a negotiated transmission service or an unregulated transmission service. The AEMC's analysis of the factors is provided below.

Table A.1: **AEMC consideration of the form of regulation factors**

FACTOR	HOW AEMC HAS TAKEN INTO FACTOR ACCOUNT
(a) the presence and extent of any barriers to entry in a market for electricity network services	The system strength transmission service appears to have considerable barriers to entry. These arise due to the economies of scope (discussed with regard to factor (b)) and economies of scale owing to potentially high capital costs resulting in declining average costs in the provision of the service. The transmission service can only be provided by a System Strength Service Provider (SSS Provider), and there can only be one System Strength Service Provider in a region.
(b) the presence and extent of any network externalities (that is, interdependencies) between an electricity network service provided by a network service provider and any other electricity network service provided by the network service provider	There appears to be strong interdependencies between the provision of the system strength transmission service and other services also provided by the SSS Provider. Many of the assets that provide the transmission service can also provide other system services provided by the TNSP. For example, synchronous condensers can provide reactive support (voltage control), in addition to providing system strength. Augmentations to transmission lines can also provide system strength and other prescribed transmission services. There are also network externalities and interdependencies between system strength transmission services provided to different System Strength Transmission Service Users. The system strength transmission service does not use dedicated network assets or non-network services that are procured to provide the service to a specific individual user. Instead, those assets or non-network services are used to provide system strength transmission services to multiple users, with investment based on forecasts of future connections over the 10-year planning period. This results in considerable economies of scale and interdependencies between system strength transmission services provide to different System Strength Transmission Service Users, which makes regulation as a prescribed transmission service more appropriate. This is a key difference between this service and system strength connection works, which are a negotiated transmission service provided to an individual user based on specific investment to meet the needs of that user. SSS Providers are well-placed to capture these scope economies through their existing planning

FACTOR	HOW AEMC HAS TAKEN INTO FACTOR ACCOUNT
	processes for meeting other system standards. These issues are discussed in Appendix C.
(c) the presence and extent of any network externalities (that is, interdependencies) between an electricity network service provided by a network service provider and any other service provided by the network service provider in any other market	There do not appear to be material interdependencies between the system strength transmission service and any other service provided by the SSS Provider in another market. As noted in relation to factor (b) above, investment to provide this service occurs on a forward looking basis over the 10-year planning period. As a result, there are limited externalities between this service and negotiated or unregulated transmission services provided by TNSPs to connection applicants as part of the connection process.
(d) the extent to which any market power possessed by a network service provider is, or is likely to be, mitigated by any countervailing market power possessed by a network service user or prospective network service user	There may be some countervailing market power by actual and prospective network service users. System Strength Transmission Service Users are not individual end-consumers of electricity, who may have few resources and little ability to negotiate the service provision. Instead, the users are typically substantial sized organisations who may have some countervailing market power. System Strength Transmission Service Users also have some countervailing market power due to having the option to remediate their system strength impacts instead of purchasing the system strength transmission service. Nevertheless, the provision of the service on a negotiated or unregulated basis would be inconsistent with the SSS Provider's obligations to undertake forward looking investment so that it can provide the service to any System Strength Transmission Service User who wishes to purchase it. As discussed above, the SSS Provider would not undertake investment to meet the specific requirements of individual users, so there is limited scope for meaningful negotiation in relation to the nature of the service provided to a specific user. It would be also inconsistent with the revenue and pricing principles to require the SSS Provider to undertake investment so that the service was available for any future users who wished to purchase it but classify it as a negotiated service which would result in a significant risk that the SSS Provider could not recover its efficient costs.
(e) the presence and extent of any substitute, and the elasticity of demand, in a market for an electricity network service in which a	There may be substitutes for the system strength transmission service provided by the SSS Provider, giving rise to elasticity of demand. For example, prospective or current users of the service could choose to remediate their system strength impact as a substitute for the system strength

FACTOR	HOW AEMC HAS TAKEN INTO FACTOR ACCOUNT
network service provider provides that service;	transmission service provided by the SSS Provider. Users could also make decisions that reduce the amount of the service they are required to purchase based on where they locate or the type of equipment they install. However, in doing so, these users would forgo the benefits of economics and scope and scale achieved through the centralised TNSP procurement process. It is for this reason that the system strength charge has been designed to incentivise users of the service to, for example, locate in a part of the network which utilises less of the service, or to make investments in equipment which reduces their usage of the service.
(f) the presence and extent of any substitute for, and the elasticity of demand in a market for, electricity or gas (as the case may be)	The elasticity of demand for electricity is not likely to be a material factor and does not appear sufficiently high to justify the provision of the service as a negotiated or unregulated service.
(g) the extent to which there is information available to a prospective network service user or network service user, and whether that information is adequate, to enable the prospective network service user or network service user to negotiate on an informed basis with a network service provider for the provision of an electricity network service to them by the network service provider	The Commission considers that primarily due to factors (a) and (b), the service should be a prescribed transmission service, making any information required for adequate negotiation of the service irrelevant. As noted above, the SSS Provider undertakes investment on a forward looking basis to provide the same service to all current and potential future users, so there is limited scope for negotiation in relation to the nature of the service provided to a specific user.

A.2.2 Revenue and pricing principles

The AEMC must take into account the revenue and pricing principles in making a rule for or with respect to transmission system revenue and pricing.[106]

The revenue and pricing principles are set out the National Electricity Law.[107] The following discusses how the AEMC has taken into account the principles in making this final rule.

In general, the Commission has sought in the development of the final rule to meet the principles by applying the existing economic regulatory framework with limited amendments. This framework is designed to be consistent with the principles.

106 Section 88B of the National Electricity Law.

107 Section 7A (subclauses 2 to 7) of the NEL.

Table A.2: **AEMC consideration of revenue and pricing principles**

PRINCIPLE	HOW AEMC HAS TAKEN INTO PRINCIPLE ACCOUNT
(2) A regulated network service provider should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs in (a) providing direct control network services; and (b) complying with a regulatory obligation or requirement or making a regulatory payment.	Under the final rule, the system strength transmission service is a prescribed transmission service. As a prescribed service, the SSS Provider would be provided a reasonable opportunity to recover the efficient costs in its provision consistent with the existing economic regulatory framework under Chapter 6A of the National Electricity Rules.
(3) A regulated network service provider should be provided with effective incentives in order to promote economic efficiency with respect to direct control network services the operator provides. The economic efficiency that should be promoted includes— (a) efficient investment in a distribution system or transmission system with which the operator provides direct control network services; and (b) the efficient provision of electricity network services; and (c) the efficient use of the distribution system or transmission system with which the operator provides direct control network services.	Under the final rule, the SSS Provider would be provided incentives for efficient investment in the network and non-network services used by the SSS Provider to provide system strength transmission services, and incentives for efficient provision of the service, consistent with the existing incentives provided under the economic regulation framework. For example, expenditure made by the SSS Provider in the provision of the service could be subject to the efficiency benefit sharing scheme and the capital expenditure sharing scheme developed by the AER.[1] Prices for use of the system strength transmission service will be set by the SSS Provider in accordance with its approved pricing methodology and the AER's pricing methodology guidelines. The pricing principles for the system strength charge in the final rule[2] require pricing methodologies to have regard to the desirability of providing signals for efficient investment and service utilisation decisions by users of the service.
(4) Regard should be had to the regulatory asset base with respect to a distribution system or transmission system adopted— (a) in any previous—	The final rule does not affect the existing processes by which the regulatory asset based is determined.

PRINCIPLE	HOW AEMC HAS TAKEN INTO PRINCIPLE ACCOUNT
(i) as the case requires, distribution determination or transmission determination; or (ii) determination or decision under the National Electricity Code or jurisdictional electricity legislation regulating the revenue earned, or prices charged, by a person providing services by means of that distribution system or transmission system; or (b) in the Rules.	
(5) A price or charge for the provision of a direct control network service should allow for a return commensurate with the regulatory and commercial risks involved in providing the direct control network service to which that price or charge relates.	Consistent with the discussion about principle (2), the total revenue received by the SSS Provider for the provision of system strength transmission services includes a return commensurate with the regulatory and commercial risks involved in providing prescribed services.
(6) Regard should be had to the economic costs and risks of the potential for under and over investment by a regulated network service provider in, as the case requires, a distribution system or transmission system with which the operator provides direct control network services.	Consistent with the discussion relating to principle (3), under the final rule, the SSS Provider will be provided incentives for efficient investment in the network assets and non-network services with which the SSS Provider provides system strength transmission services, and incentives for efficient provision of the service, consistent with the existing incentives provided under the economic regulation framework.
(7) Regard should be had to the economic costs and risks of the potential for under and over utilisation of a distribution system or transmission system with which a regulated network service provider provides direct control network services	The risks and costs of under- and over-utilisation is addressed under the final rule that provide price incentives for potential users of the system strength transmission service to use the system more efficiently. The risks and costs of over- or under-provision of the service, versus the standard for the service,[3] leading to under- or over-utilisation of the system respectively, is addressed via the existing economic regulation framework which provides incentives for the TNSP who is the SSS Provider to provide the service consistent with the service standard in an efficient manner, and the

PRINCIPLE	HOW AEMC HAS TAKEN INTO PRINCIPLE ACCOUNT
	pricing principles for system strength charges.

Note: [1] Clauses 6A.6.5 and 6A.6.5A of the NER. [2] Clause 6A.25.2(h) of the final Rule. [3] See the standard in clauses s.5.1.14 and s.5.1a.9 of the final Rule.

A.2.3 Declared network functions

The Commission may only make a rule that has effect with respect to an adoptive jurisdiction if satisfied that the proposed rule is compatible with the proper performance of AEMO's declared network functions.[108] The more preferable final rule is compatible with AEMO's declared network functions because it is consistent with those functions as it is capable of working in harmony with AEMO's performance of those functions. While the final rule requires AEMO to perform additional functions in relation to the declared network, those additional functions are consistent with, and are able to be integrated with, AEMO's existing declared network functions.

The Commission may only make a Rule that affects the allocation of powers, functions and duties between AEMO and a declared transmission system operator (DTSO) if AEMO consents to the making of the Rule, or the Rule is requested by the Minister of the relevant adoptive jurisdiction.[109] The Commission considers that the final rule does not affect the allocation of powers, functions and duties between AEMO and a DTSO and therefore, does not propose to seek consent from AEMO to the making of the Rule.

Application under Chapter 6A

Schedule 6A.4 of the NER sets out how Chapter 6A is modified in its application to AEMO in its capacity as a TNSP providing shared transmission services. These modifications give effect to the key difference from other TNSPs, which is that AEMO does not have an AER approved revenue determination, but instead, AEMO consults on and publishes a revenue methodology setting out the method for calculating its maximum allowed revenue.[110] However, like other TNSPs, AEMO has a pricing methodology approved by the AER.[111] AEMO has consulted on its proposed pricing methodology for the period 1 July 2022 to 30 June 2027 and is expected to submit this to the AER soon.[112]

Schedule 6A.4 makes some minor modifications to how Part J of Chapter 6A applies to AEMO. The final rule makes minor amendments to S6A.4 to clarify the application of the final rule to AEMO,[113] so that it remains consistent with the performance of AEMO's declared network functions. The final rule is consistent with AEMO's declared network functions because AEMO is responsible for allocating the ASRR for prescribed TUOS services,[114] and the new system strength transmission service forms part of prescribed TUOS services.[115] Specifically, the final rule inserts a modified:

---

108 Section 91(8) of the NEL.

109 Section 91(9) of the NEL.

110 Clause S6A.4.2(c) of the NER.

111 Clause S6.A.4.2(K) of the NER.

112 Available here: https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/tuos-pricing-methodology/pricing-methodology-2022-2027.pdf?la=en

113 See clause S6A.4.2(k) item 2 of the final Rule.

114 Clause S6A.4.2(k) item 1 modification to paragraph (g) in clause 6A.23.3.

115 See the amended definition of 'prescribed TUOS service' in the final Rule.

- definition in item 1 in S6A.4.2(k) for 'system strength charging period' for the purposes of clause 6A.23.5 of the final rule.[116] Clause 6A.14.3(e) of the NER (which requires the AER to approve a regulatory control period of 5 regulatory years) is inapplicable to AEMO.[117] This amendment made by the final rule enables a system strength charging period to apply to AEMO.
- item 2 in S6A.4.2(k) to reflect the same amendment made in the final rule to clause 6A.24.1(e), which is modified in its application to AEMO in S6A.4.2(k).
- definition of 'regulatory control period' in Chapter 10 of the NER as it relates to AEMO so that it is defined as a period over which AEMO's approved pricing methodology applies.[118] There is an issue under the current Rules where the definition of 'regulatory control period' means the period that AEMO treats as a regulatory control period for the purpose of its pricing methodology cannot legally be a 'regulatory control period' under the Rules. However, the definition has not been modified in S6A.4 for AEMO. While this is an existing issue, it is exacerbated by the final rule. Therefore, the Commission has made an amendment that applies to AEMO in respect of all references of 'regulatory control period' in the Rules. The definition does not specify that the period must be five years, consistent with the modification in clause S6A.4.2(f)8(b).

Application under Chapter 5

Clauses 5.1A.1(d) of the NER sets out a general statement of the responsibilities under Part B of the Rules that are allocated between AEMO and a DTSO in relation to transmission services provided by means of, or in connection with, the declared transmission system of an adoptive jurisdiction. This division of responsibilities means that:[119]

- a reference to a network service provider is, in relation to the provision of *connection services*,[120] to be read as a reference to a declared transmission system operator;
- a reference to a network service provider is, in relation to the provision of *shared transmission services*,[121] to be read as a reference to AEMO.

While the final rule introduces new obligations on network service providers (and connecting parties) during the connection process,[122] it does not change the allocation of responsibilities between AEMO and DTSOs in relation to the provision of shared transmission services and connection services in the declared transmission system.

---

116 See clause S6A.4.2(k)1 in the final Rule, which is a modification to clause 6A.23.4 of the NER as it applies to AEMO.

117 It is modified by clause S6A.4.2(k)8(b) of the NER.

118 See the amended definition of 'regulatory control period' in Chapter 10 of the final Rule.

119 See for example, clause 5.1A.1(d) and rule 5.3B of the NER.

120 Defined in Chapter 10 of the NER as: An entry service (being a service provided to serve a Generator or a group of Generators, or a Network Service Provider or a group of Network Service Providers, at a single connection point) or an exit service (being a service provided to serve a Transmission Customer or Distribution Customer or a group of Transmission Customers or Distribution Customers, or a Network Service Provider or a group of Network Service Providers, at a single connection point).

121 Defined in Chapter 10 of the NER as: A service provided to a Transmission Network User for use of a transmission network for the conveyance of electricity (including a service that ensures the integrity of the related transmission system).

122 Principally this relates to the introduction of two new access standards to be negotiated between the NSP, connecting party and AEMO for AEMO advisory matters, as well as the introduction of the system strength charge which must be determined by the relevant NSP. See Appendix C for further information on these changes.

Paragraphs (e) and (f) of clause 5.1A.1 specify particular provisions in which a reference to a network service provider will, in relation to the declared transmission system of an adoptive jurisdiction, be construed as a reference to AEMO or the DTSO. Paragraph (f)(8) specifies rule 5.20C. This means that a reference to a network service provider in rule 5.20C will, in relation to the declared transmission system of an adoptive jurisdiction, be construed as a reference to AEMO.[123] Under rule 5.20C, the network service provider is also the system strength service provider.[124] This has not been amended by the final rule and therefore, AEMO remains the network service provider who is the system strength service provider in an adoptive jurisdiction (i.e. in Victoria).

A.2.4 Application to Northern Territory

Under the Northern Territory legislation adopting the NEL, the Commission may make a differential rule if, having regard to any relevant Ministerial Council on Energy (MCE) statement of policy principles, a different rule will, or is likely to, better contribute to the achievement of the NEO than a uniform rule.

A differential rule is a rule that:

- varies in its term as between:
  - the national electricity system, and
  - one or more, or all, of the local electricity systems, or
- does not have effect with respect to one or more of those systems

but is not a jurisdictional derogation, participant derogation or rule that has effect with respect to an adoptive jurisdiction for the purpose of section 91(8) of the NEL.

As the proposed rule related to parts of the NER that apply in the Northern Territory, the Commission has assessed the more preferable final rule against additional elements required by the Northern Territory legislation.[125]

The Commission has determined not to make a final differential rule. However, as chapters of the NER amended by the final rule apply in the Northern Territory, the amendments made by this rule change will have application in the Northern Territory. The application of the final rule in the Northern Territory will be complex because the Power and Water Corporation is entirely regulated under Chapter 6, rather than Chapter 6A, for economic regulation and pricing purposes. The Northern Territory modification regulations modify the application of these chapters in the Northern Territory, and therefore, changes may be required to those regulations as a result of this rule change. The Commission will continue to engage with the Northern Territory where required in this regard.

123 Clause 5.1A.1(f)(8) of the NER.

124 Clause 5.20C.3(a).

125 From 1 July 2016, the NER, as amended from time to time, apply in the NT, subject to derogations set out in regulations made under the NT legislation adopting the NEL. Under those regulations, only certain parts of the NER have been adopted in the NT. (See the AEMC website for the NER that applies in the NT.) National Electricity (Northern Territory) (National Uniform Legislation) Act 2015.

A.3 Civil penalties

The Commission cannot create new civil penalty provisions. However, it may, jointly with the AER, recommend to the Energy Ministers Meeting that new or existing provisions of the NER be classified as civil penalty provisions.

The NEL sets out a three-tier penalty structure for the NEL and NER. A Decision Matrix and Concepts Table,[126] approved by Energy Ministers, provides a decision-making framework that the AEMC applies, in consultation with the AER, when undertaking the assessment of whether provisions of the Rules should be classified as civil penalties, and if so, under which tier.

The AEMC makes the following recommendations. The AER agrees with these recommendations.

126 https://www.aemc.gov.au/regulation/energy-rules/civil-penalty-tools

Table A.3: **Civil penalty provision recommendations for the final rule**

CLAUSE	CONTENT DESCRIPTION	CURRENT CLASSIFICATION	PROPOSED CLASSIFICATION	REASON
Existing clauses being amended				
5.3.3(b5)(3)	In response to connection enquiry, a NSP is required to provide the connection applicant with: (i) the indicative system strength quantity for the connection point (ii) the system strength locational factor for the connection point; and (iii) the relevant system strength node and the indicative system strength charge using the then current system strength unit price.	Tier 3	Tier 3 Administrative requirements	Align with existing classification. A contravention of this provision would result in a failure to meet administrative requirements on the contents of contracts which may not promote efficient investment in electricity services for the long term interest of consumers.
5.3.4B(a)	Describes the parties that the clause applies to for the system strength mitigation requirement.	Tier 2	No CPP	The content of the existing provision has been moved to paragraph (a2)(1). The new content now in (a) does not require a CPP. See first row in next section.
Existing clauses being moved or deleted				
5.3.4B(a2)	For each proposed new connection or proposed alteration to a connection to which this clause applies, a Network Service Provider must: (1) undertake a system strength impact	None	Tier 2 Market administration	Replacement for civil penalty provision that was in (a). Also adds new content for determination of the system strength charge. A contravention of this provision would

CLAUSE	CONTENT DESCRIPTION	CURRENT CLASSIFICATION	PROPOSED CLASSIFICATION	REASON
	assessment in accordance with the system strength impact assessment guidelines and paragraph (a3); and (2) determine in accordance with paragraph (a4) whether a system strength locational factor can reasonably be determined; and (3) where applicable, determine the system strength locational factor and the system strength quantity for the new connection or proposed alteration in accordance with the system strength impact assessment guidelines.			result in inadequate administrative processes which may not promote efficient investment in electricity services for the long term interest of consumers.
New clauses				
5.3.4C(a)	A Network Service Provider that is not also the relevant System Strength Service Provider must notify the information in paragraph (b) to the relevant System Strength Service Provider within 10 business days of: (1) an election being made under clause 4.3.4B(b1) for the system strength charge to be payable in relation to a new connection or connection alteration; or (2) agreement being reached under clause 5.3.12 to vary the performance of plant at an	N/A	Tier 2 Market Administration	The contravention of the provision could result in inadequate administrative processes which cause unnecessary delays and/or costs onto connecting parties, which does not promote the efficient operation of energy services for the long term interests of consumers.

CLAUSE	CONTENT DESCRIPTION	CURRENT CLAS-SIFICATION	PROPOSED CLASSI-FICATION	REASON
	SSMR connection point, relative to the technical requirements in clause S5.3.11 or clause S5.3a.7 (as applicable).			
5.3.4C(c)	If a Network Service Provider is not also the relevant System Strength Service Provider for a connection, the Network Service Provider within 10 business days of a request from the relevant System Strength Service Provider, provide information reasonably required by the System Strength Service Provider for the purposes of calculating and billing system strength charges.	N/A	Tier 2 Market Administration	The contravention of the provision could result in inadequate administrative processes which cause unnecessary delays and/or costs onto connecting parties, which does not promote the efficient operation of energy services for the long term interests of consumers.
5.3.4C(e)	A System Strength Service Provider must establish and maintain a record of all connections subject to the system strength charge and for which it is the System Strength Service Provider and must include in the record all information reasonably required by the System Strength Service Provider to identify the relevant connection for the purposes of calculating and billing system strength charges.	N/A	Tier 2 Inappropriate market participant behaviour	The contravention of this provision could result in a failure to comply with general information and reporting obligations to a regulator, in this case AEMO, which does not promote the efficient operation of energy services for the long term interests of consumers.
5.3.12(b)	A Network User to which this clause applies, must submit to the Network Service Provider with a copy to AEMO:	N/A	Tier 2 Inappropriate market participant behaviour	Align with equivalent in clause 5.3.9(b)(2). The contravention of this provision would result in a failure to comply with general

CLAUSE	CONTENT DESCRIPTION	CURRENT CLASSIFICATION	PROPOSED CLASSIFICATION	REASON
	(1) a description of the nature of the alteration and the timetable for implementation; (2) in respect of the proposed alteration to the plant, details of the design setting data in accordance with the Power System Model Guidelines, Power System Design Data Sheet and Power System Setting Data Sheet;			information and reporting obligations to a regulator, in this case AEMO, which does not promote the efficient operation of energy services for the long term interests of consumers.
5.3.12(h)	If the application of this clause 5.3.12 leads to a variation to the agreed technical requirements in clause S5.3.11 or clause S5.3a.7 (as applicable) in an existing connection agreement, the Network Service Provider and the Network User must immediately jointly advise the relevant System Strength Service Provider, including the details of any performance standards amended pursuant to this clause 5.3.12.	N/A	Tier 2 Inappropriate market participant behaviour	Align with equivalent in clause 5.3.9(h). The contravention of this clause would result in a failure to comply with general information and reporting obligations to a regulator, in this case AEMO, which does not promote the efficient operation of energy services for the long term interests of consumers.
5.2.3A(d)	A Market Network Service Provider must comply with any terms and conditions of a connection agreement for its connected plant that provide for the implementation, operation, maintenance or performance of a system strength remediation scheme.	N/A	Tier 1 Security and reliability	Align with equivalent in 5.2.3(g1) and 5.2.5(c). The contravention of this clause would result in a failure to ensure effective operation and proper performance of the power system which does not promote the efficient operation of energy services for

CLAUSE	CONTENT DESCRIPTION	CURRENT CLASSIFICATION	PROPOSED CLASSIFICATION	REASON
				the long term interests of consumers.
5.2.4(f)	A Customer must comply with any terms and conditions of a connection agreement for its connected plant that provide for the implementation, operation, maintenance or performance of a system strength remediation scheme.	N/A	Tier 1 Security and reliability	Align with equivalent in 5.2.3(g1) and 5.2.5(c). The contravention of this clause would result in a failure to ensure effective operation and proper performance of the power system which does not promote the efficient operation of energy services for the long term interests of consumers.
5.3.13(a)	A load or MNSP connecting party must not commission altered plant until the NSP has advised them that the provider and AEMO are satisfied that it has been completed in accordance with 5.3.12.	N/A	Tier 1 Security and reliability	Align with equivalent in 5.3.10(a). The contravention of this clause would result in a failure to ensure effective operation and proper performance of the power system which does not promote the efficient operation of energy services for the long term interests of consumers.

A.4 Conduct provisions

The Commission cannot create new conduct provisions. However, it may recommend to the Energy Ministers Meeting that new or existing provisions of the NER be classified as conduct provisions.

The final rule does not amend any rules that are currently classified as conduct provisions under the NEL or National Electricity (South Australia) Regulations. The Commission does not propose to recommend to the Energy Ministers Meeting that any of the proposed amendments made by the final rule be classified as conduct provisions.

B REGISTER OF CHANGES FROM DRAFT RULE TO FINAL RULE

B.1 Summary of all changes to the system strength draft rule to final rule

Table B.1: Register of changes from draft rule to final rule

Chapter 4	
4.6.6(a)(2)	A drafting correction in this subparagraph reflects the intention that the SSIAGs will define 'available fault level' as well as provide guidance about how it is calculated.
4.6.6(a)(4)	A drafting correction to this subparagraph removes the reference to a 'connecting party' since the information will also be required for a proposed alteration to a generating system or other connected plant.
4.6.6(a)(5)	The SSIAGs will include criteria for classification of loads as inverter based loads (dealt with in subparagraph (5)) and the criteria for classification of inverter based resource as large inverter based resources (dealt with in subparagraph (6)). The drafting changes in subparagraph (5) align the wording with subparagraph (6). Consequential changes have been made to the definitions in chapter 10.
4.6.6(a)(8)	This new subparagraph requires the SSIAGs to provide guidance on the methodology to be used by Network Service Providers when undertaking modelling to verify the stability of plant that has elected to pay the system strength charge, as required by clause 5.3.4B(a2)(4).
4.6.6(b)(1A)	A drafting correction changes 'simply isolated model' to 'simple isolated model'.
4.6.6(b)(5)(and (7)	Consequential changes to these subparagraphs reflect changes to clause 5.3.4B. Before the change, the subparagraphs only referred to the options to pay for remediation under old clause 5.3.4B. With the addition of a new option in that clause (payment of the charge) the clause was out of date.
4.6.6(e) and (f)	Changes to paragraphs (e) and (f) extend the right to access the model used for a full impact assessment to a person seeking to alter a generating system or other connected plant. This was an inadvertent omission from the draft rule.
Chapter 5	

5.1.2(d)	The draft rule proposed renumbering the rows in the table. For the final rule, the rows will not be renumbered and instead the new row will be inserted at 8A. This is to assist with other rule change projects that have also proposed changes to the table.
5.2A.2(b)(1) and (8)	This clause deals with designated network assets. The clause states that a Primary Transmission Network Service Provider is not entitled to receive a charge for designated network asset under chapter 6. For the final rule, it is intended that an applicant for connection to a designated network asset should have the choice to pay the system strength charge rather than remediate. The changes to paragraph (b) give effect to this intention by allowing a Primary Transmission Network Service Provider to charge or pass through system strength charges.
5.2A.7(d)(3)	This paragraph deals with the content of a network operating agreement between a Primary Transmission Network Service Provider and the owner of a designated network asset. In order to reflect the policy intention that the Primary Transmission Network Service Provider should be able to undertake works to achieve the standard in S5.1.14 in the most efficient location on the network, a change to sub paragraph (d)(3) requires the network operating agreement to allow for alteration, replacement or augmentation of the designated network asset in connection with the provision of prescribed transmission services.
5.3.1(a)(1)(i)	Changes have been made for the final rule to simplify the drafting.
5.3.1A(c)(4)	Changes to (c)(4) italicise a term that has been defined in chapter 10 since publication of the draft rule.
5.3.3(b5)	A minor drafting change aligns the wording with the drafting in another clause.
5.3.4	Minor drafting changes in paragraphs (a)(3), (a2), (a2)(4) and (a4) are intended to align better with clauses 5.3.9 and 5.3.12, which apply to alterations to connected plant.
5.3.4B(a2)(4)	This new sub paragraph gives effect to the policy intention that the Network Service Provider should undertake wide area EMT modelling to check stability of plant where the proponent has elected to pay the system strength charge.
5.3.4B(b1)	Minor drafting changes removes redundant words and better reflect clauses 5.3.9 and 5.3.12, which apply to alterations to connected plant.
5.3.4B(f)(3)	Minor drafting changes are intended to align better with clauses 5.3.9 and 5.3.12, which apply to alterations

	to connected plant.
5.3.4B(h)	The amendment removes the requirement for the ratings of the proposed plant to be provided in MVA. This reflects feedback during consultation that this may not be a valid requirement for all plant. The balance of the clause allows the information to be requested by AEMO or the NSP where reasonably required.
5.3.4C	A minor drafting change in paragraph (a) clarifies the intention of the clause and in (c) removes redundant words.
5.3.12	Changes to the heading and paragraphs (a) and (b)(4) achieve better consistency with clause 5.3.9 and correct the drafting.
5.3.13	New clause 5.3.12, included in the draft rule, deals with alteration to plant subject to the new supply side standards for system strength. It mirrors clause 5.3.9, which in turn relies on clause 5.3.10 at the commissioning stage. An equivalent to clause 5.3.10 has been included as 5.3.13 to support the operation of clause 5.3.12.
5.3A.A1(b) and (c)	A minor rule change corrects the rule reference in paragraph (b). A change to paragraph (c) italicises a term that has been defined in chapter 10 since publication of the draft rule.
5.12.2(c)(8)(ii)	The clause has been broken into subparagraphs for greater clarity.
5.14.3(b)	The draft rule proposed a new paragraph (b) that required SSS Providers to undertake joint planning where a possible credible option involved an augmentation to the transmission network of another TNSP. For the final rule, this paragraph has been removed. Instead, the provision of services on another transmission network would be treated as a non network option under clause 5.20C.3(a1).
5.14.4	The heading has been updated to reflect the broader scope of this clause. Changes to paragraph (e) (was (d) in the draft rule) extend the cooperation obligation to include the technical specification and performance standards for any proposed system strength service. This reflects the change to clauses 5.20C.4(d) and (e) that removes the requirement for AEMO to approve these technical specifications and performance standards.
5.20.6(f)(4)	This clause requires AEMO's system strength requirements methodology to provide a description of what is meant by stable voltage waveforms. Drafting changes for the final rule reflect changes to the standard in S5.1.14(b)(2).

5.20.7(a)	The final rule specifies that AEMO must publish its System Strength Report annually by 1 December. This is consistent with the timing in clause 5.20C.1 for AEMO to declare the system strength requirements each year.
5.20C.1(a)	The final rule clarifies that a system strength node can only be located on the transmission network of a SSS Provider.
5.20C.1(b) and (c)	The final rule changes the date for publication of the system strength requirements from 31 August each year to 1 December. The reasons for the new date are explained elsewhere in the final determination.
5.20C.3(a)	The final rule clarifies that if the jurisdictional planning body for a participating jurisdiction is not a TNSP, the SSS Provider will be the Coordinating TNSP for the region. The reasons for this change are explained elsewhere in the final determination.
5.20C.3(a1)	For the final rule, this paragraph clarifies that non network option can include network expenditure undertaken by a Network Service Provider other than the SSS Provider or by any other person. This recognises that the most efficient system strength solution may be investment in another network but that this will be provided as a system strength service to the SSS Provider.
5.20C.3(f1)	This new paragraph requires a SSS Provider to consult with other Network Service Providers whose networks are connected to its transmission system when preparing information for its TAPR. This replaces the general joint planning obligation in the draft rule.
5.20C.3(h)	The final rule deletes paragraph (h). This does not reflect a change in approach to the recovery of system strength service payments. Rather, the clause was regarded as redundant.
5.20C.4(e) and (f)	The changes remove the requirement for AEMO to approve the technical specification and performance standards for any proposed system strength service.
S5.1a.9(b)	Changes in paragraph remove the reference to small signals and clarify that maintaining voltage waveform stability following any credible contingency event or protected event should not be dependent on plant disconnecting from the power system or varying active power or reactive power transfer, except in accordance with applicable performance standards.
S5.1.14	The changes to the new planning standard for SSS providers: • change dates to reflect the new date for publication of the system strength requirements by AEMO;

	• correct cross references; • delete former paragraph (c) and replace it with a second example in paragraph (a) in order to overcome interpretation issues arising from the old paragraph (c); • extend the obligation to maintain stable voltage waveforms following protected events; • replace the former reference to IBR and MNSFs remaining synchronised with a new paragraph (c) to explain what is meant by maintaining stable voltage waveforms including in steady state conditions, following credible contingency events or protected events and as will be provided for in the system strength requirements methodology.
S5.2.5.5(r1)	This new paragraph, inserted for the final rule, clarifies that Network Service Providers and AEMO cannot require a Generator to have a greater level of performance than would be required if the SSS Provider had met the standard in S5.1.14.
S5.2.5.15(b)	The minimum access standard for Generators relating to short circuit ratios now refers to plant having capability to 'operate stably and remain connected', reflecting consultation responses. The paragraph also specifies that the short circuit ratio must be assessed in accordance with the methodology prescribed in the SSIAGs.
S5.2.5.15(c)	Changes to paragraph (c) are intended to clarify that the agreed short circuit ratio must be included in the connection agreement in all cases and must be the minimum of 3.0 and the value at which the generating system has plant capability sufficient to operate stable and remain connected. In addition, any arrangements agreed under paragraph (e) (explained below) must be recorded in the performance standards in the connection agreement.
S5.2.5.15(d)	The drafting changes in this paragraph made for the final rule are intended to clarify the intention and are not intended to be a change in policy from the draft rule.
S5.2.5.15(e) and (f)	These new paragraphs give additional flexibility to generators with the consent of AEMO, the relevant Network Service Provider and the SSS Provider to achieve compliance with the minimum performance standard either by investing or by purchasing additional system strength services (at its cost) so that it can operate stably at a higher short circuit ratio. The clause allows the investment or the purchase of the services to be deferred.

	The agreed arrangements must be included in the performance standards in the connection agreement.
S5.3.11 and S5.3a7	The amendments align the new performance standard for customers and MNSPs relating to short circuit ratio plant capability with the equivalent approach for Generators. The additional flexibility provided for in S5.2.5.15(e) and (f) has not been included.
S5.5.7(b1)	Cross references have been corrected.
S5.8(q)	This was paragraph (o) in the draft rule and has been renumbered due to other changes to the rules.
Chapter 6	
6.18.2(b)(6A)	This new paragraph requires the pricing proposal to set out how system strength charges for system strength connection points on a DNSP's network are to be passed through as described in clause 6.20.3A.
Chapter 6A	
6A.7.3(e)	A minor change corrects a drafting error in the rules.
6A.22.1(2)	The final rule provides for system strength service payments to be deducted from the AARR under this paragraph and added back in under clause 6A.23.3(h), consistent with the treatment of operating and maintenance costs incurred in the provision of prescribed common transmission services.
6A.22.2 (deleted)	The change to this clause proposed in the draft rule has been reversed as it is now redundant.
6A.23.2(e) (deleted)	The change to this clause proposed in the draft rule has been moved to 6A.23.3(h1) due to the revised treatment of the system strength transmission service as a prescribed common transmission service.
6A.23.3(e)(7) (deleted)	The change to this clause proposed in the draft rule has not been made due to the revised treatment of the system strength transmission service as a prescribed common transmission service.
6A.23.3(h)	This change aligns the treatment of system strength service payments with the treatment of operating and maintenance costs incurred in the provision of prescribed common transmission services.
6A.23.3(h1)	This paragraph provides for true-up of forecast, estimated and actual system strength revenue. It reflects the approach proposed in the draft rule under clause 6A.23.2(e) but has been moved to this clause due to the revised treatment of the system strength transmission service as a prescribed common transmission service.
6A.23.3A	Drafting changes to this clause reflect comments from TNSP pricing managers about the terms used and

	reflect the revised treatment of a system strength transmission service as a prescribed common transmission service.
6A.23.4	Drafting changes to this clause correct an omission from the draft rule to allow for prices to be charged to System Strength Transmission Service Users (as they are not Transmission Customers) and also reflect the revised treatment of system strength transmission services as a prescribed common transmission service.
6A.23.5	Minor drafting corrections are intended to improve the readability of the clause.
6A.24.1	Minor drafting corrections.
6A.24.2(d)	The amendment specifies the time by which the system strength unit prices must be published.
6A.25.2(h)	Consequential drafting change.
6A.26.1	Minor drafting corrections.
S6A.4(k)	This schedule deals with modifications to chapter 6A for AEMO. Two changes for system strength were proposed in the draft determination and have been confirmed for the final determination. While these were included in the mark-up published with the draft rule they were omitted from the draft rule itself. They have now been inserted in the final rule.
Chapter 10	
general system strength impact	The amendments clarify that the general system strength impact is assessed in accordance with the SSIAGs and better reflect the use of the definition to assess the impact of a new connection and alterations to connected plant.
inverter based load	Consequential changes to the definition reflect the amendments to clause 4.6.6.
inverter based resource	The short form 'IBR' has been deleted since it is not used and a minor drafting correction has been made.
large inverter based resource	Consequential changes to the definition reflect the amendments to clause 4.6.6.
prescribed common transmission services	The amended definition reflects the revised treatment of system strength transmission services as a category of prescribed common transmission service.
prescribed transmission service	A drafting correction moves system strength transmission services to a separate paragraph (d) rather than treating them as part of the services described in paragraph (b). This reflects comments on the draft rule that

	identified the inclusion of the term within paragraph (b) had unintended consequences.
prescribed TUOS services	The amended definition reflects the revised treatment of system strength transmission services as a category of prescribed common transmission service.
short circuit ratio	The definition has been restructured to clarify that calculation of the three phase fault level (used to calculate the short circuit ratio) excludes any fault current contribution from the plant side of the connection point. In addition, the definition specifies that the SCR must be assessed in accordance with the SSIAGs for the purposes of the standards in clauses S5.2.5.15(b), S5.3.11(b) and S5.3a.7(b).
system strength service	Minor drafting correction.
system strength connection point	A minor drafting change has been made to align more clearly with clause 5.3.4B(b1).
system strength connection works	Minor drafting changes reflect the use of the definition to refer to works to remedy the impact of new connections or alterations to connected plant.
system strength impact assessment	Minor drafting changes reflect the use of the definition to refer to the assessment of the impact of new connections or alterations to connected plant.
system strength service payment	A consequential change to paragraph (b) reflects the change to clause 5.20C.4(e).
Chapter 11	
11.143.1	Amendments to the definitions reflect changes to the transitional rules described below or correct drafting.
11.143.2	The dates by which AEMO must amend and publish the documents referred to in this clause have been changed to 1 December 2022 to reflect the final determination.
11.143.5	A change to the definition of 'applicable TNSP' extends the application of this clause to TasNetworks and AusGrid. Paragraphs (i) and (j) have been merged, with the result that the cross reference for Ausgrid has been corrected.
11.143.6	Drafting changes to paragraph (b) clarify when AEMO must first publish its system strength unit prices.
11.143.7	Drafting changes clarify when a DNSP must update its annual pricing proposal to reflect the requirements of new clause 6.18.2.

11.143.8 to 11.143.13	The changes correct drafting in these provisions.
11.143.13 to 11.143.16	These provisions preserve the system strength shortfall framework until the end of the 'system strength transition period'. Under the final rule this period ends on 1 December 2025. This has changed from 1 September 2025 which was proposed in the draft rule, to align with the new dates for publication of system strength requirements.
11.143.17 and 11.143.18	These new transitional rules, together with the new definitions in clause 11.143.1 of 'current regulatory control period', 'subsequent regulatory control period', 'system strength project' and 'transitional rules commencement date' give effect to the final determination with respect to the use of the pass through events and contingent project frameworks by SSSPs to recover their costs to comply with the new planning standard, as described elsewhere in the final determination.

C SUPPLY SIDE: ESTABLISHING A NEW SYSTEM STRENGTH PLANNING STANDARD

BOX 5: SUMMARY OF KEY POINTS

The evolved framework for system strength establishes a new prescribed transmission service standard for the efficient procurement of system strength. The system strength standard will be set out in two parts in the NER: first, through the form of a *system standard* in Schedule 5.1a of the National Electricity Rules (NER) and then second, through specific obligations in the form of a *network standard* in Schedule 5.1 of the NER.

The obligations under the system strength standard refer to the two key physical aspects of system strength:, the *minimum fault level requirement* and the *stability component*. The *minimum fault level requirement* is the minimum amount of system strength required for system security. The *stability component* is the additional system strength services volume required for the forecast volume of connecting inverter based resources (IBR) to operate stably.

System strength service providers (SSS Providers), who are the transmission network service provider (TNSP) or jurisdictional transmission planner for each region, must use best endeavours to meet the standard. Under the final rule, the SSS Provider is the central planner and procurer of system strength services for their region. In Victoria, AEMO is the SSS Provider because AEMO is the transmission network planner and is responsible for providing shared transmission services in Victoria.

Through placing the obligations on SSS Providers to meet the standard, the final rule introduces centralised planning and procurement of system strength. This will allow for economies of scope and scale to be harnessed.

The standard will be integrated into the existing planning and economic regulatory frameworks. The SSS Provider's planning obligations will be integrated into their transmission annual planning report (TAPR). While the SSS Provider is the planner and procurer of system strength services, joint planning and coordination provisions ensure co-operation with other network service providers (NSPs) and AEMO.

AEMO has a key role in supporting SSS Providers through publishing the *system strength requirements* report. This report will contain ten-year forecasts for the minimum fault level requirement and the volume and type of connecting IBR. It will also detail the number and location of system strength nodes, and the methodology used in identifying nodes.

Changes from draft rule to final rule

The final rule includes some changes from the draft that will enable the evolved framework to best meet the National Energy Objective (NEO) and were developed in response to

stakeholder feedback. These are as follows:

- Amending the new prescribed transmission service standard for provision of efficient levels of system strength through:
  - removing references to small signals from the *System standards* and *Network performance requirements* to better reflect the policy intent that there is sufficient system strength supplied at nodes by SSS Providers that instabilities are not created or propagated, regardless of their magnitude.
  - *updating network performance requirements* to include stability requirements in response to protected events, in addition to contingency events. This corresponds with the requirements under the s*ystem standards*.
  - *updating network performance requirements* and s*ystem requirements* to require a level of system strength services at the node which is consistent with that which is required by connecting generators to meet the generator access standards, in particular remaining connecting and not changing power transfer levels in response to contingency events (expect as permitted by performance standards).
- The AEMO & SSS Provider reporting and compliance timeline to better leverage the results of AEMO's Integrated system plan (ISP) and Electricity statement of opportunities (ESOO) reports. The new timeline has AEMO publishing their *System Strength Report* on 1 December each year, with the SSS Provider being obligated to meet that forecast on 2 December in three years time.
- Clarifying who the SSS Provider is: The final rule clarifies that the SSS Provider for a region is the Coordinating NSP if the jurisdictional planning body is not a TNSP.
- Clarifying coordination between the SSS Provider and other network service providers:
  - Arrangements for coordination between SSS Providers and other TNSPs and DNSPs have been clarified in clause 5.20C.3 of the final rule and removed from clause 5.14.3.
  - SSS Provider-AEMO joint planning arrangements have been broadened to reflect AEMO and SSS Provider collaboration in all relevant processes rather than just on non-network solutions. This is reflected in clause 5.14 of the final rule.

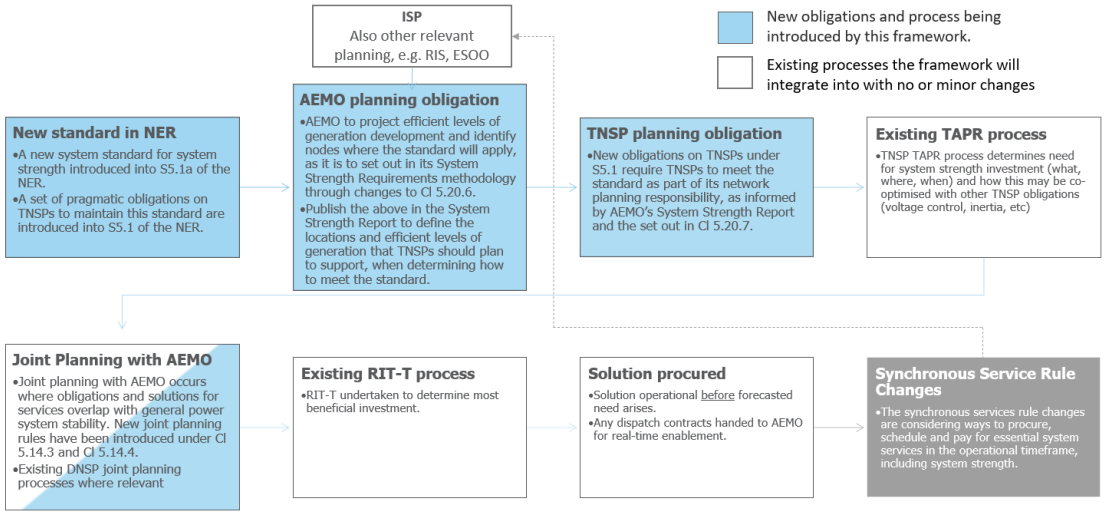
This Appendix provides detail on the 'supply side' reforms of the final rule:

- Appendix C.1 sets out the current arrangements
- Appendix C.2 details TransGrid's view on issues with the current arrangements
- Appendix C.3 summarises stakeholder views on the current arrangements and the rule change request
- Appendix C.4 to appendix C.10 sets out the Commission's final determination on the supply side arrangements, including:
  - Establishing a new prescribed transmission service standard for provision of efficient levels of system strength.

- The roles and responsibilities for AEMO and the SSS Provider under the new standard.
- Requirements for coordination between the SSS Provider and other NSPs and AEMO to meet the new standard.
- Application of the standard in an adoptive jurisdiction — AEMO as the SSS Provider.
- The Commission's response to other issues raised in draft determination submissions.

An overview of the processes involved in applying the new system strength planning standard is provided in Figure C.1 below.

Figure C.1: Overview of the application of the proposed system strength standard



Source: AEMC

C.1 Current arrangements

The 2017 *Managing power system fault levels* final rule introduced:

1. The 'do no harm' framework, which was designed to deliver any system strength needed to support new IBR as they connect to the system.
2. The minimum system strength framework, which requires SSS Providers to provide system strength, where this was needed to maintain the basic levels for system security.
3. A definition for the concept of a system strength service in the NER as a: "service for the provision of a contribution to the three-phase fault level" at a given location in the transmission network. This is known as a 'fault level node'. This means that fault current is used as a measurable proxy for the provision of system strength at given locations on the transmission network as determined by AEMO.

In relation to the minimum system strength framework, the current arrangements require:

- AEMO to develop the *system strength requirements methodology*.[127] This sets out how AEMO determines the required three-phase fault level at key locations in each transmission network necessary for maintaining a secure power system.
- SSS Providers to procure system strength services needed to meet the required level as determined by AEMO (i.e. where a system strength shortfall exists and has been declared by AEMO).[128] The NER provides that a SSS Provider is not required to undertake a regulatory investment test (RIT-T) for the relevant transmission investment, with some exceptions.[129] These services are then enabled operationally by AEMO as needed.[130]

C.2 Proponent's views on issues with the current arrangements

TransGrid's rule change request proposed to abolish the 'do no harm' obligation and amend the minimum system strength requirements to be a new system strength planning standard for SSS Providers due to issues TransGrid observed with the existing system strength framework.[131]

TransGrid set out the following benefits in support of its rule change request:[132]

- A more efficient balance of costs incurred on the market by procuring system services to address shortfalls ahead of time as opposed to the risk of inefficient market interventions.
- The facilitation of more coordinated, scale-efficient delivery of system strength services to support new generation in parallel with avoiding system strength shortfalls.
- Transmission networks will be able to operate more efficiently, as they will be empowered by more flexible arrangements to respond to rapid changes in system strength on the power system.

C.3 Stakeholder views on current arrangements and rule change request

Stakeholder submissions to the consultation paper regarding TransGrid's rule change request were broadly supportive of a planning standard for system strength. This is because stakeholders considered that it would provide some useful and timely locational and financial signals to new entrants.[133] Some emphasised that it needed to be clear and forward-looking.[134]

Some stakeholders noted concerns on TransGrid's proposal for a planning standard:

127 Clause 5.20.6 of the NER.

128 Clauses 5.20C.2, 5.20C.3 and 5.20C.4 of the NER.

129 Clause 5.16.3(a)(11) of the NER.

130 Clause 4.4.5 of the NER.

131 TransGrid, 2020, *Efficient management on system strength on the power system — R*ule change proposal, 27 April 2020.

132 Ibid, p. 19.

133 Submissions to the consultation paper: CS Energy, pp 16-17; Walcha Energy, pp. 7-8; Neoen, p. 3; Energy Australia, p. 2; Maoneng Australia, p. 2; Stanwell, p. 6; Tesla, p. 24; AEC, p. 4; TasNetworks, p. 5; Infigen, p. 1; CEC, p. 2.

134 Submissions to the consultation paper, CS Energy, pp. 16-17, and Walcha Energy, pp. 7-8.

- CitiPower, Powercor, and United Energy put forward that such a standard should include both TNSPs and DNSPs as there may be system strength solutions at both the sub-transmission and/ or distribution network level.[135]
- AEMO and Energy Australia expressed some concerns of too little incentive for TNSPs to utilise synchronous generation or future technology as well as network augmentation bias and free-rider issues.[136]

Stakeholder comments on the draft rule and determination are set out in the sections below.

C.4 Commission's final determination on the supply side arrangements

The Commission's final determination establishes a new system strength planning standard, which includes a new system standard in S5.1a and network standard in S5.1 of the NER, that will see AEMO and SSS Providers coordinate the central provision of the service. The final rule integrates this standard into the existing planning and economic regulatory frameworks, utilising many of the processes established by the 2017 shortfalls rule change to do so. The final rule is similar to the draft rule and the final *Investigation* report, with some tweaks reflecting stakeholder feedback.

BOX 6: WHAT IS A SYSTEM STRENGTH SERVICE PROVIDER (SSS PROVIDER)?

Under the final rule, a SSS Provider is either the TNSP for the region, or where there is more than one TNSP for a region, they are the jurisdiction planning body for that region, as defined in clause 5.20.3(a) of the NER. In the circumstances where the jurisdictional planning body is not a TNSP, the Coordinating TNSP would be the SSS Provider.

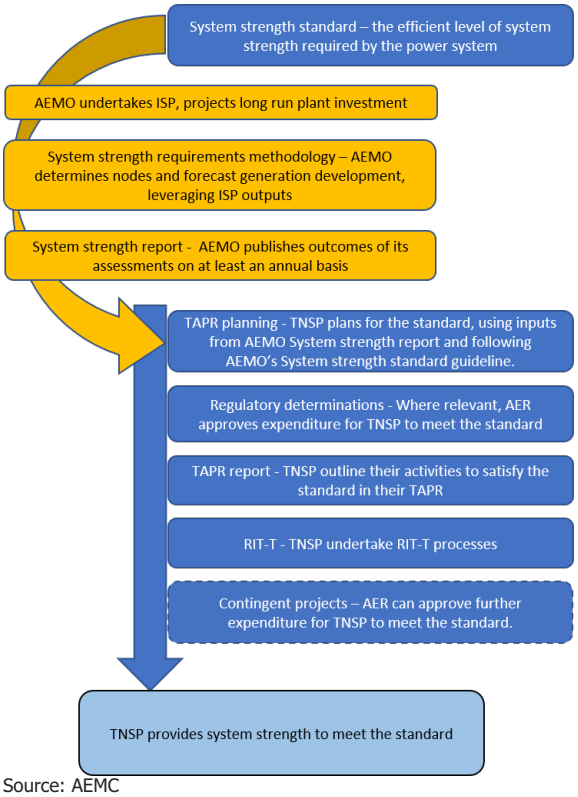
The TNSPs that are currently SSS Providers are TasNetworks, TransGrid, Powerlink and ElectraNet with AEMO fulfilling the role in Victoria.

This process is summarised in Figure C.2 below.

135 CitiPower, Powercor, and United Energy, Submission to the consultation paper, p. 6.

136 Submissions to the consultation paper: AEMO, p. 18; EnergyAustralia, p. 17.

Figure C.2: Planning process to meet the system strength standard



Source: AEMC

Note: In Victoria, AEMO would also undertake those TNSP actions (indicated in blue in the figure above) that apply in Victoria (i.e. a subset of the above) as part of its declared network functions.

The Commission considers these changes to be a necessary response to issues with the supply of system strength under the current frameworks. The key issues are:[137]

1. **The current arrangements do not support the efficient connection of new generation:** due to the split between the 'do no harm' frameworks and the minimum framework. This results in a lack of coordination which does not provide the levels of system strength needed to support the efficient connection of new IBR.
2. **The current frameworks are reactive in nature:** due to the difficulties faced by AEMO in effectively identifying system strength shortfalls through its forecasting in the face of complex and changing generation dispatch patterns. This has resulted in some declarations of system strength shortfalls being made shortly before they occur, rather than at least five years out as envisaged by the current framework. This has led to AEMO significantly intervening in the market to maintain system security.

137 For a fulsome exploration of the issues and associated recommendations please refer to the Investigation final report. Available at: https://www.aemc.gov.au/sites/default/files/2020-10/System%20strength%20investigation%20-%20final%20report%20-%20for%20publication.pdf.

3. **There is a lack of coordination of how system strength is delivered:** due to the often piecemeal and cost inefficient system strength solutions coming out from the 'do no harm' obligation. The result is a lack of ability to effectively coordinate solutions to address system strength, missing the operational efficiencies and economies of scope and scale available from effective coordination.

The rest of this Appendix provides a summary of the issues considered by the Commission in making this final determination in relation to the supply side arrangements. For each issue it sets out:

- a summary of the Commission's draft decision - Stakeholders should refer to the draft rule determination for full explanation of the draft decision in relation to the supply side.[138]
- stakeholder feedback on that draft decision - as received through submissions, bilateral meetings and our technical working group
- the Commission's analysis and final decision.

C.5 Establishing a new prescribed transmission service standard for efficient levels of system strength

The supply side of the framework under the final rule centres on establishing a system strength standard in the NER. The new standard comprises two parts:

- the minimum fault level requirement, and
- the stability component.

The minimum fault level requirement is necessary for system security, and is forecast by AEMO over a ten-year horizon. The voltage waveform stability component is required to securely host the forecast levels of IBR connections. This is done by SSS Providers using AEMO's forecast of the volume and types of connections around each node to determine the level of service required to achieve a stable voltage waveform.

The Commission's final decision maintains the approach proposed in the draft rule with minor amendments reflecting stakeholder concerns about the wording of the standard. Details of the draft decision and the minor amendments included in the final rule are set out in the following sections.

C.5.1 Commission's draft decision

New System standard in S5.1a.9 and Network standard in S5.1.14

As noted above, the draft rule proposed the system strength standard would be set out in two parts in the NER: first, through the form of a *system standard* in Schedule 5.1a of the NER (S5.1a) and then second, through specific obligations in the form of a *network standard* that sets out what SSS Providers would need to do to meet the system standard, established in Schedule 5.1 of the NER (S5.1).

138 AEMC, Efficient management of system strength on the power system - draft rule determination, Chapter 3 and Appendix B, 29 April 2021.

- The *system standard* in S5.1a.9 would be a high level requirement that sets out the general expectation of conditions on the power system relating to system strength. That is, the system standard would set out what users of the power system should expect in relation to system strength when connected to the system.[139]
- The *network standard* in S5.1.14 then sets out the specific requirements on SSS Providers, to enable the power system to meet the general requirements defined in the *system standard* in S5.1a. That is, the standard that SSS Providers would be required to meet acknowledges what should be practically and reasonably achieved by SSS Providers in relation to system strength, given the complexity of the issue.

Purpose of the two physical aspects

The SSS Providers' obligations under the system strength standard were then further described in the draft rule by reference to the two key physical aspects of system strength.[140]

1. **Minimum fault level requirement:** maintain the minimum three phase fault levels specified by AEMO in the system strength requirements for plant and network protection systems.
2. **Stable voltage waveforms:** achieve stable voltage waveforms so that the efficient amount of IBR projected to be connected by AEMO would remain stable in steady state conditions and remain synchronised following credible contingency events. Specifically, under the draft rule, the standard would require SSS Providers to plan to achieve stable voltage waveforms in their networks such that IBR:[141]
    a. Do not create, amplify or reflect instabilities in response to small signals in steady state conditions.
    b. Remain synchronised following a credible contingency event.

AEMO, as part of the *System strength requirements* methodology must provide a description of:[142]

- How the minimum fault level requirements will be calculated
- What is meant by stable voltage waveform(s)
- Matters that may be taken into account by SSS Providers to assess, for the level and type of inverter based resources projected by AEMO at system strength nodes
- What may be required to achieve stable operation in accordance with Clause S5.1.14(2) of the draft rule.[143]

The stable voltage waveform criteria gives SSS Providers both the flexibility and the obligation to account for the nuanced impacts and interactions of individual connections on

139 See the purpose of system standards expressed in clause S5.1a.1 of the NER.

140 Clauses 5.20C.1 and S5.1.14(b) of the Draft Rule and now Final Rule. These two physical aspects of system strength are consistent with the description of system strength first set out in the *Investigation into system strength frameworks in the NEM - final report*.

141 Clause S5.1.14(b)(2) of the Draft Rule and now Final Rule.

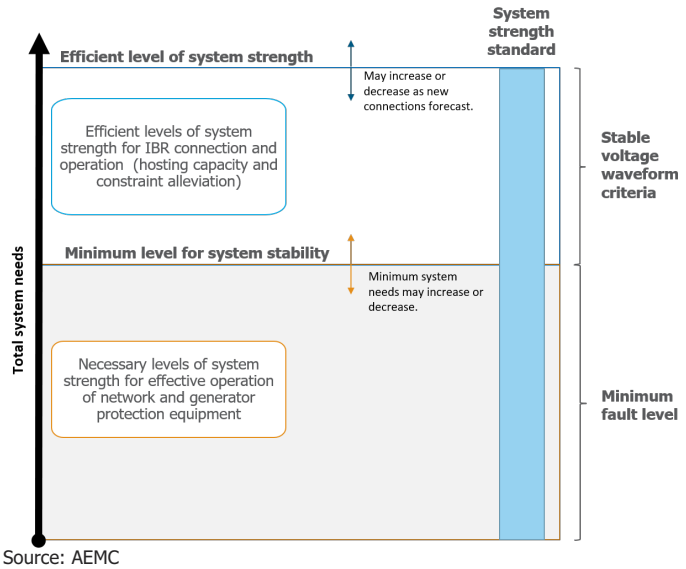
142 Clause 5.20.6 of the Draft rule and now Final Rule.

143 The Commission expected this to include a methodology for how SSS Providers should model against these stable voltage waveforms in relation to the projected IBR connections made by AEMO in its System Strength Report.

the greater power system. SSS Providers would undertake appropriate studies to determine the optimal way to support the stability of the efficient future connections projected by AEMO. This would include consideration of any system strength solution that the SSS Provider finds to be able to address the issues being experienced in each case, including both traditional solutions such as synchronous machines and contracting with existing synchronous machines, or more novel approaches such as collective inverter retuning or grid forming technologies.

These two physical aspects of the standard combine to determine the efficient level of system strength, as shown in Figure C.3 below.

Figure C.3: New system strength planning standard under Schedule 5.1 of the NER



Source: AEMC
Note: This approach has been maintained in the final rule.

In the draft determination, the Commission considered these two physical aspects of system strength to cover all system strength issues and solutions and allow the standard to evolve and adapt over time to reflect the most current thinking on system strength. The result would be a robust framework that minimises costs to consumers.

These two physical aspects of the system strength standard provide an obligation on an SSS Provider to plan for both:

- the system strength needs for system security of the existing power system and
- that which is needed to support the market benefits associated with system strength by allowing more lower-cost generation to connect and so be dispatched i.e. not subject to system strength constraints.

The purpose of each aspect of the standard is set out in more detail in the draft rule determination.[144]

Expected change of investment over time

One of the Commission's focus areas under the draft determination was on how to evolve the definition of system strength to promote innovation in how the service can be provided other than through the provision of fault current. As noted above, the voltage waveform stability criteria allows this innovation to occur by broadening the definition of system strength from solely the proxy measurement of fault current to the outcomes of the service being provided.

From this, the Commission's draft determination expected that the way the service is provided will change over time. This includes a move away from synchronous machines - including generators and condensers - towards ways that stabilise the voltage waveform in ways that do not necessarily provide fault current. This includes:[145]

- the retuning of inverters, as already demonstrated by Powerlink in conjunction with AEMO in north Queensland[146]
- grid forming inverters, as discussed in AEMO's White paper on the *Application of Advanced Grid-scale Inverters in the NEM*.[147]

In the draft determination, the Commission noted the change of investment by SSS Providers over time is encouraged by the transmission economic regulatory framework, which incentivises SSS Providers to innovate and find the lowest cost solutions. The Commission considered that innovation in service provision will reinforce the way this framework will deliver system strength in the most efficient way, resulting in lower cost for consumers in the long term.

Enablement of system strength services above the minimum three phase fault level by AEMO

The draft rule maintained the ability for AEMO to enable system strength services for the minimum three phase fault level required to maintain system security, the first physical aspect of S5.1.14 of the draft rule. However, it did not include the ability for AEMO to enable system strength services for the stability of the voltage waveform required for the type of amount of IBR determined by AEMO – being the second physical aspect of the S5.1.14 standard.

Some non-network solutions such as collective inverter retuning, or network solutions such as installation of synchronous condensers, do not require instructions from AEMO or the TNSP to be enabled. These can therefore be used in the operational timeframe to provide system strength services to meet both limbs of the standard. In addition, to meet the second

144 AEMC, Efficient management of system strength on the power system - draft rule determination, Appendix B, Section B.6, 29 April 2021.

145 For more information about the effect of these changes in the service's provision in relation to broader power system security, refer to Section B.6.4 of the Draft rule determination.

146 As detailed in AEMO's *Notice of change to system strength requirement and shortfall at Ross.* Available at: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/operability/2021/notice-of-change-to-system-strength-requirement-and-shortfall-at-ross.pdf?la=en.

147 Available at: https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/application-of-advanced-grid-scale-inverters-in-the-nem.pdf?la=en&hash=B4E20D68B23F66090ADA5FD47A50D904.

limb of the standard SSS Providers could include arrangements in the contract itself that incentivise or require generators to make themselves available in dispatch and so self commit in the wholesale market. This would enable system strength to be provided above the minimum levels in the operational time frames and help the SSS Provider to meet the second limb of the standard.

The draft rule did not specify how AEMO would enable system strength services contracted under the second limb. This was due to there being ongoing parallel rule change processes that were considering the most efficient and effective ways for operational arrangements for unit commitment and other required services that are essential for power system security. This is continuing through the AEMC's consideration of the *Capacity commitment mechanism* proposed by Delta Electricity and the *Synchronous services market* proposed by Hydro Tasmania.

In the absence of these other rule change processes addressing this issue, the Commission considered that there were two options for how these contracts could be enabled. The Commission sought stakeholder feedback on the following options in the draft determination stage of this rule change:

1. **Retain the approach taken in the draft rule** and only allow AEMO to issue instructions to meet the minimum three phase fault level. These contracts would not be activated by AEMO in real time but rather a generator that is under a system strength contract with the SSS Provider would participate in the wholesale market in accordance with its contract agreements SSS Provider.
2. **Amend the Non-market ancillary service (NMAS) framework** to include system strength services, either through amending the generic framework to be more detailed or to have a separate process for S5.1.14 contract information and approvals to occur. This would allow AEMO to enable contracts for the second limb of the standard in S5.1.14.

C.5.2 Stakeholder feedback on the draft decision

Stakeholders were supportive of the draft arrangements for the minimum fault level requirement. However, several submissions provided detailed input on the stability component of the standard. While feedback on the stability component was generally positive, a number of stakeholders provided comment on the level of redundancy included in the standard and its interaction with planned network outages. AEMO also raised some concerns regarding the wording of the standard.

Planned outages and redundancy

Submissions from NSPs and AEMO noted the stability component of the proposed standard were not set at a level which accounted for planned outages or additional redundancy.[148] In discussion with stakeholders, several noted particular difficulties maintaining system strength under outage conditions given the present 'tight' system conditions.

148 Submissions to the draft determination: Ausnet, p.1; Energy Networks Australia, p.3; AEMO, p.5.

Some stakeholders recommended that the standard should consider all possible system conditions to ensure the efficient provision of system strength services at all times, particularly during routine planned outages. Others recommended the inclusion of additional redundancy in the standard level.

During consultation, some stakeholders considered the draft rule's use of the RIT-T process to be sufficient to ensure the provision of system strength through outage conditions, while others considered that the RIT-T processes were very complex and insufficient in providing the required outage coverage for a power system in transition. As such, some stakeholders submitted that the network standard does not, but potentially should, include planned outages as part of the baseline requirement for SSS Providers to plan and procure (as part of the standard's redundancy which currently includes credible contingency events). Additionally, they considered amendments should be made to reflect a more favourable treatment for system strength services under the RIT-T. The draft arrangements were deemed to result in practical barrier to the SSS Provider procuring sufficient system strength for the needs of the system. This is because constraints, or expensive network support agreements, would be required, to allow critical maintenance work to proceed.

Wording of the new system and network system strength standards

AEMO noted that a number of wording issues in the *System Standard* required further consideration, these included:[149]

- The standard referring to "small signals" without defining the term, potentially leading to ambiguity and different interpretations of the rule.
- Introducing a requirement to meet the standard for protected events, which may imply a need for additional measures under S5.1a.9 to be assessed as part of protected event proposals.
- Clause S5.1.14(b)(2)(ii) of the standard requiring the TNSP to plan their system to maintain stable voltage waveforms such that following a credible contingency, IBR remains synchronised, which is less onerous than the present requirements on connecting generators under 5.3.4A of the NER.

C.5.3 Commission's analysis and final decision

The Commission's final decision maintains the approach proposed in the draft rule that has been outlined above, however minor amendments have been made to reflect stakeholder concern about the wording of the standard.

The framework is built around the assumption that the demand for system strength will increase in the short term. As such, the Commission's approach to establishing the new system strength planning standard is a practical one, that seeks to mitigates the consequences of inefficient market outcomes increasing consumer bills due to a lack of system strength. However, the complex transformation underway means that there are

149 Submissions to the draft determination: AEMO, p.5.

uncertainties about how it will play out, including the technological developments that may be around the corner.

The Commission is satisfied that the framework builds in flexibility to account for technological changes resulting in less system strength being needed; where demand for the service is reduced the framework will see less system strength being procured. However, any reduction in demand for the service will be dependent on whether technology changes are realised in the short-term, and there is uncertainty over this. In light of this it is important that how this standard is implemented is closely monitored and whether today's assumptions continue to hold true.

To do this, the Commission is committed to closely monitor the operation of the standard with the other market bodies - the AER and AEMO - to ensure that the provision of system strength continues to be done in a manner that serves the best interests of consumers.

Planned outages and redundancy in the network standard's baseline

The Network standard is a forward-looking planning standard, with the specific volume of required system strength services determined by the SSS Provider's interpretation of AEMO's *system strength requirements*. The final decision maintains the draft determination of the Network standard's baseline redundancy which *must* be procured by the SSS Provider when meeting the standard. This baseline includes credible contingency events and protected events for both physical aspects of the standard. Additionally, the Commission considers that AEMO has scope within its *System strength requirements* methodology to consider critical planned outage conditions in setting the minimum fault level.

The Commission discussed with our technical working group whether planned outages should be considered in the standard's baseline. Following these discussions and further analysis of the issue, the Commission agreed that it would be inappropriate and inefficient for additional redundancy, such as planned outages, to be included in the baseline Network standard.

This is because while in some cases it would be efficient to maintain the system strength standard during planned outages, particularly for long duration outages in specific parts of the network, in others it may require duplication of assets to supply system strength (particularly during through short duration outages), which would likely be an inefficient outcome.

The Commission considers that a balance is best achieved through the evaluation of proposed system strength solutions to cover outages on a case-by-case basis and that the standard's baseline redundancy proposed in the draft rule is sufficient to provide the baseline services required for an efficient and secure system. Therefore, the Commission has determined that the level of baseline redundancy included in the draft rule should remain in place for the final rule.

Planned outage coverage under the system strength standard like any other Network standard

The Commission has considered the concerns raised by stakeholders about maintaining system strength through planned outages. As noted above, planned outage coverage is not included in the baseline to be procured by the SSS Provider. However, as with other Network

standard obligations, the Commission considers planned outage coverage is best achieved through the evaluation of proposed system strength solutions to cover outages on a case-by-case basis. This is possible under the final rule through the RIT-T process (e.g. by considering a particular scenario in the RIT-T), and is consistent with the evaluation of other network investment for outages.

The use of the RIT-T process to evaluate the provision of system strength for outages has been reaffirmed through discussions with the AER and other stakeholders. The Commission notes the concerns raised regarding the RIT-T processes themselves, however we consider this to be a broader issue than just the operation of these processes with the new system strength standard. As such, as we consider changes to the entire RIT-T framework in relation to all system standards to be out of scope of this rule change. Additionally, the Commission is deliberately leveraging existing processes in this final rule and considers it inefficient and unduly complex to create duplicative, bespoke arrangements specific to system strength.

Wording of the System and Network standards

Following consultation and discussion with stakeholders, the Commission has addressed the wording issues raised by AEMO so that they better achieve the policy intent and maintain consistency with other frameworks in the NEM. The final rule includes the changes to the draft rule as set out in Table C.1.

Table C.1: **Wording changes to system standards and network performance requirements**

ISSUE(S)	STANDARD	NEW WORDING	CHANGES AND RATIONALE
The use of *small signals* without definition may lead to ambiguity	*System standards*	There should be stable voltage waveforms at connection points in the power system such that in steady state conditions plant does not create, amplify or reflect instabilities.[A]	References to small signals have been removed to better reflect the policy intent: that there is sufficient system strength supplied at nodes by SSS Providers that instabilities are not created or propagated, regardless of their magnitude.
	Network performance requirements	There should be stable voltage waveforms such that for the level and type of IBR and market network service facilities (MNSFs) projected by AEMO, in steady state conditions the IBR and MNSFs do not create, amplify or reflect instabilities.[B]	

ISSUE(S)	STANDARD	NEW WORDING	CHANGES AND RATIONALE
Consistency of *network performance requirements* regarding the response to protected events, with the *system standards* and Consistency of *system standards* and *network performance requirements* with *generator access standards*	*System standards*	There should be stable voltage waveforms at connection points in the power system such that avoiding voltage waveform instability following any credible contingency event or protected event is not dependent on plant disconnecting from the power system or varying active power or reactive power transfer at connection points except in accordance with applicable performance standards.[C]	The stable voltage waveform requirements have been extended to include the response to protected events, for consistency with the *system standards*. The requirements clarify that a TNSP cannot plan for IBR or MNSF to disconnect or alter output following a credible contingency event or protected event to maintain stable voltage waveforms (although the plan may respond in accordance with access standards).
	Network performance requirements	There should be stable voltage waveforms such that for the level and type of IBR and MNSFs connecting, it is not necessary, in order to avoid voltage waveform instability following any credible contingency event described in clause S5.1.2.1 or any protected event, for any of the IBR or MNSFs to disconnect from the power system or significantly vary the active power or reactive power transfer at the connection point	

Note: A - Clause S5.1a.9 (b)(1) of the Final Rule. B - Clause S5.1.14 (c)(1) of the Final Rule. C - Clause S5.1a.9(b)(2) of the Final Rule. D - Clause S5.1.14(c)(2) of the Final Rule.

Additionally, in response to stakeholder questions to the practical application of the draft rule, the final rule clarifies that SSS Providers cannot *plan* to constrain or disconnect any parties when planning its solutions to meet the standard. However, as with all planning standards, SSS Providers are obligated to use best endeavours to meet the new system strength

standard in the investment timeframe, which may or may not reflect conditions in real time. As such, it is reasonable that constraints may be applied to relevant generators when required to maintain system security. This flexibility to allow the power system to respond to the needs of the day is important to allow operation of the NEM in a way that minimises costs for consumers.

Therefore, for the avoidance of doubt connecting parties should not expect to face no system strength constraints. Such constraints may be required to maintain a secure and stable power system in response to operational system conditions. However, due to these changes being made, constraints are expected to occur less, and be more transparent and predictable when they are utilised.

Enablement of system strength services above the minimum three phase fault level by AEMO

The Commission received no feedback in submissions on the options regarding the enablement off services by AEMO such that SSS Providers to meet obligations of the second physical aspect of the S5.1.14 standard. Through engagement with stakeholders, the Commission considers that the position in the draft determination is still appropriate i.e. that this issue is best dealt with through the AEMC's consideration of the *Capacity commitment mechanism* proposed by Delta Electricity and the *Synchronous services market* proposed by Hydro Tasmania. Therefore the Commission has decided to maintain this approach in final rule. A directions paper was published in relation to these rule changes on 9 September 2021, and the paper makes clear that the interaction will be an ongoing focus of this work.

C.6 AEMO's role under the new standard

Under the final rule, AEMO's key role in supporting SSS Providers to meet the system strength standard is to determine the system strength requirements. The SSS Provider must account for these when determining the efficient level of system strength to meet the standard at each system strength node over time. AEMO's responsibilities include determining the number and location of nodes, the minimum fault level required at each node, as well as the volume and type of generators connecting around the node, over a ten-year horizon.

The Commission's final determination maintains the approach in the draft rule with some minor amendments to address stakeholder concerns. The draft rule's approach (that has been broadly maintained) as well as stakeholder concerns and the Commission's response to these are outlined below.

C.6.1 Commission's draft decision

Under the draft rule, the Commission proposed that AEMO's responsibilities would include:

- Determining system strength nodes where centralised and co-ordinated SSS Provider investment would be efficient (i.e. where the standard applies).[150]

150 Clause 5.20C.1(a) of the Draft Rule and now Final Rule.

- Projecting the *System strength standard specifications* using the *System strength requirements* methodology as required to determine the SSS Providers' obligations under Clause S5.1.14 of the draft rule. This includes:
  - Determining the minimum fault levels at these nodes that are required to be met in the timeframes specified in the standard,[151] and the forecasts for how they may change over the ten-year horizon.[152]
  - Projecting the efficient amount and types of generation due to connect in an area, as informed by relevant ISP projections and other planning documents such as the ESOO.[153] This would be done by determining what amount of this generation would be efficient for the SSS Provider to consider and support under the system strength standard (that SSS Providers use to determine the efficient level of system strength to procure).

Determining system strength nodes where the standard applies

Under the draft rule, the Commission determined that AEMO would declare system strength nodes where there is a level of need for system strength provision that would be efficient for it to be served through coordinated investment by SSS Providers.[154] The system strength standard would apply at each of these nodes.

When declaring a new system strength node, AEMO must provide the relevant SSS Provider a three-year period before it needs to meet the standard in clause S5.1.14, unless an earlier date is agreed between the two parties.[155] This time period was considered to be sufficient for SSS Providers to account and plan for solutions to meet the standard in this new network region represented by the node.

The draft rule required AEMO to provide an overview of the process to declare system strength nodes in its *System strength requirements* methodology.[156] The draft rule did not amend clause 5.20.6(e), other than to substitute 'fault level nodes' with 'system strength nodes'. Therefore, AEMO would continue to take into account the matters in clause 5.20.6(e) in determining these nodes. In addition to these considerations in the NER, the following factors AEMO currently analyses as part of its existing *System strength requirements methodology* would continue when determining nodes:

- The points in the power system that would be most suitable for monitoring and maintaining minimum fault levels;. These could include load centres, synchronous generation centres and areas with high densities of existing or committed IBR.

151 Clause 5.20C.1(b) and Clause S5.1.14 of the Draft Rule and now Final Rule.

152 Clause 5.20C.1(c)(2) of the Draft Rule and now Final Rule.

153 Clause 5.20C.1(c)(2) of the Draft Rule and now Final Rule.

154 Clause 5.20C.1(a)(2) of the Draft Rule and now Final Rule.

155 Clause S5.1.14(c) of the Draft Rule. This has been removed from the Final Rule as it was deemed unnecessary. This is because SSS Providers can meet the standard as soon as the system strength specification is set (where practicable). The three-year time lag is to allow time for the SSS Provider to meet the standard in terms of compliance.

156 Clause 5.20.6(f)(1) of the Draft Rule and now Final Rule.

- The locations that AEMO projects efficient levels of IBR to connect; that is, IBR development of sufficient density projected under the ISP, given forecast non-IBR, as well as its projections of where plants that may supply system strength will connect.

Further, AEMO may declare nodes "from time to time" outside of the System Strength Report under clause 5.20C.1(a). [157]This enables AEMO to declare additional nodes in response to unforeseen material changes to the power system likely to affect the system strength requirements needed for AEMO to maintain power system security.

Projecting the s*ystem strength standard specifications* each year using the s*ystem strength requirements methodology*

Under the draft rule, the Commission considered that AEMO would be responsible for determining the *System strength requirements* for each declared system strength node.[158]

The s*ystem strength requirements* are determined and published by AEMO in its System Strength Report, and include for each system strength node:

- the minimum three phase fault level
- the level and type of inverter based resources and market network service facilities projected by AEMO for the system strength node (for the purposes of the stable voltage waveform criteria of the S5.1.14 standard).

These requirements would be projected for future ten years and are used to set the efficient level of system strength a SSS Provider must provide. This is done by AEMO's system strength requirement projection for three years time being set and is known as the *System strength standards specification* for that year.

These then determine the obligation on the SSS Provider that it must plan, design, maintain and operate its network in relation to system strength to be able to meet the standard in three years' time. That is, SSS Providers are obligated to meet the standard set out in Schedule 5.1.14 of the draft rule according to the system strength standard specification as set by AEMO three-years earlier.

Figure C.4 below provides an example of how the process described above will apply. In this example, AEMO makes a series of projections of system strength requirements beginning in the year 2021/2, which begin to actively apply as the system strength standard specification for the year 2024/5.

In this example, AEMO's 2023 forecast system strength requirements include an update of an additional 500 units for each year in the projection from 2023 onwards (starting 1 September 2023 (note this will be 1 December each year under the final rule), shown in red. This may represent an unexpected change in the requirements of power system, or an increase in the efficient amount of projected connections around the node. However, this update does not affect the system strength standard specification the SSS Provider must account for to meet the standard for 2023/4, 2024/5 or 2025/26 (years within three years of the change).

157 That is, AEMO has flexibility to declare nodes such that it can fulfil its role for the purposes of NER clauses 5.20C.1(e), 4.2.6(g), 4.4.5(a) and 4.6.1(b)

158 Clauses 5.20C.1(c)(2), (d) and (e) and clause S5.1.14 of the Draft Rule and now Final Rule.

Instead, the update only changes the requirement the SSS Provider must meet in 2026/7, three-years out from the publication of the projection that contains the changes.

Figure C.4: The system strength requirements that apply to the standard for each year

Year (starting 1 September)	2021/2	2022/3	2023/4	2024/5	2025/6	2026/7	2027/8	2028/29
Binding requirement for the standard for that year (*System strength standard specification*)	NA	NA	NA	1500	2000	2000	2500	2500
2021 Forecast requirements	1000	1000	1000	1500	1500	1500	2000	2000
2022 Forecast requirements		1000	1000	1500	1500	1500	2000	2000
2023 Forecast requirements			1500	2000	2000	2000	2500	2500
2024 Forecast requirements				2000	2000	2000	2500	2500
2025 Forecast requirements					2000	2000	2500	2500

Source: AEMC

Note: 1. Under the final rule, it will be starting 1 December each year. 2. Forecast system strength requirements are shown in generic units for illustrative purposes only. 3. Each year AEMO would publish a forecast of system strength requirements over a 10-year horizon. The above figure cuts off at 2028-29 for illustrative purposes only.

This approach would embed the system strength standard, and the determination of the system strength standard specification by AEMO, in the continuous and iterative planning processes of TNSPs/SSS Providers. It would also provide SSS Providers with a known, set target to which to plan, with three years expected to be sufficient for them to undertake all planning and economic regulatory activities for a new solution to be implemented if required.

The draft rule required AEMO to publish the System Strength Report by 31 August each year, which would set out the system strength requirements and the system strength standard specification for the relevant year. At the time, the Commission considered that this would allow sufficient time for TNSPs who are SSS Providers to include these forecast requirements and the specification in their TAPRs of that year, which must be published by 31 October.

Section B.7.3 of the Draft rule determination contains further analysis on how these processes were expected to occur.

C.6.2 Stakeholder feedback on the draft decision

Stakeholders were generally supportive of AEMO's draft role and responsibilities, however some common themes were evident in the feedback.[159]

AEMO's role and responsibilities

Many stakeholders raised concerns about AEMO's forecasting processes. These included:

- Concern that past forecasts by AEMO had under-estimated of the volume of IBR connecting to the NEM, which has implications for the feasibility of the proposed framework. Given the past forecasts, submissions were concerned about the framework relying on AEMO correctly forecast system needs in order for the SSS Provider to procure sufficient system strength to meet this need.[160]

159 Submissions to the draft determination: CEC, p.2; CS Energy, p.2; AEMO, p.4; AGL p.1; CEIG, p.2.

160 Submissions to the draft determination: CEC, p.2; EUAA, p.1.

- Greater transparency in the forecasting process and methodology is important because it provides confidence in the process, such that connections utilise the centrally provided system strength and connect in the areas near declared system strength nodes.[161]
- A requirement for probabilistic forecasting should be introduced to combat the perceived 'bluntness' of ISP planning, and to better reflect the difficulty of predicting where generators will connect.[162]
- Concern that AEMO may declare too few nodes, which may dictate the location of future IBR connections, with this resulting in AEMO acting as a de facto central planner.[163]

AEMO's report timing

AEMO provided an addendum submission to the draft determination on 30 September 2021 suggesting that the first (and all subsequent) System Strength Reports be published by 1 December each year. [164]

AEMO stated that this is necessary due to the sequential set of data inputs and power system analysis that is needed to perform the 5-year system strength assessment and produce the annual system strength report. The inputs and analysis needed for the system strength assessment and report are derived from the following:

- The latest demand forecasts (in particular, minimum demand projections, which are highly relevant for system strength assessments as they influence projected future operation of synchronous generation);
- Integrated system plan (ISP) projections of future IBR developments, and including network augmentations that are expected to complete in the 5-year outlook period (as network augmentations can improve system strength); and
- Detailed time sequential modelling from the ISP, updated for latest demand forecasts as needed, as this determines projections of future minimum numbers of synchronous generation which is relevant to system strength assessments.

Typically, AEMO's processes are only able to provide sufficiently robust information by the end of October. The requisite system strength analysis then takes these inputs and includes detailed power system and EMT modelling, which is undertaken in November and early December. The outcomes are then presented in AEMO's System Strength Report. As such, AEMO advises that the date of 31 August is not workable and would involve duplication of modelling processes, and therefore cost to gain the desired outcome.

Following further consultation with SSS Providers and AEMO, it was agreed that the draft dates were poorly aligned with AEMO's internal modelling processes. It was also noted that the draft dates did not align well with TNSPs TAPRs and they would have difficulty including system strength planning without a longer period between AEMO's reports and the TAPR.

161 Submissions to the draft determination: CS Energy, p.2; Shell, p.3.
162 Iberdrola, submission to the draft determination, p.1.
163 Submissions to the draft determination: CEC, p.2; Iberdrola, p.1.
164 AEMO, addendum submission to the draft determination, p. 1.

C.6.3 Commission's analysis and final decision

The Commission's final decision maintains the approach in the draft rule with minor amendments to address stakeholder concerns. These amendments and the rationale for them is set out below.

AEMO's role and responsibilities

The Commission acknowledges stakeholders' concerns about the transparency of AEMO's forecasting methodology and that more transparent forecasting would enable better confidence in the process. However, it is the Commission's view that the arrangements provide adequate transparency in the forecasting methodology. This is because in its *System strength requirements* methodology, AEMO must:

- provide an overview of the process to declare nodes[165]
- describe:[166]
  - new connections that are forecast, and the information taken into account
  - how the assumptions about connecting plant characteristics are determined, including their system strength requirements
  - the modelling and analysis methodologies which will be used to determine nodes.

Therefore, the Commission has not made any changes to the transparency provisions in the final rule.

The Commission has also considered concerns raised about AEMO having the flexibility to determine the number of nodes. The Commission has determined to maintain this flexibility for AEMO in the final rule. This is because AEMO is best placed to determine the number of nodes given it has the most up-to-date, holistic view of the power system and its system strength needs. Prescribing a set number of nodes would be inflexible and could lead to too few or too many, resulting in higher costs to consumers.

Therefore, the Commission considers it is best to leave this flexibility with AEMO. AEMO has also proven to be collaborative with TNSPs in its approach to fault level node declaration, and this will help to ensure that the most suitable network locations are selected using the best information to do so. Additionally, AEMO is obligated to update the system strength requirements methodology, which must set out how AEMO declares nodes. This must be done in compliance with rules consultation procedures which enables stakeholders to provide input into how many nodes may be declared.

The Commission considers the final rule strikes the right balance through both requiring transparency and allowing for flexibility so that the arrangements can keep pace with changing market conditions; and in so doing, better promotes the NEO.

165 Clause 5.20.6(f)(1) of the Final Rule
166 Clause 5.20.6(f)(2) of the Final Rule

Report timing

Following feedback provided by AEMO, and consultation with AEMO and TNSPs, the Commission has changed the report and compliance timeline for the final rule. These changes were made to better align processes and allow AEMO to leverage the results of AEMO's ISP and ESOO reports, while also providing TNSPs adequate time to integrate into their TAPR processes. The timeline is set out in the table below.

Table C.2: Reporting and compliance timeline

MILESTONE	DATE
Publication date of: • Updated *System strength requirements methodology* • First *System strength report*	1 December 2022
Publication of updated *System strength impact assessment guidelines*	1 December 2022
First SSS Provider compliance date	2 December 2025
Ongoing System Strength Report publication date	1 December each year
Ongoing SSS Provider compliance date	2 December each year

The Commission considers the short (2 month) delay compared to the draft rule better promotes the NEO than the draft rule because it reduces the administrative costs involved in AEMO duplicating modelling as well as using more accurate input data for the System Strength Reports, while not delaying the implementation date materially.

C.7 SSS Provider's role under the new standard

Under the evolved framework in the final rule, the SSS Provider is the central planner and procurer of system strength for their region. The planning obligations of the SSS Provider will be integrated into their existing TAPR process, enabling economies of scope and scale to be captured. The existing prescribed transmission services regulatory framework including the AER revenue determination, RIT-T and contingent project processes will be used to regulate SSS Providers' revenue to minimise costs to consumers and ensure optimal economic outcomes.

The Commission's final decision maintains the approach in the draft rule with some minor amendments to the SSS Provider's role under the new standard to address stakeholder concerns. The draft rule's approach (that has been broadly maintained) as well as stakeholder concerns and the Commission response to these, are outlined below.

C.7.1 Commission's draft decision

Planning and investments to meet the new standard

Similar to other network standards, the Commission's draft determination was that the system strength standard would place an obligation on SSS Providers that could be integrated into their existing annual planning process and TAPR publications.

By integrating SSS Providers' obligations into existing TAPR planning processes, TNSPs would therefore be able to co-optimise all their system service obligations and resultant network investments with their obligations under the system strength standard. This promotes the SSS Provider's ability to maximise economies of scope. This is particularly important when planning to meet minimum fault levels, as TNSPs would be able to co-optimise system strength solutions with other power system stability services, such as reactive power control or inertia.

Transmission Annual Planning Report

The annual planning review process currently requires TNSPs to plan over a 10-year time horizon. In its draft determination the Commission considered that incorporating the system strength standard into this process would enable and require SSS Providers to consider the long-term changes in system strength requirements, and the power system more generally when considering system strength solutions. The iterative, long term planning undertaken by SSS Providers, and noted in their TAPR, should allow consideration of a broad range of solutions to system strength, including those with long procurement lead times, and optimise the scale and scope of their portfolio of investments.

The TAPR publication would be the key document that sets out how the SSS Provider is planning to meet the system strength standard over the upcoming 10 years and what investment is planned. In its draft rule, the Commission made additions to the TAPR requirements such that all the below information would be included in an SSS Provider's TAPR:[167]

- The activities undertaken or planned to satisfy its obligations under clause S5.1.14 in relation to each system strength node;
- Modelling methodologies, assumptions and results used by the SSS Provider in planning the activities referred to in subparagraph (1); and
- The SSS Provider's forecast of the available fault level at each system strength node over the period for which AEMO has determined system strength requirements, where applicable determined in a manner consistent with the methodology in the system strength impact assessment guidelines.[168]

The intent of including these clauses is that the TAPR would:

- Provide transparent information on available system strength to guide investment decisions by generator developers

167 Clause 5.20C.3(f) of the Draft Rule and now Final Rule.

168 AEMO would also be required to set out in their system strength impact assessment guidelines how SSS Providers calculate and project available fault levels at system strength nodes for their TAPR reporting requirements. Clause 4.6.6(a)(2) of the Draft Rule.

- Give an early indication of opportunities for market participants to offer non-network solutions prior to RIT-T commencement
- Allow for the AER to assess whether an SSS Provider is meeting the obligations of the system strength standard.

Revenue for SSS Providers to meet the standard through the transmission economic regulatory framework - RIT-T and ISP actionable projects

This section summarises the approach that was set out in the draft rule relating to:

- How SSS Providers can recover their efficient costs of meeting the new standard
- The application of the RIT-T to investments to meet the standard.

Revenue for SSS Providers to meet the standard

Chapter 6A of the NER sets out the framework the AER uses to apply in undertaking this role of economically regulating the revenue of TNSPs. The AER has oversight of TNSPs revenue in respect of their provision of prescribed transmission services through the transmission determination process.

The framework requires the AER to set a maximum allowed revenue that applies to TNSPs during a regulatory control period. A TNSP must submit to the AER a revenue proposal and a proposed pricing methodology relating to the prescribed transmission services that are provided by that TNSP. This proposal is then assessed and approved by the AER.[169] TNSPs may also submit cost pass through applications or contingent project applications to the AER seeking to recover additional revenue in certain circumstances.

SSS Providers (other than AEMO, which is discussed below) are TNSPs that are subject to these requirements. The obligation on SSS Providers to provide facilities or services to meet the new system strength standard in clause S5.1.14 is defined as a new service — the system strength transmission service.[170] The draft rule defined this new service as part of 'prescribed TUOS services', which are already a category of prescribed transmission service.[171]

The draft rule established that the facilities and services provided by the SSS Provider to meet the system strength planning standard are a prescribed transmission service for the reasons set out in Appendix A. Therefore, under the draft rule, SSS Providers would forecast operating and capital expenditure needed to meet the standard as part of their revenue proposal[172] or as part of a contingent project application. This means the standard would be treated by SSS Providers in the same way as other regulatory obligations for which TNSPs forecasts their operating expenditure and capital expenditure.

169 In determining the revenues or prices that a network business can charge, the AER forecasts how much revenue a business needs to cover its efficient costs (including operating and maintenance expenditure, capital expenditure, asset depreciation costs and taxation liabilities) and provide a return on capital.

170 See the definition in Chapter 10 of the Draft Rule and now Final Rule.

171 See the definitions in Chapter 10 of the Draft Rule and now Final Rule, and NER.

172 Part E of Chapter 6A of the NER.

Application of the RIT-T, including actionable ISP projects

The Commission determined that, where applicable, SSS Providers would apply the RIT-T to decide which investment should be pursued to meet the system strength standard. No changes to the existing RIT-T framework were considered necessary under the draft rule.

When considering alternative investment options under the RIT-T the TNSP is required to assess the benefits and costs of each alternative and choose the option that maximises the present value of net economic benefits to all those who produce, consume or transport electricity in the market.[173] This clause means that if there were two or more alternative investments each capable of meeting the standard, the RIT-T would require the TNSP to evaluate the costs and benefits of each option and chose the one that maximises the net economic benefits.

The draft rule introduced an obligation on SSS Providers to meet a system standard in Schedule 5.1 of the NER. This would enable TNSPs to undertake a reliability corrective action RIT-T.[174] While a typical RIT-T requires that the net economic benefits associated with a project are positive, a reliability corrective action RIT-T means that the TNSP can procure a solution that provides *negative* economic benefits, if it is the solution that maximises the net market benefits. In effect, this means that the benefits can be negative if this is needed to meet a system standard, as long as the TNSP has demonstrated that they are the *least* negative of all the options considered.

No new enduring RIT-T exemptions were proposed as part of the draft rule. The existing Rules provide for exemptions or modifications to the RIT-T in certain circumstances that may apply to system strength investments. These are:

- **Urgent and unforeseen issues —** The existing RIT-T exemption is available if the project is required to address an urgent and unforeseen network issue that would otherwise put the reliability of the transmission network at risk. While unlikely to occur, this exemption does allow for any urgent and unforeseen issues to be dealt with through this existing process.[175]
- **Actionable ISP projects —** If AEMO includes a system strength project in the ISP as an actionable ISP project, a shortened RIT-T process applies.[176] The ISP provisions were not amended by the draft rule. Once the new system strength standard is included in Schedule 5.1, it would come within the 'power system needs' for the purposes of the ISP under clause 5.22.3 of the NER, and AEMO would have the power to include system strength investments in the ISP as an 'identified need' and an 'actionable ISP project' under the current Rules, if it chooses to do so. This would give AEMO the ability to include system strength issues in the ISP, but would not preclude TNSPs from also progressing system strength investments outside of the ISP.

173 Clause 5.15A.1(c) and 5.15A.2(b)(12) of the NER.

174 The definition of 'reliability corrective action' in clause 5.10.2 of the NER includes investment by a TNSP in its transmission network for the purpose of meeting the service standards linked to the technical requirements of schedule 5.1.

175 Clause 5.16.3(a)(1) and (b) of the NER.

176 Clause 5.15A.3 of the NER.

C.7.2 Stakeholder feedback on the draft decision

Stakeholder submissions and feedback on the draft decision contained a range of comments about the role of SSS Providers in meeting the standard. These are set our below and include:

- Confirmation of the SSS Provider in each region.
- Planning and investments to meet the new standard.
- Transmission Annual Planning Report.
- Revenue for SSS Providers to meet the standard through the transmission economic regulatory framework - RIT-T and ISP actionable projects.

Confirmation of the SSS Provider in each region

AusNet Services requested confirmation that the SSS Provider in Victoria is AEMO rather than AusNet Services.

Planning and investments to meet the new standard

Most stakeholders were supportive of the Commission's draft determination position that system strength services should be provided by one centralised planner in each region; the SSS Provider. Some DNSPs considered that they were best placed to plan and procure system strength services for their own networks, due to familiarity and knowledge of future connections.[177] Other DNSPs suggested that nodes should also be placed on distribution networks to ensure sufficient provision of system strength services on these networks.[178]

Transmission Annual Planning Report timing

TNSPs also raised some issues with the proposed planning timeframes.[179] This focused mainly on the difficultly of including the results of AEMO's system strength requirement forecasting in their TAPR. This is due to the short period between the release of the forecasts and the TAPR. It was suggested that providing TNSPs with draft *system strength requirements* ahead of time would address this concern. TNSPs also raised concerns around the length of the period between the release of the standard's requirements and them becoming binding on SSS Providers. Three years was said to be achievable but tight, with little room for iterations on RIT-T modelling as well as commissioning, in particular for rotating solutions.

Revenue for SSS Providers to meet the standard through the transmission economic regulatory framework - RIT-T and ISP actionable projects

Revenue for SSS Providers to meet the standard

The draft revenue arrangements for SSS Providers to meet the standard were supported in principle by TNSPs. However, a number of submissions from TNSPs provided specific feedback proposing changes either on a permanent basis or as part of the transitional arrangements. These include the following suggestions:

177 Citipower, Powercor and United Energy, submission to the draft determination, p.2
178 Ausgrid, submission to the draft determination, p.2
179 ENA, submission to the draft determination, p.9.

- The ENA proposed system strength specific contingent project triggers as part of the transitional arrangements, as they considered the application of these clauses under the draft rule are unclear.[180]
- TransGrid suggested that the rules governing contingent projects should allow for a reduced expenditure threshold or the aggregation of system strength projects, given the distributed nature of system strength services.[181]
- TransGrid suggested alleviating cash flow volatility resulting from network agreements for non-network solutions through an accelerated pass through mechanism with no materiality threshold.[182]

Application of the RIT-T, including actionable ISP projects

TransGrid, AEMO and a number of generators suggested potential adjustments to the RIT-T process in their submissions. Several stakeholders raised their concern that the assessment time frames under the existing RIT-T framework are lengthy, and consideration may be required to ensure system strength services are delivered in a timely manner. A variety of changes were suggested, with some calling for:

- shortening of the process[183]
- exemptions to the test[184]
- new frameworks for non-network solutions.[185]

In contrast, other stakeholders supported retaining the existing RIT-T framework and some stakeholders called for a more rigorous process including measures such as:

- competitive tendering[186]
- project-by-project capex approvals[187]
- an obligation on TNSPs to procure a portion of the standard from non-network solutions.[188]

C.7.3 Commission's analysis and final decision

The Commission has considered stakeholder feedback in its final determination on this aspect of the rule. The Commission has made minor changes to the draft rule to address concerns about who the SSS Provider is, and TAPR timing in relation to AEMO's publication of the System Strength Report. These changes and the Commission's view on the other issues raised by stakeholders are discussed below.

180 ENA, submission to the draft determination, p.7
181 TransGrid, submission to the draft determination, p.4
182 TransGrid, submission to the draft determination, p.5.
183 AEMO, submission to the draft determination, p.2
184 Total Eren, submission to the draft determination, p.2
185 Tesla, submission to the draft determination, p.3
186 AGL, submission to the draft determination, p.2
187 Alinta, submission to the draft determination, p.2
188 Alinta, submission to the draft determination, p.2

Confirming who the SSS Provider will be in each region

The Commission has made a minor change to the final rule in clarify that the SSS Provider for a region is:[189]

1. the TNSP for the region; or
2. if there is more than one TNSP for a region:
    a. the jurisdictional planning body for the participating jurisdiction in which the region is located, if that entity is also a TNSP; or
    b. otherwise, the Coordinating TNSP for the region.

This clarification ensures that the SSS Provider is always a TNSP and future proofs it against any potential changes to jurisdictional planning bodies.

Additionally, the Commission considers the draft rule was clear that in Victoria, the SSS Provider is AEMO. AEMO is currently the jurisdictional planning body for Victoria. As such, the approach for Victoria is clear and has been maintained for the final rule.

Planning and investments to meet the new standard

The Commission maintains the draft rule's position that there should be one TNSP (AEMO in Victoria) who is the single, central planner and procurer of system strength services for each region.

The Commission considered the suggestion that DNSPs are better placed to plan and procure system strength for their own networks but has opted to maintain the position of the draft determination. This is because the Commission considers there are significant benefits in having a single party responsible for planning and coordinating the procurement of system strength services in each region and that TNSPs are best placed to perform this function. The rationale for not including DNSPs as SSS Providers is that distribution networks typically require more bespoke system strength remediation due to their network topography. As such, the benefits of central planning and coordination would not be as readily realised, compared to TNSPs as the sole central planner and procurer for their regions.[190]

TNSPs who are the SSS Provider can procure system strength solutions from a range of providers, including DNSPs, other TNSPs in the region, generators or other providers of non-network solutions. The supply of system strength from within distribution networks to meet the SSS Provider's planning standard is permitted and should be planned and procured by the SSS Provider if it is determined to be optimal through the RIT-T process.

In response to submissions from DNSPs, the final rule clarifies that the SSS Provider must consult with other Network Service Providers whose networks are connected to the transmission system of the SSS Provider when planning how to meet the standard and preparing the system strength information it is required to include in its TAPR.[191] This issue is discussed further in appendix C.8 below.

---

189 Clause 5.20C.3(a) of the Final Rule.

190 AEMC, *Efficient management of system strength on the power system - Draft determination*, p.75; *Investigation into system strength frameworks in the NEM - Final report*, Chapter 7.

191 Cause 5.20C.3(h1) of the Final Rule.

Transmission Annual Planning Report

The Commission acknowledges the difficulties raised by SSS Providers with including AEMO's system strength requirements in their TAPR given the proximity of the System Strength Report and TAPR release dates. To address these concerns the Commission has changed the publication dates for AEMO's reporting and the associated SSS Provider compliance dates. This was for reasons of AEMO's modelling timeline, detailed in appendix C.6.3, where a September date would lead to a duplication of processes, whereas a December date would allow for a sequential approach to take place A December date would also reduce the cost of AEMO's modelling exercises and also allows for the most accurate and up to date data to be used by AEMO in its forecasting of system strength needs.

In light of this, and as noted above in appendix C.6.3, the Commission has changed to the timing of the publication of the System Strength Report. In considering this change the Commission consulted with the SSS Providers who confirmed that a December date would allow sufficient time for TNSP new pricing processes (discussed in Appendix E). Moving this report to December will provide SSS Providers with ample time of eleven months to include the latest System Strength Report data into their next TAPR.

This change of date also has implications for the distribution annual planning reports (DAPR), which are released in December. These will have to be written using the previous year's System Strength Report.

The Commission's response to AusNet and AEMO's concerns regarding timing under the Victoria arrangements are covered in appendix C.9.

Revenue for SSS Providers to meet the standard through the transmission economic regulatory framework - RIT-T and ISP actionable projects

Revenue for SSS Providers to meet the standard

The Commission maintains its draft position on revenue recovery mechanisms for system strength, subject to new transitional arrangements that are discussed in Appendix F. The Commission considers that the existing revenue recovery mechanisms in the NER are sufficient for the purposes of this rule change, and any amended/additional cost pass through provisions or contingent project application processes for system strength projects are not required on an ongoing basis.

This is because the NER already allows the aggregation of multiple contingent project applications and there are precedents for such an approach.

TransGrid's concern about potential cash flow volatility resulting from non network agreements is addressed by the existing network support pass through provisions, which apply to system strength service payments (i.e. operating expenditure on non-network solutions related to system strength). The network support pass though provisions allow TNSPs to recover these costs each year though an annual true-up mechanism against forecast costs so it effectively acts as an accelerated pass through mechanism with no materiality threshold as suggested by TransGrid.

Application of the RIT-T, including actionable ISP projects

The Commission does not consider that it is appropriate to address stakeholder concerns about the RIT-T process through amending the broader transmission and planning investment framework through this rule. Addressing these issues specifically for system strength is not appropriate given it the final rule's design which aims to provide for an integrated, holistic framework.

The Commission understands these to be criticisms of the broader framework.

BOX 7: RIT-TS FOR SYSTEM STRENGTH INVESTMENTS TO MEET S5.1.14(B)(2)

As part of the RIT-T process for investments to meet the system strength standard, the SSS Provider will need to describe the 'identified need'. For example, clause 5.16.4(b) of the NER requires that the project specification consultation report must include:

1. a description of the identified need;
2. the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);
3. the technical characteristics of the identified need that a non-network option would be required to deliver, such as:
    a. the size of load reduction or additional supply;
    b. location; and
    c. operating profile.

The description of the identified need must also comply with the AER's RIT-T application guidelines.

For system strength investments, the identified need will be informed by AEMO's system strength requirements methodology and annual System Strength Reports, including AEMO's declaration of system strength nodes, system strength requirements and system strength standard specification at each node.

However, the SSS Provider will still have to undertake analysis to convert those inputs and assumptions into the description of the identified need for the RIT-T process (and for the information it includes in its TAPR). In particular, AEMO will specify minimum three phase fault levels for the purposes of S5.1.14(b)(1), but the SSS Provider will need to undertake its own analysis to determine the level of system strength services required to achieve stable voltage waveforms for the purposes of S5.1.14(b)(2).

The Commission expects the SSS Provider to clearly explain how it has undertaken this analysis as part of describing the identified need as part of the RIT-T process in accordance with the requirements of clause 5.16.4(b)(1) to (3) that are set out above.

If the AER considers that there would be value in providing greater clarity on how the

identified need should be framed for system strength RIT-Ts, the AER may wish to provide a guidance note including a case study on how it would expect SSS Providers to apply its RIT-T application guidelines in relation to RIT-T's to be completed for investments to meet S5.1.14.

C.8 Requirements for parties to coordinate to meet the standard

The SSS Provider is the sole planner and procurer for system strength for their region. The system strength supplied by the SSS Provider will propagate through the network, both within their region, and across regional boundaries. For these two reasons, it is imperative that joint planning rules and other mechanisms for coordination between the SSS Provider and other NSPs and AEMO cover all necessary parties and function effectively within the context of the evolved framework.

The final rule leverages existing joint planning requirements in the ISP process, while adding to or amending the requirements for coordination between SSS Providers, AEMO, other TNSPs and DNSPs. The final rule updates the arrangements that were set out in the draft rule to capture the benefits of a single planner and procurer for each region, while ensuring solutions are not limited to network solutions on the SSS Provider's transmission network.

C.8.1 Commission's draft decision

The draft rule introduced new joint planning obligations, which would leverage those that already exist, to ensure that SSS Providers undertake thorough joint planning with AEMO, and where necessary, other NSPs, to determine the most efficient way to maintain the system strength standard.

Joint planning for both AEMO and TNSP planning processes were crucial elements of draft rule. The new obligations proposed by the draft rule related to joint planning between:

- **The SSS Provider and AEMO —** The draft rule included a new clause, 5.14.4(d) specifying that the SSS Provider is to collaborate and cooperate with AEMO when it is looking to procure a non-network solution to meet the standard that must be dispatched in real-time by AEMO, or would otherwise affect how AEMO manages dispatch. The intent of this clause is to ensure that operational considerations of certain solutions for system strength are considered in the planning time frame.
- **The SSS Provider and TNSPs** — The draft rule included a new clause, 5.14.3(b) that would require joint planning between the SSS Provider and any relevant TNSP where a possible credible option for a SSS Provider to provide system strength services involves an augmentation to the transmission network of another TNSP. This proposed addition is meant to foster inter-regional collaborations between TNSPs when planning for system strength, given system strength provision and demand doesn't obey regional boundaries. It was also intended to address the fact that there are multiple TNSPs in some regions.

Many of the key AEMO and SSS Provider planning processes proposed under the draft rule require joint planning that is already captured under the existing joint planning arrangements in the NER. These include:

- **ISP planning and similar processes —** SSS Providers should share their knowledge and models of their specific networks with AEMO for the purposes of informing the ISP, including most up to date information of proposed works and indications of generator and load connections to their network over time. AEMO can take these contributions into account for its broader view of system and market outcomes. This is already a requirement in the Rules under clause 5.14.4.
- **The SSS Provider and DNSPs** — The existing joint planning arrangements under clause 5.14.1 of the NER set out how SSS Providers and DNSPs must effectively coordinate in planning and procurement processes where relevant new connections or potential system strength solutions occur in distribution networks.

Furthermore, AEMO and SSS Provider modelling and analysis of system strength, whether to meet their current obligations or those proposed in the draft rule, naturally requires collaboration, including the following processes:

- **Minimum fault levels —** Each SSS Provider's own network needs contribute to the minimum fault levels required at system strength nodes. Any necessary power system stability modelling requires a joint exercise between SSS Providers and AEMO.
- **Modelling system strength provision and demand from IBR —** AEMO and SSS Providers collaborate on system and plant models to model detailed power system stability, including inter regional interactions. AEMO has access to the propriety plant models required for processes such as retuning control systems**.**

An example of this joint planning under the current framework is the Power System Modelling Reference Group (convened by AEMO with SSS Provider representation). This group currently coordinates the minimum system strength and inertia requirements. This means AEMO and the SSS Provider are in agreement prior to AEMO announcing a shortfall (and related actions).

C.8.2 Stakeholder feedback on the draft decision

Several stakeholders commented that effective joint planning and coordination with AEMO, other TNSPs and DNSPs would be key to the success of the reform, with the SSS Provider responsible for procuring services across multiple networks. A number of submissions provided feedback on whether existing joint planning arrangements are sufficient to ensure the efficient planning and provision of system strength services across networks and jurisdictions.

SSS Provider-DNSP joint planning

Multiple NSPs noted their support for more explicit joint planning provisions between the SSS Provider and DNSPs.[192] Some stakeholders raised the concern that SSS Providers would

192 Submissions to the draft determination: Ergon Energex, p.2; AEMO p.2, CitiPower, Powercor, United Energy, p.2; Ausgrid, p.2.

preference procuring system strength services from within their own networks resulting in generators sub-optimally connecting at the transmission level. Others noted that the framework could be enhanced if system strength nodes are declared outside the SSS Providers' networks.

SSS Provider-AEMO joint planning

AEMO suggested that the framework could be improved by expanding joint planning arrangements to include SSS Providers being required to provide certain data and models to AEMO.[193]

During discussions at technical working group meetings, TNSPs noted the existing NER provisions would already provide AEMO with the data and models required for system strength forecasting.

On a separate matter, AEMO noted in its submission that the draft rule's joint planning provision were very narrow and only included discussion on certain non-network options. It considered the provision should reflect more end-to-end planning collaboration between SSS Providers and AEMO.

C.8.3 Commission's analysis and final decision

The Commission has considered the issues raised by stakeholders in its final decision. Arrangements for coordination between the SSS Provider and other NSPs have been amended from the draft to provide clarity on the role of DNSPs and other TNSPs in the framework. Similarly, SSS Provider-AEMO joint planning arrangements have been amended to ensure collaboration occurs in all relevant parts of the TNSP-AEMO joint planning process.

SSS Provider-DNSP and SSS Provider-TNSP coordination

In its final determination, the Commission considered whether the joint planning provisions should be extended to require SSS Providers to collaborate with DNSPs when planning and procuring system strength investments. The Commission has not made changes of a scale that were suggested by some stakeholders, but rather has made some minor amendments to the draft rule to ensure greater clarity.

As discussed in appendix C.7.3 above, the SSS Provider can procure system strength solutions from a range of providers including DNSPs, other TNSPs, generators or other providers of non-network solutions. The supply of system strength from within distribution networks or other transmission networks (for example, where there is more than one TNSP in a region, such as TransGrid and AusGrid in NSW) is permitted and should be used by the SSS Provider if it is determined to be optimal through the RIT-T process. The SSS Provider should also coordinate with DNSPs and other TNSPs in the region when planning system strength services (for example to understand DNSPs' forecasts of load and embedded generation connections).

193 AEMO, submission to the draft determination, p.5

The Commission considers that these matters should not be addressed in the joint planning provisions in clause 5.14. This is because these provisions focus on joint planning of TNSPs and DNSPs in the provision of their regulated transmission and distribution services. Where an option for meeting the SSS Provider's system strength requirements involves a DNSP providing services to the SSS Provider (e.g. though installation of new equipment in its distribution network), those services will not be a regulated distribution service and will instead be a non-distribution service or an unregulated/unclassified distribution service. The assets would not be included in the DNSP's Regulated Asset Base and the charges for those services would be recovered through unregulated charges from the SSS Provider rather than from regulated charges from distribution customers. Similarly, services provided by another TNSP to the SSS Provider would not be prescribed transmission services provided by that other TNSP.

The SSS Provider should engage with the relevant DNSP or TNSP in a similar way in relation to the provision of these services as to how it engages with other potential providers of non-network solutions. This is why the final rule updates the arrangements that were set out in the draft rule to capture the benefits of a single planner and procurer for each region, while ensuring solutions are not limited to network solutions on the SSS Provider's transmission network. It is expected however that there may be system strength solutions that may be provided by other NSPs (i.e. not the SSS Provider). The final rule allows for this possibility.

As a result, the final rule does not make any further changes to the joint planning provisions and it removes the proposed change to clause 5.14.3(b) from the draft rule, Instead, it ensures appropriate collaboration between the SSS Provider and other TNSPs and DNSPs by making changes to the system strength provisions in clause 5.20C.3.

The final rule contains a new clause 5.20C.3(f1) which provides that the SSS Provider must consult with other Network Service Providers whose networks are connected to the transmission system of the SSS Provider when preparing the system strength information it is required to include in its TAPR including:

1. the activities undertaken or planned to satisfy the SSS Provider's obligations under clause S5.1.14 in relation to each system strength node;
2. modelling methodologies, assumptions and results used by the SSS Provider; and
3. the SSS Provider's forecast of the available fault level at each system strength node.

Clause 5.20C.3(a1) also clarifies that, for the purpose of clause 5.20C.3, a 'non-network option' includes network expenditure undertaken by a Network Service Provider other than the SSS Provider or by any other person.

SSS Provider-AEMO joint planning

The Commission considers that the existing framework provides AEMO with the necessary powers to obtain the information that is required for the accuracy of their modelling. However, the Commission has determined that the NER clause 5.14.4(d) added under the draft rule is unnecessarily specific and has reworded the arrangements under Clause 5.14 to reflect that AEMO and SSS Provider collaboration processes are "end to end" rather than just on non-network solutions. This is reflected in Clause 5.14(e) of the final rule.

C.9 How the standard applies in the Victorian jurisdiction

In an adoptive jurisdiction (i.e. Victoria), AEMO would be the SSS Provider responsible for maintaining the proposed system strength standard in this region. There are some differences in how the Rules apply in Victoria in relation to Chapter 5 of the NER.[194] Because of this, the AEMC is required to consider how the rule will operate in an adoptive jurisdiction.

C.9.1 Commission's draft decision

The Commission considered that the draft rule was compatible with the performance of AEMO's declared network functions because AEMO is the transmission network planner and is responsible for providing shared transmission services in Victoria.

The Commission considered that, in relation to the SSS Provider's obligations to meet the system strength standard, no changes to the Rules were required as part of the draft rule. It also did not consider that any transitional Rules specific to AEMO's role in Victoria would be needed in respect of this aspect of the draft rule.[195] This is because, while the draft rule introduced new obligations on network service providers, it aligns with AEMO's existing functions and does not change the allocation of responsibilities between AEMO and DTSOs in relation to the provision of shared transmission services and connection services in the declared transmission system.

Unlike other TNSPs, there would be no AER oversight of AEMO's revenue requirements to meet the new system strength standard in its role as Victorian TNSP, as AEMO does not have an AER revenue determination. As an alternative, AEMO must consult on and publish a revenue methodology setting out the method for calculating its maximum allowed revenue for prescribed transmission services for each regulatory year. The AER does not approve this revenue methodology. As such, the efficiency of expenditure to meet the system strength standard in Victoria will primarily be tested through competitive tender processes as other investments in Victoria in the current regime. The RIT-T will also continue to apply to AEMO's investment decisions in the same way as other TNSPs, as it currently does.

C.9.2 Stakeholder feedback on the draft decision

AusNet and ENA raised a number of concerns relating to the application of the evolved framework under the Victorian transmission arrangements:

- The functional split in the Victorian framework can contribute to delays, costs and complexity in transmission activity. The provision of system strength through the evolved framework in the draft rule is expected to be more challenging under the Victorian arrangements. [196]
- In particular, the requirement to apply a competitive tender process may slow delivery of system strength solutions in Victoria, noting that recent experience indicated that

194 See, for example, clause 5.1A.1(d) and rule 5.3B of the NER.

195 Appendices D and E discuss other aspects of the final rule that necessitate amendments to the Rules and transitional arrangements.

196 AusNet, submission to the draft determination, p.2

meeting this timeframe would require SSS Providers outside of Victoria to plan and procure service inputs early and simultaneously and would involve tight timeframes. AusNet questions whether the potential benefits from contestability will outweigh the additional costs and complexity of the tender and contracting process.[197]

- The clarity of responsibility between the DTSO and jurisdictional planner, particularly with respect to maintaining system strength under outage conditions.[198]

AusNet suggested determining whether any steps may be able to be conducted in parallel rather than sequentially may be a potential solution to their concerns regarding timing.

AusNet also requested that the Commission confirm that the SSS Provider in Victoria is AEMO and not AusNet, noting that some sections of the draft determination incorrectly referred to AusNet as being an SSS Provider.

C.9.3 Commission's analysis and final decision

The Commission has not made any changes to the final rule in relation to this issue, and maintains the position set out in the draft determination.

The issues raised by AusNet and ENA in relation to the application of the rule in Victoria are not specific to system strength, rather they are broader issues related to the transmission planning and investment framework in Victoria. The Commission does not have the power to address those issues as part of this rule change given the scope of this rule change and the limitations in the National Electricity Law on the Commission's powers to make rules that regulate AEMO's declared network functions or affect the allocation of powers, functions and duties between AEMO and a declared transmission system operator where the rule change is not submitted by AEMO or the Victorian Minister or consented to by AEMO.[199] Some of these issues may be able to be considered as part of the current Transmission Planning and Investment Review.

The Commission has considered the issues raised by AusNet in relation to responsibility for maintaining system strength during planned network outages. Given the decision discussed in appendix C.5.3 that the new system strength standard should not include planned or unplanned network outages, the Commission does not consider that it is necessary to address this issue as part of the final rule (even if it had the power to do so, which as noted above it may not). Under the final rule, the SSS Provider is the party who is responsible for all obligations related to meeting the system strength standards in S5.1 and S5.1a. In Victoria, AEMO is the SSS Provider. To the extent that there remains any lack of clarity around responsibility for issues related to planned network outages in Victoria, that is a broader issue related to the Victorian arrangements for outages.

197 AusNet, submission to the draft determination, p.7
198 AusNet, submission to the draft determination, p.7
199 See sections 91(7) and 91(9) of the NEL.

C.10 Responses to other stakeholder issues on the supply-side

Table C.3: Other issues raised in draft determination submissions

STAKEHOLDER	ISSUE	AEMC RESPONSE
Powerlink, p.3	Concern about the situation where SSS Providers need to pay thermal synchronous plant for system strength services when wholesale energy market prices are low or negative. Thermal generators may have minimum loading constraints and will likely need to be compensated under low price conditions. This may impose significant costs on TNSPs. Powerlink considers the AEMC should assess the implications of this situation, including the impact on SSS Providers' working capital.	Payments by TNSPs to synchronous generators for system strength services are already covered by the network support pass through. This pass through allows TNSPs to receive an annual true up for the difference between actual costs and forecasts under these contracts. Further, any change to this would require changes broader than this rule change or a bespoke framework for system strength, and therefore considered outside the scope of the rule change or inappropriate respectively.
Aurizon, p.2	The AEMC should consider how existing Identified User Shared Assets (IUSAs) are providing, or could further provide, system strength services, including how latent capability or capacity in transmission assets providing negotiated transmission services are currently providing the proposed prescribed system security services and reducing costs for IBR connections.	Such issues should be addressed in the IUSA negotiated contracts between the relevant parties. The rules do not address this situation anywhere, and that supplying system strength to IBR does not incur any additional costs to the identified user. Thus, it is unnecessary and inconsistent to include provisions for the renegotiation of IUSA cost allocation additional to those already included in S5.1. This renegotiation can already happen under the current framework.
TransGrid, p.8	There may be cases where it is efficient for SSS Providers to acquire synchronous condensers that were installed under the existing arrangements and operate these assets as part of the regulated network. This would require the SSS Provider to justify the acquisition through a RIT-T process, however from experience	These comments relate to the RIT-T in a more general sense than would be appropriate to address in this rule change. The Commission also understands from discussions with the AER that the way TransGrid has described the problem is not how it would occur, with

STAKEHOLDER	ISSUE	AEMC RESPONSE
	in similar situations, TransGrid understands the AER takes the view that such assets are sunk cost and have zero value. This means the SSS Provider could not actually acquire these assets from the project at a fair value. The AEMC should consider whether a transitional provision to the RIT-T process to enable these assets to be transferred to the SSS Providers and brought into the RAB at a value as determined under a RIT-T process.	assets being rolled in at the net cost.
AER, p.2	The draft rule proposes that TNSPs publish information regarding the available fault level in their annual planning report. AEMC should give additional consideration as to whether this should include an assessment of whether relocation of synchronous condensers from areas of high system strength to areas of low system strength is efficient, or whether existing frameworks already provide an incentive for this.	The general incentive regulation framework will apply and already provides incentives to do so where possible (including information in its TAPR to this effect) and if it is at a lower cost.
AER, p. 2	It may be difficult for the AER to deny a project that is inefficient because the standard is a reliability corrective action standard. Therefore, AER is wondering how the efficient level concept can be reflected in the standard's wording to allow the AER to be able to act on the policy's intent when approving expenditure.	The way the rule requires SSS Providers to meet AEMO forecast from three years prior is an intentional aspect of the framework. It is necessary to ensure that there is sufficient lead time to procure system strength services in a timely manner. The Commission considers that investment which is undertaken to meet a forecast that is higher than the subsequent forecast is unlikely to result in a stranded asset. It would likely instead be investment which is delivered earlier than would be efficient. We will however, actively monitor the stranded asset risk with the AER and commence a review of the standard if this is deemed to be too high.

STAKEHOLDER	ISSUE	AEMC RESPONSE
		Additionally, the market bodies - AEMC, AEMO and the AER - will all be closely monitoring the implementation and operation of the new standard to make sure it continues to meet the long-term interests of consumers. This is discussed further above.
AEMO, p. 9	AEMO suggested that it may be preferable to use a more generic term such as "power-electronics connected loads" rather than "inverter based loads", as the connection will be via a converter rather than an inverter.	The Commission understands AEMO's view but considers that the Chapter 10 glossary definition of 'inverter based loads' included in the final rule to be broad enough to cover all power electronics connected loads. The term's definition has been written specifically to be as broad as possible. In doing so, we consider that any confusion can be clarified by AEMO's SSIAG and system strength requirements which will play a key role in determining what in included and excluded rather than explicitly what may or may not be inverter connected.

D DEMAND SIDE: TWO NEW GENERATOR ACCESS STANDARDS

BOX 8: SUMMARY OF KEY POINTS

The 'demand side' reforms of the final rule introduce two new access standards that relate specifically to system strength. These new standards will help manage the relevant inverter based resource (IBR) plant's demand for system strength, complementing the supply side reforms.

These new access standards:

- require new connecting IBR (asynchronous generating units and inverter based loads) and market network service providers (MNSPs) to operate stably and remain connected at a minimum short circuit ratio (SCR) level of 3.0. This SCR standard forms the basis of the system strength charge, since it is a key input into determining the 'demand', or quantity, for system strength services of various connecting parties.
- prevent generating systems which comprise partly or fully of asynchronous generating units from including a vector shift or similar protection relay that would operate for a voltage phase angle shift less than or equal to 20 degrees, as measured at the connection point.

These new standards apply to newly connecting:

- asynchronous generators in Schedule 5.2.5 — both the SCR and voltage phase shift access standard
- loads in Schedule 5.3 — only the SCR access standard
- MNSPs in Schedule 5.3a — only the SCR access standard.

These standards will not apply to plant that has already connected to the grid. Further information on the savings provisions as well as the transition to the new arrangements are discussed in Appendix F.

Clause 5.3.9 of the NER, that requires generators that alter their generating systems to renegotiate their performance standards in certain circumstances, has been amended. This is to allow generators to renegotiate technical performance in respect of the SCR requirements, which enables them to reduce their exposure to the system strength charge. As there is currently no similar provision in the NER for loads and MNSPs to alter plant and re-negotiate their registered performance standards, the final rule introduces two new clauses 5.3.12 and 5.3.13 that will allow relevant inverter based loads and MNSPs to renegotiate technical performance in respect of the SCR requirements if they alter their plant in the future.

Additionally, the SCR standard has been designed with flexibility to allow for jurisdictions to include its own lower, REZ-specific SCR requirement(s) on connection through their REZ

programs.

Changes from draft to final rule:

The final rule includes some changes from the draft that will enable the evolved framework to best meet the NEO and were developed in response to stakeholder feedback. These changes are as follows:

- Two changes have been made to avoid an SCR of 3.0 becoming a barrier to efficient connection:
  - The glossary definition of SCR has been amended to exclude from the calculation of the SCR any contribution to the three phase fault level from the installation of system strength improvement devices on the plant side of the connection point. This change allows all connecting parties to generating systems to meet the proposed minimum standard with the inclusion of appropriate local system strength mitigation facilities.
  - The drafting of the standard has been changed to include situations where it would be more efficient for the developer to negotiate an SCR that is above 3.0 and pay the System Strength Service Provider (SSS Provider) for the incremental provision of system strength above the SCR of 3.0. This will allow for efficient connections that may not be able to meet at SCR of 3.0 at the connection point.
- The wording of the standard has also been changed to better reflect the intent that compliance should be able to be assessed easily and early in the connection process.
- Inclusion of a new clause - 5.3.13 - to complement 5.3.12 of the draft and final rule by setting out how altered load or MNSP plant must be commissioned.

This Appendix details the 'demand side' reforms of the final rule, which include two new access standards for system strength that will apply to IBRs that create a 'demand' for system strength — including generator, load and MNSP plant. These new standards help manage the demand for system strength by requiring and incentivising plants to reduce their demand for system strength.

The new standards, which mandate that newly connecting IBR plant operate at a minimum capability, provide a backstop level of performance that places a cap on the amount of system strength services used by these connections. The SCR standard not only complements the supply side arrangements, but the approach also forms the basis of the system strength charge (discussed in Appendix D), as it is a key input into determining the 'demand', or quantity for system strength services of various connecting parties. The new voltage phase shift standard, which is applied only to asynchronous generating systems, will also support the general security of the power system, by clarifying how these generating systems should respond to, and remain stable, following certain events on the power system.

Together, these new standards will help to promote the efficient use of system strength in the system, minimising costs for consumers and therefore promoting the NEO.

The term 'IBR plant' specifically refers to generation, market network service facilities or load, that is connected to the network via an inverter, has a nameplate rating greater than 5 MW, and is registered as a generating system, MNSP or customer load. It does not refer to other forms of IBR such as distributed energy resources (such as residential solar systems) and network service provider's voltage control equipment.

This Appendix covers the following:

- Appendix D.1 sets out the background of the current arrangements, including the current 'do no harm' frameworks and existing access standards
- Appendix D.2 sets out a short summary of TransGrid's views related to this issue, as set out in the rule change request
- Appendix D.3 sets out stakeholder views on this issue
- Appendix D.4 sets out the Commission's final determination, including:
  - the new SCR access standard
  - the new voltage phase shift access standard
  - application of NER clause 5.3.9 for altered generating systems and introduction of an equivalent clause — 5.3.12 — for load and MNSPs in relation to the SCR standard
  - other issues raised in draft determination submissions.

D.1 Current arrangements

The existing arrangements have two processes that impose technical limitations on the capability of newly connecting plant relating to their demand for system strength. These are the 'do no harm' arrangements and the NER access standards, as set out below.

D.1.1 The 'do no harm' arrangements

The current 'do no harm' arrangements only apply to IBR generators and MNSPs. They incentivise connecting parties to install equipment that will have a low impact on the stability of the existing network. This is through the requirement for connection applicants to implement a system strength remediation scheme (or have the network service provider undertake system strength connection works), if the IBR plant connection will have an adverse system strength impact.[200]

D.1.2 The NER access standards

The NER also set out mandatory technical limits that all connecting plant (be it a generator, load or MNSP plant) must meet prior to be able to connect to the power system. These limits are known as access standards.[201]

All new generating systems with nameplate capacity greater than 5MW are required to connect in accordance with these access standards, by negotiating with the local

200 Clause 5.3.4B of the NER.

201 For example, Schedule 5.2 of the NER sets out the conditions for connection of generators, including the access standards in S5.2.5 and S5.2.6.

(transmission or distribution) network service provider, to determine generator performance standards (GPS) that are specific to each generating system.[202] These GPS must meet the requirements of the generator access standards.[203]

These access standards include a wide range of requirements related to the secure operation and planning of the power system.[204] Some of these standards currently capture some aspects of managing the demand for system strength implicitly, as discussed further below, however, there are currently no access standards that specifically relate to system strength.

Loads that connect under Chapter 5 and MNSPs are also required to negotiate access standards with the local network service provider. The access standards for loads in Schedule 5.3 and for MNSPs in Schedule 5.3a are not as detailed as those for generators and also do not include specific requirements in relation to system strength.

The current standards that are relevant to the discussion in this chapter are set out below.

Short circuit ratio (SCR)

The current system strength arrangements do not include a specific requirement to be able to operate down to a given SCR level. Rather:

- IBR plant needs to be able to meet performance standards at its location in the power system.
- Generators and MNSPs plant must met the costs of remediating any system strength impacts caused by the connection of its generating system.

In addition, the SCR requirements need to be provided by connecting generators as part of required modelling data.[205]

The current access standards in NER Schedules 5.2, 5.3 and 5.3a provide an incentive on IBR plant to use modern inverters with good technical performance capabilities. Such inverters are also generally less susceptible to inverter-driven instability and hence require a lower SCR to operate.

202 These are sometimes referred to as "generator performance standards", or GPS. However, the access standards refer to the standards that are defined in the NER, while the GPS refer to the actual technical performance requirements that are negotiated by each generator as part of establishing its individual connection agreement with the relevant NSP.

203 The access standards for connecting generators are described in Schedules 5.2.5 and 5.2.6 of the Rules. Most of these standards include a "minimum" and "automatic" level. When negotiating a connection to the relevant network under clause 5.3.4A, a connecting generator must propose a standard that is as close as practicable to the automatic access standard taking into account: the need to protect plant from damage, the power system conditions at the location of the proposed connection and the commercial and technical feasibility of complying with the automatic access standard with respect to the relevant technical requirement. Many of these standards, particularly those that relate to power system security, are "AEMO advisory matters", where the network service provider must take into account AEMO advice when deciding whether to accept or reject a proposed standard.

204 The AEMC amended the generator access standards and the framework for negotiating performance standards in the *Generator technical performance standards* rule, which was published on 27 September 2018 (ERC0222).

205 Schedule 5.5.4 of the NER.

Voltage phase shift

The generator access standards include requirements for generating systems to maintain continuous uninterrupted operation for a number of conditions including frequency disturbances,[206] voltage magnitude disturbances[207] and multiple network faults.[208] However, currently the generator access standards do not explicitly include a requirement for generating systems or their generating units to remain connected following a large shift in the phase of the voltage at the generator's connection point.

While the generator access standards do not explicitly consider voltage phase shifts, S5.2.5.5 of the rules requires a generating system, and each of its generating units, to remain in continuous uninterrupted operation[209] for any disturbance caused by a credible contingency event.[210] This implies a connecting party needs to demonstrate that a connecting generating system would ride through the shift of the phase of the voltage at the connection point associated with a credible contingency involving the tripping or switching of a transmission line.

Process for renegotiating

GPS are negotiated for generating systems at the time of connection and the connecting party is required to maintain this technical performance to meet those GPS over the life of the plant. However, over the life of the plant, it is likely that some alternations, including the upgrading and replacement of some sub-systems, may be required. These upgrades and changes may affect the way the plant behaves, and its ability to continue to meet its GPS.

Clause 5.3.9 of the NER provides a process for generators to renegotiate the affected aspects of the GPS. There is no equivalent clause/process for renegotiation of S5.3 or S5.3a GPS for loads and MNSPs respectively.

Where the alteration to the generating system will affect its performance, the system strength requirements or the network capability, the generator is required to provide the relevant network service provider and AEMO with:[211]

- a description of the nature of the alteration and the timetable for implementation
- details of the altered generating unit design data and generating unit setting data (in accordance with relevant AEMO guidelines)
- the proposed amendments to the registered performance standard, where the alteration affects the performance under the relevant access standard
- where relevant, the generator's proposed system strength remediation scheme.

The network service provider, and AEMO (in relation to advisory matters), then assess the proposed alteration and the impacts on performance standards. The network service provider

206 Schedule 5.2.5.3 of the NER.
207 Schedule 5.2.5.4 of the NER.
208 Schedule 5.2.5.5 of the NER.
209 Continuous uninterrupted operation is defined in Chapter 10 of the Rules. It relates to the performance of generating systems during and following a disturbance or fault in the system.
210 The automatic and minimum access standards are in S5.2.5.5(c)(1) and S5.2.5.5(k)(1) respectively.
211 Clause 5.3.9(b) of the NER.

and generator must advise AEMO of any changes to the registered performance standard where the assessment and associated negotiation lead to a variation to an existing connection agreement. Note that the negotiated performance standard must be no less onerous than the performance standard that applies prior to the proposed alteration.[212]

D.2 Proponent's views on issues with the current arrangements

In addition to its proposal for a system strength standard, TransGrid suggested that the AEMC consider 'introducing a new system strength performance standard in Schedule 5.2 of the NER, requiring a connecting generating system to be capable of stable operation down to a SCR of 2 at its connection point'.[213] TransGrid noted that such a standard would improve the effectiveness of the system strength framework it proposed.

D.3 Stakeholder views on current arrangements and rule change request

Stakeholder views relating to do harm arrangements are discussed in Appendix D in relation to the system strength charge.

Stakeholders' submissions to the consultation paper did not provide any comments on the technical standards. Stakeholder views on the technical standards proposed in the draft rule are set out below in appendix D.5.2 and appendix D.6.2.

D.4 Commission's final determination on demand side measures

The Commission's final determination on demand side measures involves introducing new access standards that relate specifically to system strength for newly connecting plant. These are:

- asynchronous generators in Schedule 5.2 being required to meet both the SCR and voltage phase shift access standard
- loads in Schedule 5.3 being required only to meet the SCR access standard
- MNSPs in Schedule 5.3a being required only to meet the SCR access standard

These technical standards will require plant to use inverter equipment with a base level of capability and limit how much system strength these units can demand. The final rule implements the *Investigation's* final report recommendations for the demand side and is expected to contribute to the more efficient use of system strength services being supplied under the rule. These new standards will not apply to synchronous generating systems, and will rely on the generator and relevant NSP negotiating an appropriate level for the connecting generating system above the minimum.

These changes are deemed necessary because, as set out earlier in this determination, the Commission considers the current 'do no harm' arrangements need to evolve as they are resulting in a number of inefficient outcomes This includes acting as a potential deterrent for

212 Clause 5.3.4A(b)(1A) of the NER.

213 TransGrid, *Efficient management on system strength on the power system — Rule change proposal*, 27 April 2020, p. 11.

new entrants in the NEM and creating cost and time delays for new connections, all of which is contributing to higher costs for consumers.

The arrangements under the final rule incentivise generators and MNSPs to use low SCR ability inverters to reduce their system strength impact, and hence the cost of any remediation. However, these arrangements do not:

- Provide this incentive when a generator or MNSP connects IBR plant to a location where there is sufficient latent system strength for it to operate. Instead, the proponent may even have an incentive to use up as much of the available system strength that it can to make the location less attractive for potential future competitors.
- Apply to inverter based loads. This means that these loads are not incentivised to limit their demand for system strength in the same way as generators and MNSPs despite potentially having a similarly adverse impact on the service.

Additionally, the Commission considers there is a need for the access standards to explicitly address ability of IBR plant to operate in environments with low levels of system strength.[214] Clarity around these requirements would provide greater investment certainty as well as a safeguard performance level for all IBR plant, both reducing costs of supplying the service.

New access standards are also required to clarify how asynchronous generators[215] should maintain stability following a voltage phase shift. This is an emerging issue for asynchronous generators connected to low system strength networks, and would support the general stability and security of the power system.

These issues are addressed by the amendments to the NER made in the final rule. In summary, the Commission considered that the inclusion of these two additional access standards was expected to better promote the NEO by:

- enhancing security of the power system, by delivering greater certainty that generation that demands system strength will remain stable and connected to the power system under lower system strength conditions
- lowering demand for system strength services, therefore reducing the mitigation costs and increasing network hosting capability
- increasing flexibility for future re-tuning of generator control systems as the penetration of generation increases to enable lower cost, demand based solutions to be explored and utilised, to help deliver efficient utilisation of the available network and reduce costs for consumers.

The rest of this Appendix provides a summary of the issues considered by the Commission in making this final determination on the demand side. For each issue it sets out:

214 While some access standards speak implicitly to these matters, none did so explicitly.

215 The term asynchronous is used in the NER to refer to those generating units and generating systems that do not consistent of synchronous generating units. While this is not the most accurate description inverter based plant, it has been used in this final rule to maintain consistency with the way the NER describes this type of plant.

- a summary of the Commission's draft decision - stakeholders should refer to the draft rule determination for full explanation of the draft decision in relation to the demand side.[216]
- stakeholder feedback on the draft decision - received through submissions, bilateral meetings and our technical working group
- the Commission's analysis and final decision.

D.5 Short circuit ratio access standard

SCR is a measure of the available system strength, expressed as fault level, at the point of connection of an IBR plant of a given size. Most IBR plant currently being connected in the NEM generally employ grid following inverters that require a minimum SCR to operate. The difference between inverter types, being either grid following and grid forming - is critical to understand the growing demand for system strength and is summarised in Box 9 below.

BOX 9: SYSTEM STRENGTH AND INVERTER TYPES: GRID FOLLOWING AND GRID FORMING - WHAT'S THE DIFFERENCE?

IBR plant connected to the power system can be broadly categorised into two distinct classifications of capability in the context of system strength:

- Grid following inverters: that can be described as 'demanding' system strength.
  - This is because grid following inverters do not contribute any system strength to the power system and instead rely on tracking or "following" a strong voltage waveform in order to remain stable and synchronised to the grid.
- Grid forming inverters: that do not 'demand' system strength like grid following inverters do, and which may contribute to the strength of the power system through stabilising the voltage waveform.
  - This is because grid forming inverters can create their own voltage reference and do not need a reference from the system. The Commission notes this is an emerging technology where work is underway to understand this technology, and integrate it into the power system.

D.5.1 Commission's draft decision

The draft rule proposed to introduce a new access standard for a minimum SCR for new:

- asynchronous generators[217]
- network users where the plant to be connected includes any inverter based resource[218]
- MNSP's plant that demands system strength.[219]

---

216 AEMC, Efficient management of system strength on the power system - draft rule determination, Chapter 3 and Appendix C, 29 April 2021.

217 Clause S5.2.5.15(a) of the Draft Rule (and now Final Rule).

218 Clause S5.3.11(a) of the Draft Rule (and now Final Rule).

219 Clause S5.3a.7(a) of the Draft Rule (and now Final Rule).

This new access standard was designed to reduce the demand for system strength services by requiring connecting party's plant to be capable of operating stably if the system strength becomes lower in the future, thus reducing the need for remediation to maintain stability. This new standard will also support improved system security outcomes in that the IBR plant would more likely to be able to operate stably following contingencies events that result in a weaker system.

Inclusion of inverter based loads

The draft rule also applied the mechanisms to manage the consumption of system strength to IBR plant that are loads. This is in recognition that both load and generation can use inverters that demand system strength to operate stably. The draft rule included two new definitions for this purpose: one for 'inverter based load' and one for 'inverter based resources' which is a collective term for asynchronous generators and inverter based load.[220] This is an expansion of the existing 'do no harm' arrangements that only captured MNSPs and generators.

Link between demand side and system strength charge

The draft rule specified that the SCR access standard registered for that plant would inform the system strength quantity (SSQ) which is used in the calculation of the system strength charge. This is discussed further in Appendix E.

As this 'quantity' is an estimate of the consumption of system strength it provides a strong incentive on connecting parties to reduce their consumption of system strength. This could be achieved through the use of well-designed and well tuned inverters, as well as reducing the impedance of the electrical reticulation network within their facilities. In addition, the existing requirement for generators, MNSPs and loads to meet their performance standards would also incentivise the use of inverters with a high level of performance.

The Commission considered that having the minimum standard underpin the charge would minimise demand for system strength more effectively than a standard with a corresponding automatic standard. That is, the charge would provide an incentive to connecting parties to do better than the minimum standard of 3.0 because that would reduce the amount the to be paid. The Commission considered that this would be simpler and more effective than if the NSP had to negotiate with the connecting party up to an automatic standard.

Setting the level of the SCR access standard

The level of the SCR requirement would impact both the cost of connecting new IBR plant and the cost-effectiveness of the measures undertaken by TNSPs to mitigate system strength impacts. This is because a tighter minimum SCR standard (i.e. one where the minimum SCR number is lower, e.g. a SCR of 2.0) could increase the cost of connecting new IBR generation. The costs of higher capability and more expensive inverters would eventually flow through to consumer costs. Conversely, a looser standard (i.e. one where the minimum

220 See Chapter 10 of the Draft Rule (and now Final Rule).

SCR number is higher, e.g. a SCR of 4.0) could increase present and future mitigation costs of managing inverter-driven instability.

The draft rule set the SCR minimum access standard at 3.0. Under this standard an IBR plant would need to be able to operate when the SCR is as low as 3.0. The Commission engaged GHD consulting to undertake a survey of original equipment manufacturers (OEMs) as a key input when considering the settling the level of the SCR standard. The Commission chose this level for the draft rule, a more preferable position than the 2.0 SCR standard suggested by TransGrid in its rule change request, because it considered that:

- Modern inverters that have sufficient capability to meet the existing access standards would also likely be capable of operating at an SCR well below 3.0.
- This would give a margin for the impedance of the plant system's reticulation network between the individual inverters and the connection point (at which the standard applies).
- There would be sufficient competition between OEMs who have products capable of supporting connections with an SCR of 3.0.

Compliance with the recommended SCR standard

The SCR access standard in the draft rule consisted of a requirement for a generating system, MNSP or load that demands system strength to demonstrate its capability to operate effectively down to a nominated SCR of 3.0. However, the actual tuning, or setting, of the plant would be done by reference to the actual conditions at the connection point at the time of connection. As such, demonstrating that the plant is capable of meeting an SCR of 3.0 may require different inverter settings than the settings required to meet the other access standards, which represents the current system conditions. The latter setting are those that the plant should connect to the grid with.

That is, it is important to note that the new draft SCR access standards would not:[221]

- remove the obligation to meet all other performance standards at its specific location
- mean the inverters should necessarily be tuned to the low SCR level specified in the access standard, rather they should instead be tuned to the specific requirements at the connection point, which may be a much higher SCR.

However, the Commission expected that most OEMs will be able to demonstrate their equipment can meet the SCR standard for their customers to reduce the modelling imposed by this standard on each connection.

Under the draft rule, the performance of the IBR plant in relation to the SCR access standard would be used to determine the system strength charge, as discussed in section D.7.4. Therefore, the SCR performance should be based on a model of the plant operating in isolation, such as a single machine infinite bus (SMIB) model, to be consistent with the basis of the system strength charge.

221 Clause S5.2.5.15(d) of the Draft rule (and now Final Rule).

The draft rule also included a requirement for AEMO to include in its system strength impact assessment guidelines:[222]

- a methodology for the purpose of assessing the short circuit ratio for clauses S5.2.5.15, S5.3.11 and S5.3a.7, and
- guidance on the information that must be provided by a connecting party to demonstrate compliance with the minimum access standard in clauses S5.2.5.15(b), S5.3.11(b) and S5.3a.7(b) (as applicable) or if the procedures in clause 5.4.3A have been followed, a negotiated access standard.

This was included to provide consistency of how these standards will be applied by NSPs across the NEM and in so doing provide transparency to connecting parties on what is expected from them to meet these standards. This is necessary as assessing the system strength needs, and the associated evidence required to demonstrate compliance, is likely to depend on the specific technology used in IBR plant, which may change in the future as technology evolves.

D.5.2 Stakeholder feedback on the draft decision

The Commission received broad support for the proposed introduction of an SCR access standard into the NER.[223]

However, the Commission received some detailed feedback on:

- the level of the standard, with different stakeholders calling for the level to be tightened, loosened or changed so that is measured at the inverter terminals as opposed to the connection point.
- the compliance with the standard, with submissions noting the proposed S5.2.5.15 drafting was unclear[224]

Level of the standard

Submissions that called for the level to be loosened based this on the impedance of the internal plant reticulations systems that leads to a lower SCR value at the connection point.[225] Hence, an SCR of 3.0 at the point of connection may act as an unfair barrier to connection for large wind farms with extensive internal reticulation. Feedback during our technical working group session on the issue echoed this concern with industry participants putting forward that moderately sized wind farms would be required to remediate behind the connection point to facilitate this new standard. The suggestion was that the SCR level being defined at the inverter terminals would remove the reticulation system concerns above.

Conversely, other submissions called for the standard to be tightened, noting that a tighter requirement would lead to reduced overall system strength costs.[226] A tightening of the level of the standard was put forward on the basis that reasonable quality, well-tuned inverters

222 Clause 4.6.6(a)(3) and (4) of the Draft Rule (and now Final Rule).
223 Submissions to the draft determination: TransGrid, p. 10; ENA, p. 7
224 Submissions to the draft determination: CEC, p. 4; Engevity, p. 3; TransGrid, p. 10
225 Submissions to the draft determination: CEC, p. 3-4; Engevity, p. 2-3; Tilt Renewables, p. 2
226 Submissions to the draft determination: ENA, p. 7; TransGrid, p. 10.

would be able to operate at lower SCR values. Submissions noted the jurisdictional arrangements in South Australia mandate equipment that are capable of operating down to an SCR of 1.5.[227] However, it should be noted this value is measured at the high voltage terminals rather than the point of connection, as proposed for the NER SCR standard.[228]

Further to the concerns of some plant not being able to meet an SCR standard of 3.0 due to large reticulation systems, Engevity identified that the glossary definition of SCR excluded the use of system strength mitigation facilities within the generating system in compliance with this new access standard.[229]

Compliance of the standard

Stakeholders, including through our technical working group, gave clear feedback that the wording of the standard would increase the complexity of the connection studies by requiring assessment at an SCR level of 3.0 and the local connecting area conditions.[230] In addition, they noted that the wording of the clause (b) and (d) of S5.2.5.15 was unclear and likely to result in misinterpretation of the requirements.

D.5.3 Commission's analysis and final decision

The Commission considers setting the SCR access standard at 3.0 at the point of connection is appropriate for new connecting IBR plant and is cost-effective way to mitigate system strength impacts. This mitigation of system strength impacts leads to an effective cap on costs that consumers will have to fund on the supply side, and as such an SCR of 3.0 limits the risk place on consumers. However, the Commission agrees that issues raised by stakeholders in response to the draft rule should be addressed within its final decision.

The level of the standard and barriers to connections

The Commission maintains that the level of the SCR access standard is appropriately set at 3.0. This level was informed from survey analysis of OEMs currently active in Australia that supply inverter connected generating systems. This analysis indicated that OEMs can provide a system that operates stably for an SCR of 3.0 at the connection point. This accounted for relevant plant reticulation systems between the inverter terminals and the connection point. A lower value of SCR would result in the standard acting as a barrier to entry for some connection points and impose a higher cost of system strength.[231] The minimum access standard does not restrict connections from installing equipment that performs better than a level of 3.0 and is incentivised through the system strength charge to do better than this standard.

---

227 Essential Services Commission of South Australia, Amended 2017 model license conditions for new generators, Dec 2019, p. 1.

228 It is less onerous for an inverter to meet a lower number at the inverter terminals than the same number at the point of connection as the impedance of the system between the inverter terminal and the point of connection does not need to be accounted for in the former calculation.

229 Engevity, Submissions to the draft determination, p. 2

230 Engevity, Submission to the draft determination, pp. 2-3.

231 A higher SCR at the connection point will automatically increase the system strength charge paid by the customer as the SCR is used to calculate the system strength quantity, NER 6A.23.5(j).

While the Commission maintains a level 3.0 is appropriate, it is not the intention to prevent efficient connections that may not be able to meet an SCR of 3.0. The Commission agrees that in certain circumstances there is large balance of plant impedance such that an SCR of 3.0 could not be met. In these situations, the Commission considers there to be two options for the connection to meet the 3.0 SCR standard and have made the associated changes to the final rule to allow them to occur:

1. **Install system strength improvement device(s) behind the connection point to allow it to achieve an SCR of 3.0.**[232] The drafting of S5.2.5.15 in the draft rule did not allow for the installation of system strength improvement devices on the network or within the generating system to allow the minimum standard to be met. The glossary definition of the short circuit ratio has therefore been amended to exclude any fault current contribution from any system strength improvement device installed within the generating system, market network service facility or load facility. This change would allow all plant to meet the proposed minimum standard with the inclusion of appropriate local system strength mitigation facilities.
2. **Negotiate an SCR that is above 3.0 and pay the SSS Provider for any additional system strength services necessary to maintain stable operation with an SCR ratio of 3.0 at the connection point:** These arrangements would allow for the delaying of the provision and funding of any additional services while the SCR at the connection point remains above the level required for the generating system to maintain stable operation:[233] This drafting allows connections that are incapable meeting an SCR of 3.0 to connect, providing that approval is obtained from AEMO and the NSP.

Changing the glossary definition for the SCR access standard clarifies that the short circuit ratio excludes fault contributions from within the generating system. The requirement within S5.2.5.15 is for generating systems to be able to maintain stable operation with an SCR of 3.0. This requires stable operation of the generating system with the three phase fault contribution from the power system being equal to three times the rating of the generating system. This definition means facilities installed on the generating side of the connection point that provide additional system strength will not change the short circuit ratio at the connection point, but could aid in the allowing the generating system to maintain stable operation.

Alternatively, if the fault contribution from equipment installed on the generating side of the connection point was considered in calculating the SCR, this would effectively change the minimum performance standard to require stable operation from all sources on the connecting parties side of the connection point. This would include any additional fault contribution from facilities on the generator side of the connection point required to keep the fault level at 3.0. This definition would remove the ability to achieve compliance with S5.2.5.15 by installing equipment on the generating side of the connection point, and therefore would not be appropriate.

232 See Short circuit ratio definition in Chapter 10 of Final Rule.

233 Clauses S5.2.5.15(e) and (f) of the Final Rule.

The Commission is comfortable that the two options outlined in the list above remove potential barriers to efficient connections occurring in the NEM due to the 3.0 SCR level and that this does not increase costs paid by consumers. The Commission considers that these changes in the final rule better promotes the NEO. It does this by placing the onus on the connecting party whose project specifics is imposing higher costs on the power system. It requires that party to bear the costs and in so doing incentivises efficient behaviour.

Additionally, the SCR standard allows for jurisdictions to include its own lower SCR requirement on connections specific to its REZ programs. That is, jurisdictions could apply more onerous SCR standards if they considered appropriate, with these more stringent requirements delivering demand side benefits because they would place even more downward pressure on the demand for system strength services within that REZ. The generators in the REZs that are subject to different SCR standards would not be excluded from the SSMR so that they could still seek to purchase system strength services from the SSS Provider which may be more cost effective than undertaking self remediation. In this sense, our framework would work with and complement any jurisdictional policies put in place.

Clarifying how compliance with the standard is established

Compliance with the SCR standard is intended to be assessed simply, early in the connection process and without the need for bespoke EMT studies. The Commission agrees with stakeholder feedback that the initial drafting of the standard could cause additional complexity by requiring connecting parties to duplicate their connection studies to show compliance with an SCR of 3.0, and the network conditions at the connection point.

The drafting in clause (b) of S5.2.5.15 has been altered to reflect these concerns and utilise considerations put forward by Engevity and TransGrid.[234] These changes remove reference to 'capability', 'steady state operation' and 'meeting its performance standards' instead replaced with to operate stably and remain connected. These changes aim to avoid confusion surrounding the duplication of connection studies as well as clarifying how connections with demonstrate compliance with the standard.

Commission analysis determined the proposed wording of S5.3a.7 and S5.3.11 relating to MNSP's and loads respectively could also be likely to result in the same misinterpretation of the requirements. As such, the relevant clauses of these SCR standards have also been amended in the final rule.

D.6 Voltage phase shift access standard

The Commission understands that some generating systems use a vector-shift protection to detect when the generating system can be disconnected when it becomes isolated from the remainder of the power system. Such vector shift protection systems operate when the phase shift at the generating system exceeds a specified threshold. The Commission also

234 Submissions to the draft determination: Engevity, p. 2, TransGrid, p. 10.

understands that generating systems with vector-shift protection can be susceptible to tripping during some disturbances if they are set at too low a threshold.

As such, this new access standard is designed to enhance the ability of these IBR generators to remain connected following large changes in the system voltage, which are more likely to occur in parts of the system with low system strength. The standard only applies to asynchronous generating systems and supports general security of the power system.

D.6.1 Commission's draft decision

The Commission considered that where generating systems have included a vector shift protection system, this system should be capable of performing to a sufficiently high threshold. That is, these protection systems should not trip for a voltage phase shift of less than 20 degrees.

Furthermore, while the existing requirements of S5.2.5.5 do in effect require new connecting generating systems to be able to maintain continuous uninterrupted operation following a credible contingency events and multiple network faults, this is not explicitly clear.

The Commission considered that an explicit voltage phase shift access standard should be established in the NER. This would:

- provide a safety net for future network conditions that may cause larger voltage phase angle shifts
- be consistent with Australian and international practice, including the IEEE standard and AS4777.

The draft rule did not include equivalent access standards for voltage phase shift for loads and MNSPs. The Commission did not apply the voltage phase shift protection to loads and MNSPs because the technical performance requirements in S5.3 and S5.3a for loads and MNSPs are less prescriptive than those in S5.2 for generation. In addition, the Commission is not aware of MNSPs and loads tripping due to a vector shift protection with a setting that is too sensitive.

The draft rule introduced a new access standard for voltage phase shift that applies only to asynchronous generators. This new access standard is designed to enhance the ability of these IBR generators to remain connected following large changes in the system voltage, which are more likely to occur in parts of the system with low system strength.[235] This new standard would support improved system security outcomes, by helping to keep generators stable and connected, following disturbances or changes on the system that result in voltage phase shifts.

235 Such phase shifts of the terminal voltage of a generating system occur when a network element, such as a transmission line, is switched out of service and the power flows within the network are redistributed. A similar shift in the phase of the voltage at the generating system can also occur when a transmission element is switched in, however, this is less likely to interrupt the operation of the generation as switching in a transmission would increase the system strength.

National and international experience on voltage phase shift technical standards

The Commission has drawn on a number of related national and international technical standards that impose minimum settings for vector shift protection systems to inform the development of the new voltage phase shift standard in the evolved framework. These include:

- Australian Standards: AS4777.[236]
- Institute of Electrical and Electronics Engineers Standard: IEEE Std 1547.[237]
- South African grid code.[238]

D.6.2 Stakeholder feedback on the draft decision

Feedback from stakeholders was broadly supportive of the new voltage phase shift access standard.[239]

Level of the standard

TransGrid suggested the minimum standard could be raised.[240] Feedback that suggested raising the standard suggested that at present assessment practices through AEMO's Dynamic Model Acceptance Test (DMAT) Guideline include testing at 40 and 60 degree phase shift angles.[241] TransGrid claimed that this higher voltage phase shift access standard would be suitable for reasonable quality, well-tuned generator inverters, with the higher standard reducing the demand for system strength from new connections and reducing overall system strength costs.

Need for a specific voltage phase shift access standard

Engevity noted that voltage phase shift protection for anti-islanding events is not sensitive or secure and not often used. This makes this provision unnecessary given existing provisions in the rules.[242] AEMO considered that the voltage phase shift access standard could be specified outside of the rules in guidelines or a methodology, which would accommodate technological improvements over time.[243] Additionally, other protection systems in generating systems could be included to the minimum access standards in S5.2, these protection systems and settings are documented through protection design reports. As such, it would be inconsistent to document them through the generator performance settings.

236 AS/NZS 4777.2.2020, Grid connection of energy systems via inverters, Part 2: Inverter requirements, section 4.5.5.

237 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, IEEE 2018, section 6.5.2.6

238 Grid connection code for renewable power plants connected to the electricity transmission system or the distribution system in South Africa, National Energy Regulator of South Africa, August 2019.

239 Submissions to the draft determination: CEC, p. 4; TransGrid, p. 11

240 Submissions to the draft determination: CEC, p. 4, TransGrid, p. 11

241 TransGrid, Submission to the draft determination, p. 11

242 Engevity, Submission to the draft determination, pp. 3-4.

243 AEMO, Submission to the draft determination, p. 9.

D.6.3 Commission's analysis and final decision

The Commission's final decision is to make no changes to the draft rule and maintain the 20-degree access standard is an appropriate minimum value that aligns with Australian and international standards.

Level of the standard

The DMAT model used by AEMO and referenced in stakeholder submissions is not a technical requirement that has the same impact on a connection proceeding as a minimum access standard. Tests described within the DMAT guidelines are used to verify that the model provided by the OEM is suitable to be used to assess the ability of the generating systems to meet the generator performance standards and is not directly related to the performance of a generator.

While the DMAT tests models for stable operation against 40 and 60 degree step change in the voltage phase angle, it should be noted that these changes are quite extreme. In analysis by the Commission, it is understood that the majority of connection points in the NEM should not experience these voltage angle changes.

Raising the access standard to a higher value could have the unintended consequence of some inverters being refused connection even when they are in an area of the NEM unlikely to experience such a large change in voltage phase. Retaining the access standard from draft to final rule at 20-degrees is an appropriate safeguard against increasing costs to consumers without acting as an unfair barrier to connection and therefore not promoting the NEO.

Need for a specific voltage phase shift access standard

The Commission considers the need for an explicit access standard for voltage phase shift better promotes the NEO than Engevity's suggestion that it is not required or AEMO's suggestion to move it to an existing access standard in S5.2.5. This is because the separate access standard allows for the greatest clarity on both what obligation new asynchronous generators will face from commencement of the standard. Additionally, it provides clarity on the obligation on existing plants when undergoing a Clause 5.3.9 process, as they will not have to comply with this new S5.2.5.16 standard.

D.7 Process to re-negotiate

This section discusses the process that IBR plant will go through when they wish to make changes to their performance standards. Making such changes is the way that these parties will be able to reduce their system strength quantity (i.e. to reduce their demand for system strength), in order to lower their system strength charge (explored further in Appendix D).[244] Therefore, the final rule amends the existing process for generators (i.e. clause 5.3.9) to include this new standard as well as includes processes for how relevant load and MNSPs can renegotiate their access standard (new clauses 5.3.12 and 5.3.13) for a minimum short circuit ratio.

244 This is done by altering its system such that it has a lower SCR access standard through using less system strength, resulting in a lower system strength quantity component of the charge and therefore a lower overall charge.

D.7.1 Commission's draft decision

The draft rule proposed to amend the existing process set out in clause 5.3.9 of the NER to allow for generators to alter their systems and renegotiate its SCR and voltage phase shift access standards.

The draft rule excluded existing generators from the application of clause 5.3.9, even if they alter their plant in the circumstances under clause 5.3.9.[245] This is because existing plant will not have a registered performance standard in respect of the new access standards and thus no real basis for re-negotiating a variation to these performance standards. In addition, a registered SCR performance standard is not required for existing as the system strength charge does not apply to these generators.

In relation to MNSPs and IBR loads that alter their plant and re-negotiate their registered performance standards, the draft rule included a new clause 5.3.12 that provides a process for IBR loads and MNSPs to be able to renegotiate their SCR requirements. This clause is limited to the SCR requirements and does not allow these parties to renegotiate any other aspects of their connection agreement.[246]

Similarly to that for generators, this was included in the draft rule to allow loads and MNSPs to alter their plant over time, in order to reduce their system strength need, and hence reduce their system strength charge. This would have the effect of allowing them to reduce their demand for system strength on the system and may reduce costs for consumers in the long-run. However, the new requirements for loads and MNSPs will only apply to the specific access standards related to minimum SCR; other elements of the load and MNSP access standards will not be subject to the new 5.3.12 process.

D.7.2 Stakeholder feedback on the draft decision

The Commission received no stakeholder feedback regarding its draft decision on the process to re-negotiate their performance standards.

D.7.3 Commission's analysis and final decision

The Commission's final decision is in line with its draft position with an additional clause to complement new clause 5.3.12. This new clause sets out the commissioning process for altered loads and MNSPs.[247] This new clause ensures that the process for renegotiation and commissioning is consistent under the final rule for loads and MSNPs as it is for generators.[248]

245 Clause 11.xxx.11(c) of the Draft Rule. Clause 11.143.11 of the Final Rule.

246 A general ability to renegotiate other access standards is out of scope of the issues being considered for this rule change.

247 Clause 5.3.13 of the Final Rule.

248 See clauses 5.3.9 and 5.3.10 of the NER.

D.8 Other issues raised in draft determination submissions

This section sets out the issues relevant to the demand side raised in the second round of consultation on this rule change request and the AEMC's response to each issue.

Table D.1: Summary of other issues raised in draft determination submissions

STAKEHOLDER	ISSUE	AEMC RESPONSE
Powerlink, p. 4, Technical Working Group members.	Powerlink noted that the proposed rules need to consider the interactions between the system strength requirements and the obligations under the generator performance standards. Powerlink cited the interaction within S5.1a.9 for SSSPs being responsible for planning to meet credible contingencies and the GPS in S5.2.5.5. Technical working group members considered sufficient negotiating flexibility existed in the rules regarding S5.2.5.5 and TNSPs currently negotiate GPS requirements in a manner unlikely to require generators connecting near the node to remediate. Additionally, TWG members were queried if there was concern that this could lead to a scenario where a generator could not pass the S5.2.5.5 fault ride through GPS requirements despite paying for the planned levels of system strength at the node.	The Commission through its analysis is confident there should be sufficient negotiating range in S5.2.5.5 to allow connecting generators to meet the ride through and reactive current response requirements. The intent of the revised system strength rule changes is to provide a mechanism whereby a generator can elect to pay a system strength charge and in return be confident that the SSS Provider will provide sufficient system strength services to provide a stable voltage waveform and allow connection of the proposed generating system. It would be inconsistent with this intent if a generator that elects to pay the system strength charge is required to provide additional system strength improvement facilities, beyond those provided by the SSS Provider, to allow the automatic access standards specified in S5.2.5.5 to be achieved. The Commission considers that to preserve this intent an additional provision will be added within S5.2.5.5 to provide guidance regarding the negotiation of this standard.

STAKEHOLDER	ISSUE	AEMC RESPONSE
		The additional negotiating principle in clause S5.2.5.5(r1) requires that when carrying out assessments of proposed performance standards for S5.2.5.5 the NSP and AEMO must take into account the system strength services the SSS Provider is required to provide to meet the standards specified in S5.1.14. This change should provide sufficient guidance to the NSP and AEMO that additional system strength investments beyond those undertaken by the *System Strength Service Provider* are not required where the generator has elected to pay the system strength charge.
AusNet, pp. 8-9	AusNet noted concerns that the system strength standard outlined in the draft Rule is inextricably tied to a minimum fault level requirement. AusNet acknowledges that system strength is a complex engineering phenomenon for which no direct metric is currently available. With fault level being the closest proxy that can be easily modelled in investment time frames. However, fault level is an imperfect measure that does not capture key aspects of system strength such as a solution's waveform stabilising capability. This may result in SSS Provider's relying on fault levels as the primary measure of adequate system strength and limit the introduction of emerging technology.	The Commission undertook significant consultation in determining the best way to define system strength through our *Investigation* as well as this rule change. A minimum fault level requirement will always be needed in the power system to ensure the correct operation of protection system in the network and for individual generators. These systems are a significant cost and enormously important to a safe power system. While some technologies could replace these systems, we do not consider this can occur for a long time. This is due to the relatively early stage for protection systems that operate on system indicators other than fault level, such as synchrophasors, as well as protection systems are long life assets. The Commission understands that work is ongoing

STAKEHOLDER	ISSUE	AEMC RESPONSE
		within AEMO to fully understand these emerging technologies and the true minimum fault level in the network, which is expected to decrease over time.
Energy Australia, pp. 2-3	Energy Australia supported the exclusion of a demand side damping standard due to the issue of defining such a standard with unclear benefits at this time. Energy Australia considers there may be merit in further exploring this and other aspects of the final framework as part of a broader, post-implementation review to occur three years after rule implementation.	The Commission considers any review to include additional standards would be addressed within AEMO's periodic review of the generator performance standards.

E COORDINATION: SYSTEM STRENGTH MITIGATION REQUIREMENT

BOX 10: SUMMARY OF KEY POINTS

The final rule implements the system strength mitigation requirement (SSMR), which evolves the existing 'do no harm' obligation and coordinates the supply and demand sides of the system strength framework. This reform will contribute to more effective use of system strength services and will see the associated costs more efficiently shared between consumers and connecting parties, evolving the current framework where costs are also shared.

There will now be two ways a connecting party can be provided with system strength under the final rule's evolved system strength framework. Connecting parties now have a choice between using a system strength service provided by the system strength service provider (SSS Provider), or to provide its own system strength. This means that connecting parties can either:

1. Pay the SSS Providers for hosting capability, with the charge reflecting the system strength requirements of the connecting party.
2. Undertake remediation to address their general system strength impact, as determined by the relevant NSP using electromagnetic transient (EMT) type modelling under the existing full impact assessment (FIA) process. Remediation actions could include connecting a synchronous condenser behind their connection point, or contracting with a third party.

The system strength charge is made up of three components that are multiplied together:

1. **The system strength unit price (SSUP):** this component of the system strength charge reflects the change in **forward-looking** costs of the SSS Provider supplying system strength at each system strength node, as a result of a change in demand for the service.
2. **The system strength locational factor (SSL):** this component reflects the localised nature of system strength. It changes the magnitude of the charge that a particular connection would face depending on its approximate electrical distance (or impedance) from the closest system strength node.
3. **The system strength quantity (SSQ):** this component of the charge is important for determining the efficient allocation of the cost of the system strength services provided by the SSS Provider due to the amount of the service used by the connection. The system strength quantity for the purposes of the charge is estimated from: the size of the connecting party's plant in megawatts (MW) and its short circuit ratio (SCR) (MVA/MW) requirements.

The key benefit of the SSMR is the choice it provides to connecting parties. The Commission

considers that this choice will help reduce the complexity, and associated costs of the connection process while providing simpler and clear investment price signals to new connections. The increased investment certainty, related to more predictable remediation requirements and streamlining of the connection process, is expected to contribute to lower costs for consumers.

Changes from draft to final rule

The final rule includes some changes from the draft rule (in response to stakeholder feedback) that will enable the evolved framework to best meet the NEO. These are as follows:

- The final rule makes explicit the responsibility for SSS Providers to conduct wide-area EMT modelling to verify the stability of connecting parties who pay the charge.
- Under the draft rule, the SSMR was integrated into the current NSP pricing process by creating a new system strength transmission service that is a type of prescribed transmission use of system (TUOS) service. Under the final rule, the system strength transmission service is a prescribed common transmission service. This change, and related consequential changes, largely preserves the policy intent but avoids unintended price distortions for customers that could have arisen if it was a prescribed TUOS service.
- Some minor wording changes have also been made to the transmission pricing provisions to clarify issues raised in submissions.
- A new provision has been added requiring DNSPs to explain in their annual pricing proposals how they will pass through system strength charges to customers connected to their distribution networks.

This Appendix sets out the following:

- Appendix E.1 sets out current coordination arrangements
- Appendix E.2 and appendix E.3 set out proponents and stakeholder's views on the consultation paper and draft determination
- Appendix E.4 through appendix E.9 sets out the Commission's final determination on the System strength mitigation requirement (SSMR), which includes:
  - who is liable under the SSMR
  - the system strength charge and its three components
  - the process when a connecting party chooses to remediate
  - integration of the system strength charge into transmission and distribution pricing processes
  - the application of the SSMR in Victoria as an adoptive jurisdiction
  - the Commission's response to other stakeholder issues.

E.1 Current arrangements

The relevant NSP (be it transmission or distribution) is required to perform a system strength impact assessment when assessing the connection application of a generating system or market network service provider (MNSP) under Chapter 5 of the NER. Currently there is not an equivalent requirement for connecting loads.

This impact assessment is intended to determine if the connection of the generating system or MNSP is going to cause an *adverse system strength impact*, and is undertaken in accordance with AEMO's *system strength impact assessment guidelines* (*SSIAG*).[249] It occurs in two stages:

- A preliminary assessment at the connection enquiry stage to determine if an adverse impact is likely and if a full impact assessment is required.[250]
- A full assessment at the connection application stage to determine the size and manner of any adverse impact.[251]

This means in practice, the new connecting generator is required to fund the costs associated with the provision of any required system strength services. This is done through either:[252]

- system strength remediation works (i.e. work done by the connecting generator itself) or
- a system strength remediation scheme (i.e. work done by the NSP or third party on behalf of the connecting generator).

The obligation on new connecting generators only applies at the time the connection is negotiated, based on the information available at that time. After this obligation has been established, it is incorporated into the connection agreement between the generator and the NSP.

E.2 Proponent's view on issues with the current arrangements

In its rule change request TransGrid proposed removing the 'do no harm' framework.[253] This is because TransGrid considered the framework was a significant contributor to increasing costs and delays in connecting new generation to the power system due to the system strength impact modelling and remediation requirements of the full impact assessment (FIA) stage.

TransGrid also noted that under the current arrangements, generator connection processes still require each plant to negotiate and meet generation performance standards (GPS) to connect. This is problematic, because in lieu of incentives to locate efficiently under the 'do no harm' obligation, a generator may be penalised when trying to meet their GPS, as well as being exposed to the risk of constraints.

---

249 Adverse system strength impact is defined in relation to security of the power system and relates to the impact of the connecting generating system on the ability of the power system to maintain stability in accordance with the NER, and for other generating systems to maintain stable operation following any credible contingency event or protected event.

250 Clauses 5.3.3(b5) and 5.3.4B(a)(1) of the NER.

251 Clause 5.3.4B(a)(2) of the NER.

252 Clause 5.3.4B(e) and (f) of the NER.

253 TransGrid, *Efficient management of system strength on the power system* — rule change request, p. 10-18.

In addition to removing the 'do no harm' arrangements TransGrid also suggested the Commission could consider changes to the cost recovery arrangements, such as enabling TNSPs to charge connecting generators for the provision of system strength services, rather than passing the costs of that service directly through to consumers through transmission use of service charges.[254]

E.3 Stakeholder views on current arrangements and rule change request

This section sets out stakeholder submissions to the consultation paper on TransGrid's proposed solution. There are two main categories of views that are relevant to this appendix — those on the proposal to remove the 'do no harm' requirement, and those on cost recovery arrangements.

E.3.1 Stakeholder view's on the proposal to remove the 'do no harm' obligation

Various industry participants and industry groups supported the removal of the 'do no harm' requirements arguing that it would pave the way for more efficient system strength planning and management.[255]

However, some stakeholders held a different view and suggested the 'do no harm' requirements be retained because they are more useful in remote locations, and they provide a market-based solution for system strength.[256]

E.3.2 Stakeholder views on cost recovery arrangements

Numerous stakeholders supported cost recovery arrangements that would include a financial contribution for system strength services from users of the service.[257] Some called for a requirement on generators to contribute to the cost of a connection where the generator is contributing to the need for system strength. Suggestions included sharing costs between generators and consumers as well as signalling to generators to use the service efficiently.

ARENA agreed that generators should contribute to the costs but considered that it was important that generators "are only required to contribute to the efficient cost of connection and these costs should be made transparent and firm at the earliest opportunity".[258]

254 Ibid, p. 11.

255 Submissions to the consultation paper: AEC, pp. 4-5; Ausgrid, p. 3; CEC, p. 2; Energy Australia, pp. 15-17; Maoneng, p. 5.

256 Submissions to the consultation paper: Brickworks, p. 8; Energy Queensland, p. 12; Monash University, p. 25, OMPS Hydro, p. 13; CS Energy, p. 17.

257 Submissions to the consultation paper: AEMO, p. 17-18; ARENA, p. 15; Brickworks, p. 8; CitiPower, Powercor, and United Energy, p. 7; CS Energy, p. 18; GE Renewable Energy, p. 9; Energy Queensland, pp. 4, 12-13; Clean Co, p. 9; Walcha Energy, p. 8.

258 ARENA, Submission to the consultation paper, p. 18.

E.4 Commission's final decision — Overview of the system strength mitigation requirement

The Commission's final decision is to implement the SSMR as proposed under the draft rule, with some amendments so that it better promotes the NEO. The SSMR would coordinate the supply and demand sides of system strength by:

- promoting the efficient use of the service by connecting parties, and
- sharing the costs of service between connections that require the service and consumers.

The SSMR process will evolve the current 'do no harm' provisions and work alongside the supply and demand side reforms to support more efficient connection of connecting parties.

In making this change, the Commission notes the strong stakeholder consensus on the need to evolve the 'do no harm' obligations. The main issue, raised by industry during the *Investigation into system strength frameworks in the NEM* (the *Investigation*) and in submissions to this rule change, was that the process introduced material uncertainty into the connection process and project development. Stakeholders were concerned about the potential for costly and inefficient remediation measures.

The Commission has concluded the 'do no harm' framework needed to evolve because:

- It requires most new connections to undertake remediation work, resulting in numerous discrete, remediation actions to take place. This is increasing operational complexity and potentially creating system security risks, rather than mitigating them.
- The unlikely co-ordination of remediation work between individual generators is resulting in piecemeal system strength investments that miss out of economies of scope and scale.[259]

The Commission also notes that the current arrangements do not incentivise connecting parties to act in a manner that minimises total system costs, because those parties do not face the marginal costs associated with the provision of system strength arising from their actions. That is, connecting parties:

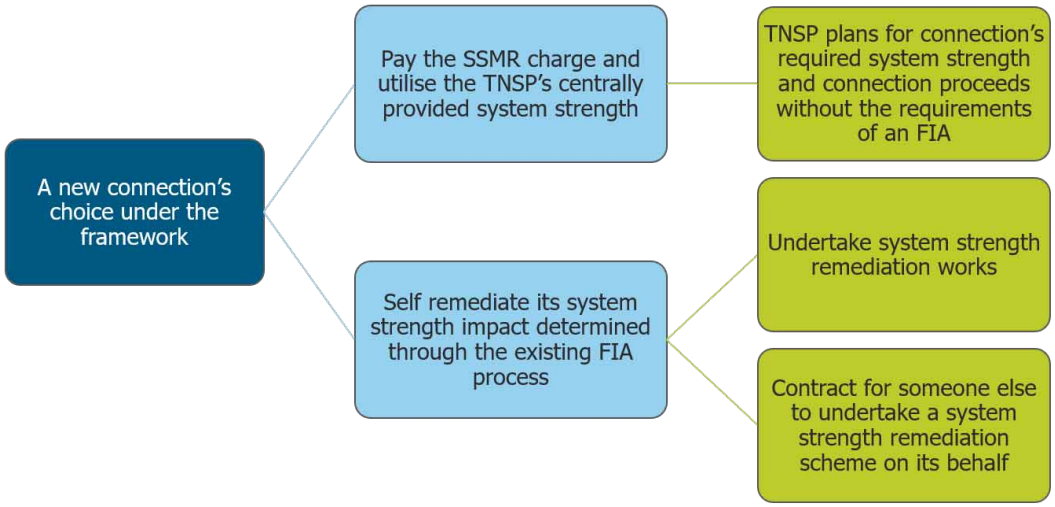
- do not face the marginal costs associated with using system strength where that service is provided by the TNSP consistent with it maintaining minimum system strength levels; and
- who are not required to remediate their actions may nevertheless cause marginal costs to be incurred, for example bringing forward in time future costs required to provide system strength.

Therefore, at a high level, the SSMR introduces a choice for a connecting party to allow it to utilise a system strength service provided by the sSSS Provider, or to provide its own. As shown in the figure below, there will be two ways the system strength needed by a connecting party can be provided under the evolved system strength framework. This can be either through:

259 Stakeholders noted that co-ordination of system strength investments is extremely difficult due to project financing, timeframes challenges, and the competitive nature of the connection process.

1. SSS Providers providing hosting capability (noting that there may still be system strength constraints for operational reasons as discussed in appendix E.8) for connecting parties through investing in efficient levels of system strength;, connecting parties are charged for this in proportion to their system strength needs;
2. the connecting party undertaking remediation of its general system strength impact, as determined by the relevant NSP using EMT type modelling as per the existing FIA process.

Figure E.1: Choice for a new connection under the SSMR – pay the charge or remediate



Source: AEMC

The key benefits of the SSMR can be summarised as follows:

- From a connecting party perspective, it allows selection of the lowest cost system strength solution, with increased price certainty and a clearer price signal, to meet their connection's situation.
- From a broader perspective, it efficiently allocates the costs of centralised system strength provision between consumers and users of the service, whilst promoting certainty for investors. It does this by providing a greater level of transparency that can be factored upfront into preliminary considerations about whether to connect to the NEM, and if so, where.

This choice will help reduce the complexity, and associated cost, of the connection process. Specifically, it will avoid iterative modelling processes required by an FIA, and uncertainties around the potential for costly self remediation, by electing to pay the transparent system strength charge. From this, it is expected that future connections could be streamlined compared to the existing processes, noting that complex EMT modelling will still be required to assess a connection's generator performance standards.

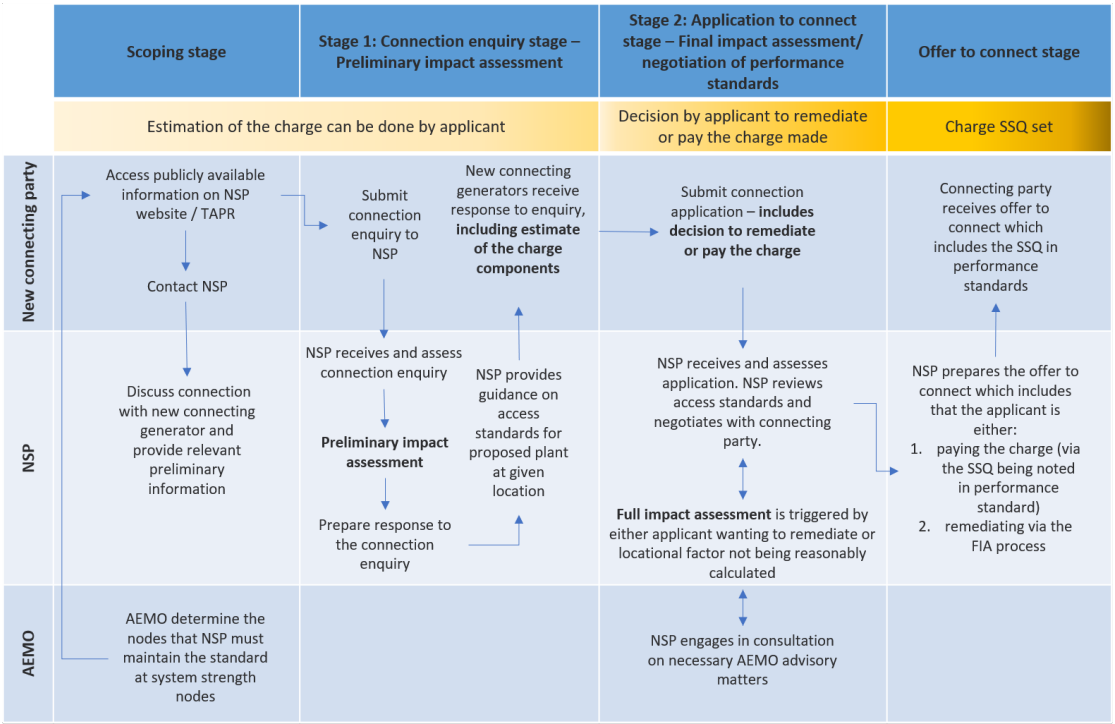
The benefits described above will all ultimately contribute to lower costs for consumers. As such, the Commission considers that evolving the 'do no harm' obligation into the SSMR best contributes to the achievement of the NEO.

The following sub-section describes how the SSMR integrates into the connection process while the rest of the Appendix details the remaining aspects concerning the SSMR.

E.4.1 Integration of the SSMR into the connection process

This subsection discusses the SSMR process involved in each step of the connection process.

Figure E.2: Integration of the SSMR into the connection process



Source: AEMC

The figure above sets out how the SSMR will integrate with the existing connection process, including:

- **The scoping stage:** this is the early stages of development where prospective developers should be able to estimate costs easily. This can be done using the published SSUP (the TNSP's forward-looking costs for the provision of system strength in $/MVA) and by the participant calculating its own SSQ and SSL using single machine infinite bus (SMIB) modelling and AEMO's SSIAG.
- **Stage 1:** this is the preliminary impact assessment (PIA), where the NSP provides an estimate of remediation and charge in response to the connection enquiry. This occurs at the receipt of a connection enquiry and under the final rule, the analysis in the PIA stage

must be use a SMIB model[260] and the NSP in response to a connection enquiry must provide an estimate of the:[261]

- magnitude of general system strength impact that it would need to remediate should the connection applicant choose to remediate — this is equivalent to the SSQ
- system strength need (SSQ) and locational factor (SSL) as well as an estimate from this of what the charge would be should it choose to pay it.

This means the applicant could make an informed decision in the connection application about whether to remediate or pay the charge.

- **Stage 2:** this consists of the full impact assessment (FIA) at the Connection application, where the applicant decides to remediate. The FIA is undertaken at the receipt of a connection application and is only required if the:[262]
  - applicant chooses to remediate instead of paying the charge
  - in the very unlikely event that the system strength locational factor cannot be reasonably calculated.

  This process then continues as per the existing arrangements except that a connection must remediate its '*general system strength impact*' rather than its '*adverse system strength impact'.* This reflects the remediation required to return the power system *back to the level of system strength that the local system had prior to its connection* rather than in reference to returning it to the minimum level, as occurs in the existing framework.

E.5 Who is liable under the SSMR — Generators, MNSPs and loads connecting under Chapter 5 of the NER

This section discusses the Commission's consideration of the connections that would be liable under the SSMR – that is, the parties the charge would apply to under the final rule.[263]

E.5.1 Commission's draft decision

In the Commission's draft decision, it determined that the system strength charge would apply to all parties that connect under the process in Chapter 5 of the NER following the commencement of the rule. The requirement would apply to any party that consumes system strength services as a consequence of that connection — this would be set out in AEMO's *SSIAG*.

This generally means those liable under the SSMR would be:[264]

260 Clause 4.6.6(b)(1A) of the Final Rule.

261 Clause 5.3.3(b5)(3) of the Final Rule.

262 Clause 5.3.4B(a2)(3) of the Final Rule.

263 Note, this is not the distinction of which generators or loads consume system strength, as this is the SSQ component of the charge. Rather, this section sets out the thresholds which determine if a connection under Chapter 5 is required to undergo the SSMR process.

264 Table D.2 in this rule's draft determination providers greater detail on the types of connections who face the SSMR.

- generating systems 5MW or greater connecting to either the transmission or distribution networks
- loads that contain a large inverter based resource (as defined by AEMO in its SSIAG) for whom Schedule 5.3 of the NER applies[265]
- MNSPs.

The Commission's inclusion of loads under the SSMR, along with generators and MNSPs who were captured under the existing framework, was to create parity and consistency between the types of connections demanding system strength. This is also consistent with the policy direction recommended through the ESB's effective integration of distributed energy resources (DER) and flexible demand workstream under the Post 2025 work for a two-sided market and a trader services model. It is also technologically neutral given it charges in the same way those parties that 'demand' system strength. This aimed to provide for greater regulatory flexibility to support innovation by attaching obligations to services at connection points as opposed to attaching them to registration categories and assets.[266]

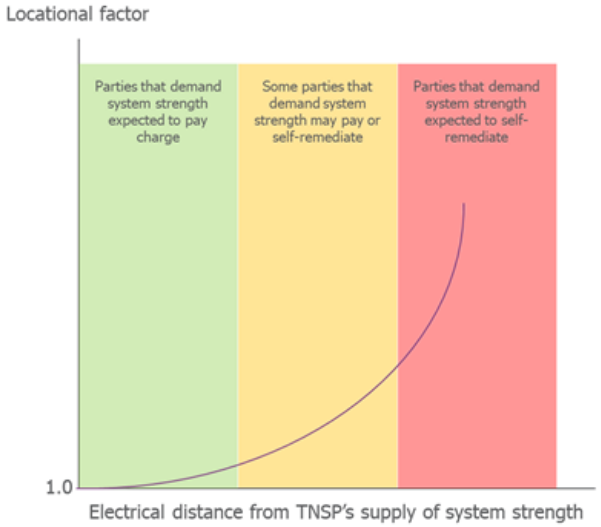
The Commission also proposed that the SSMR would apply universally across the NEM, rather than only in administratively determined system strength zones (as originally proposed in the Investigation final report).[267] This means that all connecting parties can be said to face the SSMR, regardless of their location, or proximity to a system strength node. This expectation is shown in Figure E.3 below.

265 For the avoidance of doubt, the charge would not apply to non-registered embedded generators connecting under Chapter 5A. However, it should be noted that AEMO will determine in its SSIAG a threshold at or above which the system strength impact of inverter based loads is considered significant enough such that they will have to undergo the SSMR. This means such connections must connect through Chapter 5 and cannot undergo a connection through Chapter 5A.

266 For a more detailed discussion on this, see Chapter 1 - Section 1.3.3

267 Stakeholder feedback was broad opposition to the idea of zones as it was seen to be overly complex, potentially subject to perverse incentives, and to not support investment as expected.

Figure E.3: Expected outcomes of the SSMR depending on a connection's electrical distance from a system strength node



Source: AEMC

The Commission determined that under the draft rule, the SSMR would only apply to those parties who connect following commencement of the applicable parts of the rule. That is, it would not apply to the parties who connected or signed connection agreements prior to the rule commencing. How the draft rule saw the SSMR applying to connections that are underway but yet to be completed is discussed in the transitional arrangements in Appendix F.

E.5.2 Stakeholder feedback on the draft decision

Stakeholders were generally supportive of the draft rule's arrangements on parties liable for the SSMR. In particular, multiple stakeholders noted their support for the inclusion of loads in the charging framework.[268]

Including small (<5 MW) plant out of rule change scope

Some stakeholders noted that plant smaller than 5 MW should be included in the framework, either directly,[269] or via a liability placed on their NSP.[270] This was considered by some stakeholders to be particularly relevant for the emergence of generation and demand aggregators, who may constitute a significant portion of the market in the future, despite the small individual unit size.

268 Submissions to the draft determination: CS Energy, p. 5; TasNetworks, p. 3
269 CS Energy, submission to the draft determination, p. 6
270 Terrain Solar, submission to the draft determination, p. 2

E.5.3 Commission's analysis and final decision

The Commission's final decision maintains the draft arrangements for parties liable for the SSMR charge and has clarified how the final rule interacts with the dedicated network asset framework.

The Commission considers including small (<5 MW) plant is out of scope

The Commission considered the proposal to include plant smaller than 5 MW in its final decision, including aggregators of smaller plant. The Commission maintains its draft determination view that the system strength impact of connection smaller than 5MW, i.e. those connecting through Chapter 5A, are relatively insignificant on an individual basis and this would not warrant introducing complex assessment and remediation processes. As such, the Commission do not consider it to be appropriate to apply the SSMR to these low impact connections at this time.

The Commission also considers this suggestion to be out of scope due to the extent of the changes needed to facilitate it. These changes would include significant changes to the connection and registration process for participants.

Interaction of the final rule with the dedication network assets (DNAs) rules

The final rule includes a new amendment to clause 5.2A.2(b) of the NER to clarify the treatment of DNAs and reflect the commencement of the National Electricity Amendment (Connection to dedicated connection assets) Rule 2021 No. 7 (the DNA rule), which was made on 8 July 2021.

The final DNA rule

The DNA rule introduced the concept of Designated Network Assets. DNAs are material (have a total route length of 30 km or more) additions to the transmission network to facilitate the connection of a particular connection. The costs of constructing, operating and maintaining a DNA are funded by the parties connected to the DNA. A DNA forms part of the Primary TNSP's transmission network and the Primary TNSP provides the service of setting the functional specification for the DNA and controlling, operating and maintaining the DNA as a negotiated transmission service. All Primary TNSPs are also SSS Providers.

The DNA rule inserted clause 5.2A.2(b)(1), which states that 'a *designated network asset* is for the benefit of specific *Transmission Network Users* and a *Primary Transmission Network Service Provider* is not entitled to receive a charge for a *designated network* asset under Chapter 6A.' Chapter 6A relates to the economic regulation of transmission services.

Commission analysis and final decision

The Commission considers that users who connect to the transmission network through a DNA should be treated in the same way as other connecting parties for the purpose of the application of the system strength rules. Given that a DNA is part of the SSS Provider's transmission network, a user connected to a DNA is a *System Strength Transmission Service User* and its connection point is a *system strength connection point* under the final rule.

Users connected to a DNA should have the same choices as other connecting parties to either elect to pay the system strength charge or remediate their system strength impact. To achieve this outcome, the final rule includes an amendment to clause 5.2A.2(b)(1) to exclude system strength charges from the scope of that clause. This change means the system strength charge will apply to users connected to a DNA in the same way as parties that are directly connected to the TNSP's shared network.

The Commission expects that a party connecting via a DNA who is subject to the system strength mitigation requirement under clause 5.3.4B will face the same choices as other connecting parties, i.e. to either:

- elect to pay the system strength charge; or
- remediate its system strength impact though:
  - having a system strength remediation scheme with equipment located behind its connection point; or
  - paying the system strength connection works cost.

The Commission does not expect that the SSS Provider will wish to locate system strength equipment on the DNA's side of the 'boundary point' but rather place it on the shared network side. Given the radial nature of DNAs, locating system strength equipment on a DNA does not appear to be an efficient way to provide system strength services to meet the standard in S5.1.14.

The Commission notes that the definition of 'designated network assets' specifically excludes equipment or plant that provides prescribed transmission services. This exclusion in the designated network assets definition means that equipment to provide system strength services should not be included by the Primary TNSP in the functional specification or the network operating agreement for a DNA. System strength services for users connected via a DNA would instead be planned for and provided by the SSS Provider in the same was as for users who are directly connected to the shared transmission network.

The exclusion of system strength equipment from the definition of the DNA, and from the functional specification and network operating agreement removes the risk of DNA users being double charged for system strength services. For example, in the unlikely event that the SSS Provider decided that the most efficient solution to meet the S5.1.14 standard was to construct equipment to provide system strength services and connect that equipment to a DNA that was located close to the relevant system strength node, that equipment would:

- not form part of the DNA so the costs of it would not be recovered from the DNA owner or DNA users as a negotiated transmission service; and
- be used to provide system strength transmission service, which is a prescribed transmission service, so the costs of it would be recovered from transmission customers through system strength charges and prescribed common transmission service charges.

E.6 The SSMR charge and its three components

This section sets out what the system strength charge consists of, and how its three components reflect the applicant's system strength impact, quantity and location under the final rule.

E.6.1 Commission's draft decision

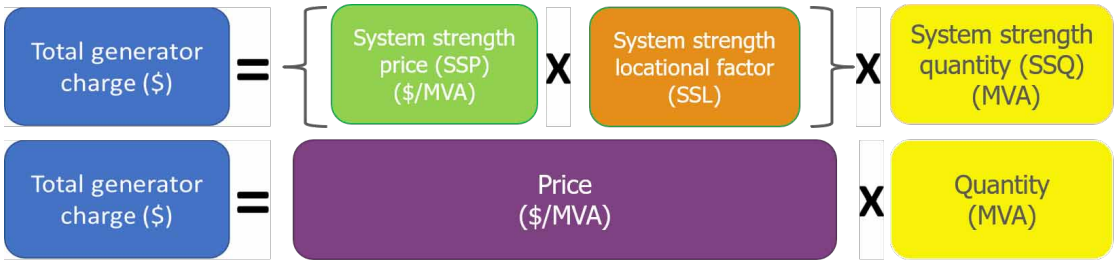
The underpinning economic objective of the SSMR framework as set out in the Commission's draft determination, was to incentivise new connections to make efficient investment decisions relating to location and plant design. Both of these factors would influence the magnitude of any charge they would face under the draft rule. Providing the price reasonably reflected the marginal cost in the provision of the service (inclusive of the locational differences in costs), generators, MNSPs and loads that require system strength to connect would be incentivised to:

- consume the TNSP provided service where the cost of avoiding it is higher, or
- not consume the TNSP provided service where the cost of self-provision is cheaper.

In either case, the incentive would be for the connecting party to act in a manner that is consistent with optimising the use of the service by coordinating the supply and demand sides of the system strength service. This optimisation would result in a minimisation of total system costs, therefore better contributing to the achievement of the NEO.

Under the draft rule, the system strength charge would consist of three components combined to send price signals to newly connecting generators, MNSPs and loads.[271]

Figure E.4: Components of the system strength charge



Source: AEMC

It may be helpful to consider the equation in Figure E.4 above, in the following way:

- Everything inside the brackets – the system strength unit price component multiplied by the locational factor – is the per unit *price* of system strength, measured in $/MVA.
- The remaining component — the total system strength quantity – is the total *quantity* of system strength used, measured in MVA. The price multiplied by the quantity equals the total charge.

271 See clause 6A.23.5(e) and the definition of 'System Strength Transmission Service User' in the Draft Rule and now Final Rule.

Each component reflects different cost drivers — being provision of the service or the use of it due to either technology or distance — and as such would send price signals for the connecting party to incentivise efficient behaviour. This is summarised in the table below.[272]

272 Also see clause 6A.23.5 of the Draft Rule and now Final Rule.

Table E.1: **Summary of system strength charge components as set out in the draft rule**

CHARGE COMPONENT	WHAT IT IS REFLECTING	WHO CALCULATES IT	WHEN/HOW DOES IT CHANGE
System strength unit price (SSUP) — green	The system strength unit price ($/MVA) reflects the **forward-looking** cost of the SSS Provider supplying system strength at each system strength node. Each SSS Provider would determine the SSUP applicable to each of the system strength nodes in its network. The SSUP would be fixed (subject to indexation) for the system strength charging period, which is a period starting in the second year of the SSS Provider's five-year regulatory control period and ending in the first year of the next regulatory control period.	The SSS Provider in its *Transmission pricing methodology*, which must comply with the requirements of the AER's *Transmission pricing methodology* guideline. In this the AER would specify permitted methodologies for determining the SSUP component of the charge following the principles set out in NER clause 6A.25.2(h). Those principles provide the AER flexibility to determine, and adjust over time, the most suitable calculation methodology accounting for simplicity, and technology and demand changes — be it long-run marginal costs (LRMC) or long-run average cost (LRAC). More information on this is set out in draft determination section D.7.2.	This would be recalculated by SSS Providers each system strength charging period, which is roughly in line with the 5-year regulatory control periods. This is then published by the relevant TNSP and DNSP in their annual transmission and distribution pricing schedules.
System strength locational factor (SSL) — orange	The relative electrical distance from the closest system strength node for a newly connecting generator or load. This would be calculated as the ratio of the: • additional fault level that would need to be added at the nearest system strength node to restore the available	AEMO provides guidance through the SSIAG, Clause 4.6.6(a)(1), (a)(2) and (b)(9). The relevant NSP would use this guidance to calculate this component on a connection-by-connection basis.	This would be updated by the relevant NSP every system strength charging period. This is then published in

CHARGE COMPONENT	WHAT IT IS REFLECTING	WHO CALCULATES IT	WHEN/HOW DOES IT CHANGE
	fault level (AFL) at the connection point to the pre-connection level, and • system strength quantity requirement of the connecting party plant. This would be fixed for each connection point for which the charge is payable, for the remainder of the system strength charging period in which the connection offer is made and then for subsequent system strength charging periods. AEMO will provide guidance in the SSIAG about situation when the SSL is manifestly excessive or it is unreasonable for the NSP to calculate the SSL. Where these circumstances occur, the connection will have to undertake full remediation of its general system strength impact because the charge is not suitable for these connections.		the relevant transmission or distribution annual planning report.
System strength quantity (SSQ) — yellow	The expected consumption of the service (MVA/MW x MW) by the connecting party connecting to the grid, which is estimated from: 1. the size of the connecting plant in MW 2. its SCR ratio as determined by the relevant SCR access standard. It will also be calculated using a single machine infinite bus (SMIB) model (which is a simple isolated model of the plant's system). The SSQ component would be determined in accordance with the SCR access standard in clauses	AEMO provides guidance through the SSIAG. The relevant NSP would use this guidance to calculate this component on a connection-by-connection basis.	This would be fixed at connection or can be updated by the process when a party makes alterations to their plant, necessitating a change to the agreed performance standards, via NER clause 5.3.9 for generators and new clause 5.3.12 for MNSPs

CHARGE COM-PONENT	WHAT IT IS REFLECTING	WHO CALCULATES IT	WHEN/HOW DOES IT CHANGE
	S5.2.5.15, S5.3.11 or S5.3a.7 (as applicable) and AEMO's system strength impact assessment guidelines. Following connection, a party wishes to reduce its charge it can reduce the SSQ by partially or fully remediating and in doing so reducing the total system strength charge. Additionally, AEMO in the SSIAG would determine a threshold under which connections do not need to undergo the SSMR as they have negligible system strength impact. We expect that in time this will include connections using the appropriate level of grid forming inverter capabilities.		and load.

Further detail of these components is set out in section D.7.2 of the draft determination for this rule change, which remains relevant under the Final Rule.

E.6.2 Stakeholder feedback on the draft decision

There were two main suggestions in stakeholder submissions about the methodology used to calculate the SSMR, which were that it must be as transparent as possible, and it must be known by stakeholders well in advance. These, as well as some other issues raised in submissions, are detailed below.

Many stakeholders noted that it was imperative that the system strength unit price calculation methodology was as transparent and static as possible, and was known well in advance.[273]

In addition, several stakeholders noted the importance of transparency and advanced notice of any changes in the charge. Some stakeholders called for the charging period to be lengthened beyond the proposed five years for greater investment certainty.[274] Others considered that the proposed period erred too far toward investment certainty at the expense of efficiency.[275] The use of a smoothing mechanism was suggested in both cases to provide some certainty to investors.

The CEC suggested that the AER should have oversight over the nodal system strength unit prices, to prevent them being set too high, resulting in generators self-remediating inefficiently.[276] The EUAA considered that there should be public consultation on the methodology.[277] Some developers suggested that the SSL and SSUP should be capped at connection such that they can only decrease over the life of the project.[278]

The CEC also raised concerns around the transparency and the practicality of reproducing the SSQ and SSL calculations. They noted that detail on the calculation methodology was needed in advance.[279] They also noted that proponents should be able to calculate their potential SSL using publicly available data and the published methodology.[280] This would allow proponents to make the decision to opt in or out of the SSMR charge as early as possible in the development process, avoiding unnecessary expenditure.

E.6.3 Commission's analysis and final decision

The Commission's final decision maintains the draft arrangements on the SSMR and its components. In arriving at this decision, the Commission gave thorough consideration to stakeholders' submissions, which are covered in more detail below.

273 Submissions to the draft determination: AGL, p.3; CEC, p.5; CS Energy, p.2
274 Submissions to the draft determination: AGL, p.3; CEC, p.5; CS Energy, p.2
275 Energy Australia, submission to the draft determination, p.3
276 CEC, submission to the draft determination, p.5
277 Energy Users Association of Australia, submission to the draft determination, p.1
278 Submissions to the draft: Terrian Solar, p.2; Tilt Renewables, p.2
279 CEC, submission to the draft determination, p.6
280 CEC, submission to the draft determination, p.5

AER oversight of SSUP methodologies as proposed in draft rule is sufficient

The Commission considers that draft determination's provision for the approval process of SSUP methodologies by the AER to be sufficient to ensure that nodal SSUP's are set in a way that promotes efficient connection behaviour. There are additional factors which should alleviate stakeholders concern of the charge being set too high, without the need for additional oversight by the AER:

- Firstly, the amount paid by the generators under the SSMR charge is only part of the cost recovery of the assets, with consumers paying the rest through common transmission charges.
- Secondly, paying the SSMR charge allows connecting generators to avoid undergoing the lengthy FIA process.

The five-year SSL and SSUP update period is appropriate

The Commission considers that the five-year period provides an appropriate balance between investment certainty and economic efficiency. It does this by reflecting the marginal costs of the SSMR charge, particularly SSUP and SSL. Given these costs will change over time, the SSUP and SSL should change as well to provide better price signals. Similarly, capping the SSUP and SSL at the time of connection would manipulate these price signals undesirably. The mixed views on this from stakeholders indicates that the right balance is likely to have been struck.

The five-year price period allows some alignment with the regulatory control period.

The Commission also considers that inclusion of smoothing mechanisms to be unnecessary due to the five-year fixed period. Additionally, the administrative costs associated with setting up a smoothing mechanism are likely to outweigh the benefits, particularly given the Commission considers the materiality of the issue to be small.

Published methodologies provide adequate transparency

Under the final rule (as in the draft rule), pricing and system strength locational factor calculation methodologies must be published in advance by AER and then TNSPs, and AEMO respectively. Additionally, AER and AEMO must update the relevant methodologies in accordance with the rules consultation procedures. Further, TNSPs are required to engage publicly while updating their transmission pricing methodology. The Commission considers this to provide sufficient transparency of the calculation process, such that connecting parties may reproduce their own calculations prior, to enable optimal decision-making.

E.7 The process when choosing to remediate general system strength impact — Full impact assessments and remediation works/schemes

Under the final rule the proponent for the connecting party's plant can choose not to pay the system strength charge where it considers remediation to be less costly. Remediation in

relation to a FIA is equivalent to reducing the SSQ to zero.[281] This would be a particularly attractive option when the connecting plant is located further from the system strength node and the SSL could be significantly greater.

The proponent of a connecting generator, MNSP or connecting load could reduce its SSQ to zero where it:

- includes a system strength remediation scheme in the scope of the connecting plant, including the use of grid forming inverters where it is shown (as per AEMO's SSIAG) that they do not add to the need for system strength, or
- negotiates with the network service provider to undertake system strength connection works as part of the connection agreement.

In each case, a system strength impact assessment would need to be undertaken by the NSP to assess that the connection of the plant would not produce a general system strength impact.

This section covers the Commission's consideration of the requirements that apply when a proponent elects to remediate rather than pay the charge. This involves the FIA and the available remediation options.

E.7.1 Commission's draft decision

Full impact assessment – using power system modelling to calculate 'general system strength impact' of the connection

In its draft rule, the Commission noted how the connection of IBR can increase the risk of inverter driven instability. This occurs when the quantity of IBRs in part of the network is high relative to the fault level, leading to interactions between the various inverters and between the inverters and the system. A system strength impact is said to occur when it is not possible to maintain stable operation of the power system in the steady state or following any credible contingency event or protected event.

The Commission noted that to date, the majority of PIAs have indicated that a full assessment has been needed, as the majority of connection inquiries are in weaker parts of the network and located near other connecting parties. This can introduce a lot of uncertainty for proponents of connecting party because the:

- EMT modelling for the FIA is time-consuming and introduces delays into the connecting process
- local NSP is usually performing multiple system strength assessments concurrently in the same part of its network
- assessment may need to be repeated when:
  - the specification and control system tuning of the connecting party is amended as part of the negotiation of technical performance standards

281 Partial remediation is also an option for a new connection to reduce their SSQ and therefore their system strength charge. However, this does not require a full impact assessment to be carried out and would still involve the connection paying the charge and therefore choosing that option in its connection application.

- other connecting party is committed in the same part of the network.

The draft rule required a proponent to ensure that they remediate their general system strength impact where they choose not to pay the connection charge. This remediation would be for the total amount of system strength impact that the connection has on the system (and different to the adverse system strength impact which is related to the minimum level of system strength required for security) caused by its connection. This would mean that:

- the available fault level at the connection point is not affected by the connection of the connecting party
- a full impact assessment is undertaken to ensure that its general system strength impact is fully mitigated.

The Commission considered that a system strength impact assessment would still be required to ensure that the connection of the connecting party would not adversely impact power system security and the operation of the power system. However, in the draft rule the Commission set out its expectation that the impact assessment would generally be less complex and time-intensive than the current FIA because most proponents would pay the connection charge and those proponents that do not, would likely be in more remote parts of the network with limited interactions with other connecting parties.

Thus, the output from the FIA would be actions required by the connecting party to its plant necessary to maintain the available fault level and to address any other factors contributing to its general system strength impact on the power system. This would assist the proponent to choose whether to pay the connection charge or address the general impact at its own expense.

System strength remediation schemes and connection works – qualifying for an offer to connect

Once the connection applicant has been advised of the amount of general system strength impact it has on the system, it must remediate to qualify for an offer to connect to the power system. In doing so it would have to negotiate with the NSP and has two options:[282]

- **System strength remediation scheme:** The connecting party could address the general impact through a system strength remediation scheme. The draft rule did not limit the nature of system strength remediation schemes, but the Commission set out an expectation that they could consist of one or more of the following:
  - a synchronous condenser behind the connecting party plant's connection point to provide the fault level necessary to compensate for the system strength needs of the connecting party plant
  - re-tuning of the connecting party's plant control systems to reduce the system strength need
  - the use of grid forming inverters to eliminate the system strength need

282 Clause 5.3.4B of the Draft Rule.

  - contracting with existing plant not otherwise contracted.
- **System strength remediation works:** where the proponent has the local NSP undertake system strength connection works to increase the fault level at the connection point. The draft rule did not limit the nature of system strength connection works, but the Commission set out an expectation that they could consist of one or more of the following:
  - a network owned and operated synchronous condenser at a location near the connection point
  - an additional network element (such as a transmission or distribution line) to increase the fault level at the connection point, noting that this would also increase the active power transfer from the connecting party plant
  - contracting with existing plant not otherwise contracted.

Difference between 'adverse system strength impact' and 'general system strength impact'

The 2017 *managing power system fault levels* rule change defined 'adverse system strength impact' as the ability of the power system to maintain stability (i.e. in reference to the minimum three phase fault level required for power system stability), and for generating system or MNSP to remain in stable operation following a credible contingency or protected event. This is applied when:

1. AEMO considers there is a risk that a NSP's, MNSP's, generator's or customer's equipment will have an adverse system strength impact, in which case AEMO can request information in accordance with the rules' requirements for data provision.[283]
2. A NSP performs a system strength impact assessment as part of the connection process, specifically whether the connecting generator or MNSP is required to undertake system strength remediation scheme or fund the NSP undertaking system strength connections works.[284]

AEMO's ability to request additional information if they are concerned that an NSP's plant or equipment will have an adverse system strength impact will continue to apply.[285]

However, the draft rule proposed that the NSP's assessment of the connecting party's impact on the local system strength will not be done in reference to the adverse system strength impact, but rather to the concept of 'general system strength impact'.[286]

This is the amount equal to the connecting party plant's adverse system strength impact as well as the amount of available fault current it reduces at its connection point as a result of its connection. The latter would be equivalent to the SSQ, which would be determined from the SCR performance standard and the rating of the IBR plant. However, the connecting plant must be able to operate stably in the network it is connecting to, which is why it must also make sure it remediates its adverse system strength impact.

283 As specified in clauses 5.2.3(j), 5.2.3A(a), 5.2.4(c) and 5.2.5(d) for NSPs, MNSPs, customers and generators respectively.
284 As specified in clause 5.3.4B of the NER.
285 Clause 5.2.3(j)(3) of the NER.
286 See the definition in Chapter 10 of the Draft Rule and now Final Rule.

BOX 11: DEFINITIONS OF 'ADVERSE SYSTEM STRENGTH IMPACT' AND 'GENERAL SYSTEM STRENGTH IMPACT'

Adverse system strength impact: An adverse impact, assessed in accordance with the SSIAG, on the ability under different operating conditions of:

(a) the *power system* to maintain system stability in accordance with clause S5.1a.3; or

(b) a *generating system*, *market network service facility* or *inverter-based load* forming part of the *power system* to maintain stable operation including following any *credible contingency event* or *protected event*,

so as to maintain the power system in a *secure operating state*.

General system strength impact: In relation to a new *connection* or an alteration to a *generating system* or other *connected plant*, the amount equal to its *adverse system strength impact* as well as any additional amount by which it reduces the *available fault level* at the *connection point* for the new *connection* or *connected plant*, assessed in accordance with the *SSIAG*.

Source: Definition of both are contained in Chapter 10 of the Final rule.

When the connecting party chooses to pay the system strength charge

Under the draft rule, the NSP would determine the system strength charge that the proponent of connecting IBR plant can elect to pay. This charge would be based on the general system strength impact, in conjunction with the associated system strength price and system strength locational factor.[287] Under the draft rule, it would not be necessary to calculate the adverse or general system strength impact in reference to that particular connecting party as the system strength charge gives the proponent access to the centrally provided system strength.

When the connecting party chooses to remediate

Under the draft rule the proponent of connecting IBR plant choosing to remediate would need to implement a system strength remediation scheme or fund the NSP to undertake system strength connection works to address the general system strength impact. That is, the proponent would need to restore the available fault level at the connection point and address any residual adverse system strength impact. The Commission considered that in practice, it is likely that a system strength remediation scheme or system strength connection works that are sufficient to restore the available fault level would also provide sufficient system strength to maintain power system security, but a system strength impact assessment would be required to confirm this.

Requiring the IBR plant to address the general system strength impact, by restoring the available fault level at the connection point to the pre-connection level and addressing its adverse system strength impact, means that its connection would not bring forward costs of

287 Clause 5.3.4B(a2) of the Draft Rule.

meeting system strength needs for the NSP or future connecting IBR plant. That is, all connecting IBR plant would be required to address its full impact on system strength, which avoids a some IBR proponents free-riding on existing system strength in the network.

E.7.2 Stakeholder feedback on the draft decision

Stakeholders were supportive of the draft arrangements, particularly in relation to expected improvements in the FIA process.[288] These are expected to occur due to the reduction in modelling iterations required throughout the process with fewer generators undertaking the FIA process.

However, the CEC raised the concern that NSPs may influence the time frame of the FIA process, and the scope and cost of self-remediation options.[289] It was also noted that proponents may have difficulty identifying potential parties from which to contract system strength services as a means of self-remediating, with an information portal detailing such parties offered as a solution.[290]

E.7.3 Commission's analysis and final decision

The Commission's final decision, following consideration of stakeholders' concerns, is to maintain the draft arrangements regarding full impact assessments and remediation works/schemes for generators who elect to self-remediate.

Draft arrangements are sufficient to ensure FIAs are completed in a timely, unbiased manner

The Commission considered the concern that NSPs may unfairly influence the FIA process. It notes there is an existing process for FIA dispute resolution, under NER Clause 8.2. This process does not account for disputes which arise prior to the completion of the FIA, however the Commission does not envisage this to be an issue, for two reasons:

- There is little incentive for the NSP to encourage the proponent to pay the charge — their revenue is set independently to the connection process.
- This rule change should reduce the volume of FIA-related work as generators pay the charge and less modelling is required of TNSPs, which should lessen any delays.

Requiring AEMO to facilitate the identification of system strength service suppliers inappropriate

The Commission has considered Alinta's concern that connecting parties will experience difficulty identifying counterparties from whom they could contract system strength services. We consider that the concern is unfounded for the following reasons:

- Given the locational nature of system strength, the pool of potential counterparties will likely be fairly small and identifiable. This is particularly true in the weaker areas of the network where self-remediation is expected to occur.

288 Submissions to the draft determination: AGL, p.2; CEIG, p.2
289 CEC, submission to the draft determination, p.6
290 Alinta, submission to the draft determination, p.2

- The SSIAG must provide general guidance about options for system strength remediation schemes—AEMO will produce these and will include some information on options available to connecting parties. It is not appropriate for the AEMC to be prescriptive in the rules about what AEMO includes in its guidelines.

E.8 The process that applies when choosing to pay the SSMR charge

The SSS Provider has a number of obligations that apply in relation to connecting parties who elect to pay the charge. They must:

- calculate the SSQ for the connection point
- calculate the SSL for the connection point
- validate the stability of the connecting plant in the wider network.

This section covers the Commission's consideration of the validation process and obligations for SSS Providers when connecting parties pay the charge. The process and responsibility for calculating the SSQ and SSL are covered in more detail in appendix E.6.

E.8.1 Commission's draft decision

The stability of connecting plant in the wider network will be verified by TNSPs during the connection process

The draft rule specified that connecting parties who pay the charge would avoid undertaking the often-lengthy FIA process. The SSS Provider however, would still need to confirm that the plant will operate stably under the centrally provided system strength services. This would be done as part of the connection process, using wide-area EMT modelling. During this process, the generic plant model used by the SSS Provider in their planning process would be replaced by a more accurate model of the connecting generator.

The draft rule did not explicitly delegate responsibility for wide-area EMT modelling for generators who pay the charge. The Commission understood however, that TNSPs would undertake the modelling as part of the connection process. Additionally, the Commission considered that AEMO could prevent the connection from going ahead until they are satisfied that the connecting plant will be stable in the wider network, through their function on *advisory matters*.

Over and under forecasts of IBR volumes will be smoothed in the long term

The Commission considered that the demand of system strength by IBR in the power system is expected to continue to grow, out to the medium term. In the event that AEMO over-forecasts the volume of IBR connecting, there would be a short period of over supply, which would be smoothed by future periods of less expenditure. Similarly, in the event AEMO under-forecasts, there would be increased procurement in the period following to correct the under forecast. The Commission expected there to be periods of under and over forecast which will net out in the long run.

E.8.2 Stakeholder feedback on the draft decision

Stakeholder submissions and feedback on the draft decision were broadly supportive of the process that applies for paying the charge.[291] However, they did contain a range of comments which fall into the two categories below.

The responsibility for wide-area EMT modelling to verify stability of connecting plant is not clear

AEMO raised the concern in their submission, that by allowing connecting parties to avoid the FIA process, the responsibility for the TNSP to conduct wide-area EMT modelling is removed.[292] In further discussions, AEMO noted that under the draft arrangements they could prevent generators who were not stable from connecting, but they have no way of compelling TNSPs to undertake wide-area EMT modelling to verify this.

TNSPs noted during discussions that, as was the Commission's understanding, they would undertake wide-area EMT modelling to verify the stability of the connecting plant during the connection process.

Reliability corrective actions if more IBR connects than forecast

In its submission, Iberdrola considered the scenario where more IBR connects than is forecast by AEMO and the supplied system strength falls short of the stability component of the standard.[293] In this scenario Iberdrola suggested that the SSS Provider should be obligated to undertake reliability corrective actions to deliver sufficient system strength.

E.8.3 Commission's analysis and final decision

The Commission's final decision, after considering the concerns raised by stakeholders, maintains the approach proposed in the draft rule. The reasons for this are set out in the sections below.

For avoidance of doubt, the Commission also wishes to be clear on what the charge is doing. The SSMR provides a new and different avenue to obtaining compliance with NER clause 5.3.4B. The inclusion of the charge means that connecting parties continue to share the costs of system strength services with consumers. However, the final rule helps to minimise system strength costs overall through building in incentives that limit demand for system strength services to be procured by the SSS Providers. The charge is designed to reflect the system strength costs that a connecting party would impose on the system. Through the charge the connecting party is incentivised to reduce its impact. It can do that by full or partial remediation or by choosing to locate in a part of the grid where it would face a lower charge due to that location having higher levels of system strength.

Therefore, for the avoidance of doubt parties connecting to the network should not expect to face no system strength constraints. These may still arise in operational timeframes in response to real-time needs of the power system. However, due to the more forward-looking

291 Submissions to the draft determination: TransGrid, p. 5; AGL, p. 2; Alinta, p. 1; CEC, p. 4; PIAC, p. 1.
292 AEMO, Submission to the draft determination, p. 8.
293 Iberdrola, submission to the draft determination, p.4

provision of system strength these constraints should be more predictable, and on the whole, should be lower than in the absence of these changes being made.[294]

Responsibility for voltage waveform stability verification should be explicit

The Commission has considered the feedback from AEMO and TNSPs and has amended the draft rule to make explicit the responsibility to conduct wide-area EMT modelling. Two factors were particularly important in this decision:

- Under the draft rule the situation could arise where AEMO was not confident that the connecting plant would be stable in the wider network, and the NSP will not undertake the modelling. This would result in the connection being stuck in limbo, unable to proceed until the modelling was completed.
- TNSPs noted during consultation that they would be undertaking wide-area EMT modelling as part of the connection process regardless. As such they would not be incurring any additional cost as a result of making the responsibility explicit.

The Commission has codified this responsibility while taking care to avoid excessive prescription, with the addition of clause 5.3.4B(a2)(4) of the Final Rule.

This acknowledges that EMT modelling is required to map inverter interactions given the complexity of these interactions. However, it does reflect that if a connection is paying the charge (and utilising the centrally provided system strength) then that connection will still need to have its stability checked but will not have to undertake remediation actions as a result. Any of these issues created by insufficient system strength would be for the SSS Provider to take reasonable endeavours to resolve.

Over and under forecasts of IBR volumes will occur, and will be smoothed appropriately by the framework as proposed in draft rule

The Commission has considered Iberdrola's comments regarding reliability corrective actions on SSS Providers when connecting IBR volumes exceed forecast. The Commission considers that the arrangements proposed in the draft rule are sufficient and therefore, these have been maintained in the final determination.

The intent of the policy was an important consideration in making this decision. That is, connecting parties are paying the charge to avoid installing their own system strength remediation scheme and the associated lengthy FIA process. However, the service provided by the SSS Providers to parties who pay the charge does not eliminate the risk of efficient constraints being applied by the market operator. Consequently, it would be inappropriate to require SSS Providers to invest to meet any shortfalls in the voltage waveform stability component of supplied system strength services as a reliability corrective action.

294 That is, it is not a prescribed transmission service for those connections, nor has a performance standard element that provide compensation for these connections should constraints be applied to them.

E.9 Integration of the SSMR into the NSP pricing processes

This section sets out how the system strength charge will be integrated into the SSS Provider's pricing methodology and collected from System Strength Transmission Service Users, including:

- the creation of a new system strength transmission service, which is a type of prescribed common transmission service
- how system strength charges are determined by the SSS Provider in accordance with its pricing methodology and the AER's pricing methodology guidelines
- how revenue from system strength charges is incorporated into the pricing principles for prescribed transmission services, including how any residual costs and differences between forecast and actual system strength revenue are recovered through prescribed common service charges
- the process for invoicing and payment of system strength charges, including how the SSS Provider invoices System Strength Transmission Service Users and how other TNSPs and DNSPs invoice connected parties who are subject to the system strength charge.

E.9.1 Commission's draft decision

The Commission's draft determination position was that the provision of system strength would become a prescribed transmission service with some costs recovered through a separate charge. This section sets out how this was proposed to be done using the existing pricing processes in the draft rule.

The new SSMR transmission service, which was classified as a prescribed TUOS service

The draft rule proposed to create a new service called a *system strength transmission service*.[295] This service covers the provision by the SSS Provider of facilities and services to meet the new system strength standard in clause S5.1.14 at the system strength nodes.

The system strength transmission service is provided by the SSS Provider to connecting parties that are subject to the SSMR framework and who elect to pay the system strength charge instead of self-remediating. The draft rule defines these parties as *System Strength Transmission Service Users*, which covers each:

- transmission network user connected at a connection point to the transmission network of a SSS Provider where the connection point is for a connection in respect of which an election is made to pay the charge (i.e. a system strength connection point); and
- NSP whose network is connected to the transmission network of a SSS Provider and whose network includes a connection point that is a system strength connection point.

The NER currently divides regulated transmission services into prescribed transmission services and negotiated transmission services. For the reasons discussed in Appendix A, the SSMR transmission service was classified as a prescribed transmission service. This means

295 See the definition in Chapter 10 of the Draft Rule and now Final Rule.

that a regulated price would be determined for the service that was payable by all System Strength Transmission Service Users, as explained below.

Prescribed transmission services are currently divided into various different categories of prescribed services. The draft rule established that the system strength transmission service would be classified as a prescribed TUOS service, which is consistent with it providing benefits to connecting parties that vary depending on the location of the connection point. The draft rule made relatively minor changes to the definitions of prescribed transmission service, prescribed TUOS services, and negotiated transmission service to clarify this classification of the service.

How system strength charges would determined by the SSS Provider under the draft rule

System strength charges are calculated as explained in appendix E.6 above.

The draft rule proposed to give effect to the policy explained above by amending the relevant provisions of Part J of Chapter 6A of the NER as follows.

Pricing methodology guidelines

Rule 6A.25.2 of the NER sets out the requirements for these guidelines, including certain required contents. Under the draft rule, the AER is required to update its existing guidelines to specify permitted methodologies for the SSS Provider determining the SSUP, having regard to the principles specified in clause 6A.25.2(h) of the draft rule. TNSPs' pricing methodologies must comply with the requirements of the NER and the AER's pricing methodology guidelines.

Pricing methodology

Rule 6A.24 of the NER sets out the requirements for pricing methodologies. The system strength charge is determined by the SSS Provider in accordance with the SSS Provider's pricing methodology. Each TNSP currently has a pricing methodology, which is proposed by the TNSP, consulted on and approved as part of the AER's revenue determination process. The draft rule introduced new requirements for TNSPs to include in their pricing methodologies.[296] For those TNSPs who are also SSS Providers, there are additional requirements.[297]

Components of the system strength charge

The three components of the system strength charge are as explained in appendix E.6 above:

1. System strength unit price (SSUP).
2. System strength locational factor (SSL).
3. System strength quantity (SSQ).

Clause 6A.23.5 of the draft rule set out the various components of the charge and requirements for how each component is calculated.

296 Clause 6A.23.6 of the Draft Rule.
297 Clause 6A.23.5 of the Draft Rule.

The system strength unit price component is fixed for the SSMR charging period

The draft rule set out that the system strength unit price must be fixed for the *system strength charging period*. Each SSMR charging period runs from the start of year 2 of the SSS Provider's regulatory control period until the end of year 1 of the next regulatory control period.

This would mean an SSMR charging period would typically be 5 years and the system strength unit price would typically be fixed for 5 years, providing some price certainty for connecting parties.[298] Connecting parties would also receive at least one year's advance notice of changes to the system strength unit price, as prices for the next charging period would be determined in accordance with the SSS Provider's pricing methodology which is approved by the AER as part of the revenue determination process shortly before the start of year 1 of the regulatory control period.

As set out in the draft determination, the Commission sought to align the charging period as closely as possible with the SSS Provider's regulatory control period. However, the Commission considered that it was not possible without unacceptable compromises for these periods to exactly align so that the system strength unit price was fixed for a regulatory control period. This is due to how prices for transmission charges are set in year 1 of a regulatory control period.

TNSPs must publish their prices by 15 March each year so that DNSPs can use those prices for setting their prices in April or May each year and retailers can have final network prices sufficiently in advance of their commencement on 1 July each year. This means that in the first year of a regulatory control period, TNSPs must set their prices before the AER has made its final determination on their revenue allowances and approved their updated pricing methodologies. In year 1, TNSPs therefore base prices on the AER's draft determination and/or their previous pricing methodologies. Given that the system strength unit price would be fixed for 5 years, the Commission considers that it is important to have the pricing methodology approved before the system strength unit price is set. That is, to avoid a charge which applies for 5 years that is formed on an estimate.

Incorporation of SSMR revenue into the pricing principles for prescribed transmission services

Rules 6A.22 and 6A.23 currently describe how a TNSP's maximum allowed revenue (i.e. its total revenue for providing all prescribed transmission services over the regulatory control period as determined by the AER) is converted into annual revenues and prices for each prescribed transmission service.

How the system strength charge was proposed to be integrated into these provisions by the draft rule is illustrated in Figure D.5 on Appendix D.11.2 of the draft determination.

The intention of this process was that:

298 In practice, regulatory control periods are almost always 5 years. However, a TNSP can propose and the AER can approve a regulatory control period of a different length.

- The SSS Provider would calculate system strength charges in accordance with the requirements discussed above and levies those system strength charges on System Strength Transmission Service Users.
- Because system strength charges are based on estimated long run costs of providing the transmission service and forecasts of future connections, there is likely to be a difference between the revenue earned by the SSS Provider in a regulatory year and the SSS Provider's costs of providing transmission services in that year (including the 'residual cost'). This difference would be accounted for by adjusting the non-locational component of prescribed TUOS service charges as discussed below. This adjustment would ensure that the total revenue earned by the SSS Provider matches its maximum allowed revenue determined by the AER.

The key steps in this process are described in the draft determination in Appendix D.11 (and are the same under the final rule).

Invoicing and payment of system strength charges

The system strength charges would be integrated into the current billing process for transmission services in rule 6A.27 under the draft rule. The draft rule also made corresponding changes to chapter 6 in respect of the invoicing and payment of system strength charges levied by DNSPs on parties connected to a distribution network.

Each TNSP must calculate system strength charges payable by System Strength Transmission Service Users connected to its network.[299]

The SSS Provider would charge under the draft rule:

- generators and customers - being relevant loads and MNSPs - connected to the SSS Provider's transmission network; and
- TNSPs in the same region, and DNSPs with a transmission or distribution network connected to the SSS Provider's transmission network, in relation to generators (other than generators connecting under Chapter 5A) and large customers connected within their respective transmission or distribution systems, i.e. those with a system strength connection point.

Where there are multiple TNSPs in a region, TNSPs who are not the SSS Provider will calculate system strength charges based on the prices published by the SSS Provider. Under the draft rule, the relevant TNSP would invoice parties who are connected to its network and are subject to the charge.

TNSPs would invoice these System Strength Transmission Users for system strength charges in the same way as they currently invoice for other prescribed transmission services.[300] The users have an obligation to pay system strength charges under clause 6A.27.3 of the draft rule.

299 Clause 6A.27.1(a) of the Draft Rule now Final Rule.

300 Clause 6A.27.1 and 6A.27.2 of the Draft Rule now Final Rule.

DNSPs would calculate and invoice charges for generators and large customers connected to a distribution network who are subject to the charge (i.e. have a system strength connection point).[301] The DNSP's system strength charges must match the SSS Provider's charges to the maximum extent possible.[302] To enable DNSPs to mirror the level and structure of the SSS Provider's system strength charge, including any changes made by the SSS Provider to those charges, changes to the DNSP's system strength charges would not be subject to the usual tariff structure statement process or distribution pricing principles.

To enable other TNSPs and DNSPs to pass through system strength charges to connecting parties, the SSS Provider's invoice to a TNSP or DNSP for system strength charges must separately identify the system strength charge by connection point.[303]

E.9.2 Stakeholder feedback on the draft decision

Drafting clarifications proposed in submissions

Submissions did not propose any material changes to how the SSMR is integrated into the NSP pricing process. The following drafting changes or clarifications were proposed in submissions:

- ENA submitted that the requirement in clause 6A.25.1(i) of the draft rule that the AER pricing methodology guideline includes "principles for determining forecast annual system strength revenue and forecast actual annual system strength revenue" was unnecessary. ENA considered that TNSPs are routinely required to establish forecast elements and actuals for annual pricing so it is not clear that specific guidance is required for system strength related revenue.[304]
- ENA proposed wording changes to clauses 6A.23.3A(a) and 6A.23.3A(b) of the draft rule where certain references to a 'forecast' should be changed to 'estimate'.[305] ENA considered 'forecast' is appropriate for a matter than is entirely forward looking (e.g. where the relevant year has not yet commenced) while 'estimate' is preferable where there is some actual data to inform the matter (e.g. where the relevant year is part way through).
- Ergon and Energex sought clarification on the mechanism for DNSPs to bill Distribution Network User for system strength charges. Ergon and Energex considers that it was unclear whether the intent is to recover system strength charges directly from eligible Network Embedded Generators (as suggested in clause 6.20.3A of the draft rule) or whether these charges should be included in network tariffs and DSNPs' pricing proposals (as suggested in the transitional arrangements).[306]

301 Clause 6.18.7(e) of the Draft Rule now Final Rule.
302 Clause 6.20.3A of the Draft Rule now Final Rule.
303 Clause 6A.27.2(d) of the Draft Rule now Final Rule.
304 ENA, submission to the draft determination, p.9
305 ENA, submission to the draft determination, p.9
306 Ergon and Energex, submission to the draft determination, pp. 2-3

Classification of the system strength transmission service

In addition to the formal submissions, the AEMC engaged with TNSP pricing managers to obtain feedback on the transmission pricing provisions of the draft rule.

As part of that engagement, TNSP pricing managers noted that making system strength transmission services a prescribed TUOS service could result in unintended price impacts for some transmission customers. In particular, that approach could result in:

- Some of the costs of providing system strength transmission services being recovered from customers on a locational basis. This could result in non-IBR load customers in locations where system strength investments are made paying higher transmission charges even though those customers do not obtain a locational benefit from the provision of system strength services.
- Different pricing outcomes depending on whether system strength transmission services were provided using network or non-network solutions.

TNSP pricing managers suggested several options for amendments to the draft rule that could be made to address these issues, including:

- making system strength transmission services a prescribed common transmission service instead of a prescribed TUOS service; and
- treating system strength service payments in the same way as operating and maintenance costs expected to be incurred in the provision of prescribed common transmission services in relation to the adjustments that are made as part of the pricing process.

E.9.3 Commission's analysis and final decision

The policy intent of the final rule maintains that of the draft rule. The Commission has made several amendments to the draft rule to ensure clarity, principally relating to how DNSPs pass the charge through to connections on their networks. The final rule also amends the classification of the system strength transmission service, to ensure the charge is distributed equitably across customers, regardless of their location in the network. These changes are covered in more detail below.

Drafting clarifications proposed in submissions

The final rule retains the requirement that the AER pricing methodology guideline must include principles for determining forecast annual system strength revenue and actual annual system strength revenue. The Commission agrees with ENA's comment that TNSPs are routinely required to calculate forecast and actual revenues, but considers that this provision may be useful to ensure all TNSPs calculate these matters in a consistent manner.

The Commission agrees with ENA's proposed in relation to the use of 'forecast' or 'estimate' and notes that ENA's proposed changes are consistent with how those terms are used in other parts of the transmission pricing provisions. The final rule amends the use of these terms in clauses 6A.23.3A and 6A.25.2.

In response to Ergon and Energex's request for clarification, the Commission confirms DNSPs will bill Distribution Network Users for system strength charges in accordance with the amended clause 6.20.3A. Under that clause, DNSPs must bill the Distribution Network User on a pass through basis so that the amount, structure and timing of the amount billed by the DNSP replicates as far as is reasonably practicable the amount, structure and timing of the corresponding system strength charge billed to the DNSP by the relevant SSS Provider.

DNSPs are not required to itemise system strength charges for individual customers in their annual pricing proposals. However, a new provision has been added to the final rule at clause 6.18.2(b)(6C) to require DNSPs to explain in their pricing proposals how they will pass through system strength charges in accordance with clause 6.20.3A. If there are any reasons why the DNSP is not able to replicate the amount, structure and timing of the SSS Provider's system strength charge, the DNSP would be expected to explain those limitations and how it will match the charge as far as is reasonably practicable in accordance with this provision.

Classification of the system strength transmission service

The Commission agrees with the comments made by TNSP pricing managers that making system strength transmission services a prescribed TUOS service could result in unintended pricing distortions and impacts for customers.

Prescribed TUOS services are appropriate for services that provide specific benefits to transmission customers based on the location of their connection point within the transmission network. In contrast, prescribed common transmission services are services that provide equivalent benefits to all transmission customers without any differential based on their location.

System strength transmission services will provide different benefits to generators and IBR loads based on their location. However, from the perspective of most transmission customers who pay charges for prescribed transmission services (e.g. non-IBR load customers), system strength services do not provide any locational benefit. It therefore would not be appropriate for some customers to pay higher transmission charges because they are located near a location where a TNSP makes investments to provide system strength service.

Making system strength transmission services a prescribed common transmission service addresses this issue. This approach will mean that if the SSS Provider's revenue from system strength charges is less than its costs of providing those services in any year and the difference is recovered from transmission customers, that amount will be recovered equally from all transmission customers without any differential based on where on the network those customers are connected.

The Commission also agrees that the SSMR should be incorporated in the pricing provisions in a way that results in the same pricing outcomes regardless of whether the SSS Provider invests in a network capex solution or a non-network opex solution. This will be achieved if system strength service payments are treated in the same way as operating and maintenance costs expected to be incurred in the provision of prescribed common transmission services, which are currently subtracted under 6A.22.1(2) and then added back in at 6A.23.3(h) to ensure that the full amount of those costs is allocated to charges for

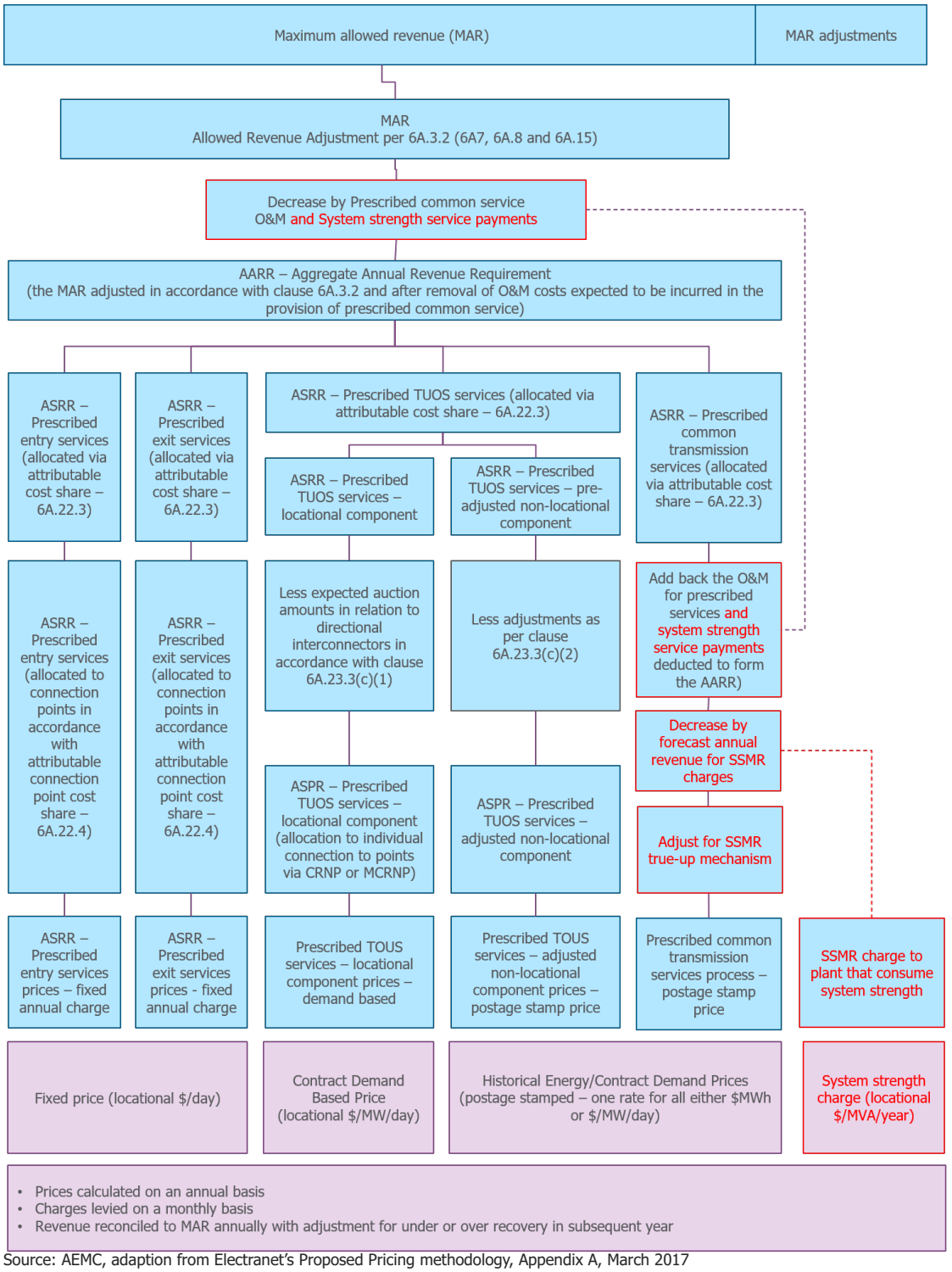
prescribed common transmission services rather than being smeared across all categories of prescribed transmission services.

As a result, the final rule contains the following changes from the draft rule, being amendments to the:

- definitions of prescribed common transmission services and prescribed TUOS services in chapter 10 so that system strength transmission services are a type of prescribed common transmission service;
- transmission pricing provisions in clause 6A.23.2, 6A.23.3 and 6A.23.3A to reflect that system strength transmission services are a prescribed common transmission service;
- transmission pricing provisions in clause 6A.22.1(2) and 6A.23.3(h) so that system strength service payments are treated in the same way as operating and maintenance costs expected to be incurred in the provision of prescribed common transmission services in relation to the adjustments that are made as part of the pricing process;
- definition of prescribed transmission service so that the system strength transmission services are a separate limb of the definition.

The diagram below shows how the final rule integrates the system strength charge into Part J of Chapter 6A of the NER.

Figure E.5: Amendments to Part J of Chapter 6A of the NER to integrate the SSMR



Source: AEMC, adaption from Electranet's Proposed Pricing methodology, Appendix A, March 2017

E.10 Application of the SSMR in adoptive jurisdictions

As noted in Appendix A and C, the Commission may only make a rule in relation to AEMO's declared network functions that is compatible with those functions. In relation to the SSMR, the Commission considers that this is consistent with those functions.

Schedule 6A.4 of the NER sets out how Chapter 6A is modified in its application to AEMO in its capacity as a TNSP providing shared transmission services. These modifications give effect to the key difference from other TNSPs, which is that AEMO does not have an AER approved revenue determination, but instead, AEMO consults on and publishes a revenue methodology setting out the method for calculating its maximum allowed revenue.[307] However, like other TNSPs, AEMO has a pricing methodology approved by the AER.[308] AEMO has consulted on its proposed pricing methodology for the period 1 July 2022 to 30 June 2027 and is expected to submit this to the AER soon.[309]

Schedule 6A.4 makes some minor modifications to how Part J of Chapter 6A applies to AEMO. The draft rule makes minor amendments to S6A.4 to clarify the application of the draft rule to AEMO,[310] so that it remains consistent with the performance of AEMO's declared network functions. The draft rule was consistent with AEMO's declared network functions because AEMO is responsible for allocating the annual service revenue requirement for prescribed TUOS services,[311] and the new system strength transmission service formed part of prescribed TUOS services.[312]

The final rule classifies the new system strength transmission services as part of prescribed common services, for the reasons covered in appendix E.9.3.[313] Similar to the draft, this is consistent with the performance of AEMO's declared network functions. Stakeholders did not make any submissions on the application of the SSMR in adoptive jurisdictions and the Commission has decided to maintain the approach set out in the draft rule in the final.

307 Clause S6A.4.2(c) of the NER.

308 Clause S6A.4.2(K) of the NER.

309 Available here: https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/tuos-pricing-methodology/pricing-methodology-2022-2027.pdf?la=en

310 See clause S6A.4.2(k) item 2 of the Draft Rule now Final Rule.

311 Clause S6A.4.2(k) item 1 modification to paragraph (g) in clause 6A.23.3.

312 See the amended definition of 'prescribed TUOS service' in the Draft Rule.

313 See Chapter 10 definitions in the Final Rule.

E.11 Responses to other stakeholder issues on the system strength mitigation requirement

Table E.2: Other issues raised in draft determination submissions

STAKEHOLDER(S)	ISSUE	AEMC RESPONSE
PIAC, p.1; MEU, p.3; EUAA, p.1	Consumers should not pay for the provision of system strength to generators.	The Commission considers this rule change best meets the NEO and consequently the needs of consumers. The evolved framework will allow for more low-cost IBR to enter the system, ultimately resulting in lower costs for consumers. Further reasoning for why the Commission has decided to make system strength a prescribed service is set out in Chapter 3 and Appendix A.
Tesla, p.2	The final rule should have explicit requirements such that 'grid forming' inverters would be assessed to have an SSQ of zero.	While it would be inappropriate for the rules to be prescriptive on this matter, it will be covered by the *system strength impact assessment guidelines* published by AEMO.
Edify, p.1	The existence of a mechanism to provide cost indexing over the life of the service provided by the NSP.	The *system strength unit price* may be updated each year of the charging period for indexation, to the extent the *pricing methodology guidelines* permit it.
TransGrid, p.14	Querying of the rationale behind allowing further assessments under Clause 5.3.4B(a4) and recommends that this provision is removed from the final rule.	The Commission considers that NSPs can already recover these costs (i.e. of updating the SSL if asked) through existing arrangements - including through the connection processing agreement. As such, this clause has been removed. Therefore, the Commission notes that such a request is allowed without this clause.
ENA, p.5	Clause 5.3.4B(h) that requires connection applicants to specify ratings of the proposed plant in MVAs unnecessary. This is because it assumes that remediation can only be achieved by new synchronous plant.	The Commission agrees and has amended clause 5.3.4B(h) in the final rule to remove the specification of MVA rating.

F TRANSITIONAL ARRANGEMENTS: A SEQUENCED APPROACH TO EVOLVING THE FRAMEWORK QUICKLY

BOX 12: SUMMARY OF KEY POINTS

The final rule requires an inter-related sequence of events to occur for the efficient and timely implementation of the evolved framework. These events can be grouped into three categories:

1. **Supply side implementation:** This involves AEMO amending the system strength requirements methodology through the rules consultation procedures to reflect the final rule and releasing its first system strength report by 1 December 2022. This means the current shortfalls framework is maintained until 1 December 2025. The System Strength Service Provider's (SSS Provider's) first compliance date for meeting the new standard starts from three years from the first system strength report i.e. 2 December 2021.
2. **Pricing and revenue arrangements for network service providers:** This involves network service providers making changes to their pricing and revenue arrangements. This is to provide for the additional costs imposed on them by the supply side arrangements, and how these costs are charged to consumers through transmission use of system (TUOS) charges and users of system strength services through the system strength charge.
3. **Demand side and system strength mitigation requirement implementation:** This involves AEMO updating its system strength impact assessment guidelines through the rules consultation procedures by 1 December 2022, ahead of the commencement of rule amendments (including the ability for a connection to choose the system strength charge instead of remediating) on 15 March 2023. In relation to how the transitional arrangements apply to connections applicants, those who have submitted:
   a. a connection enquiry but are yet to submit an application to connect, will come under the new System strength mitigation requirement (SSMR) and access standard arrangements.
   b. an application to connect but not received an offer to connect will, by default, come under the existing arrangements (i.e. required to comply with 'do no harm' and not need to meet the new access standards), but would have the option of coming under the new framework by requesting this of the NSP.

Changes from draft to final rule

The final rule has changed the timing of initial and ongoing milestones for the system strength framework. The Commission has made these changes following consideration of stakeholder feedback. In doing so, the Commission has tried hard to accommodate concerns

while minimising delays to the implementation time frame set out in the draft rule. The changes will support improved implementation of the framework so that the final rule better meets the NEO. These changes are as follows:

- AEMO must now publish the revised System strength requirements methodology and the first System strength report by 1 December 2022. This is as a consequence of moving the first system strength compliance date for SSS Providers to 2 December 2025, in response to feedback provided by AEMO on the optimal timing of these reports.
- AEMO must now publish the revised System strength impact assessment guidelines by 1 December 2022.
- Additional transitional rules have been introduced in relation to cost pass through arrangements and contingent projects. These provisions will provide greater certainty to SSS Providers and the AER in relation to how SSS Providers can recover their efficient costs of providing system strength services in their current regulatory control period and the next regulatory control period.
- Minor amendments have been made to the transitional arrangements related to transmission pricing methodologies.

The Commission notes feedback from several stakeholders that there is a need to evolve the system strength framework as soon as possible in order to mitigate against the avoidable costs and delays that are currently being experienced through the existing framework. This was reinforced through feedback on the draft determination. To ensure timely and efficient implementation of the evolved framework, the final rule requires an inter-related sequence of events to occur.

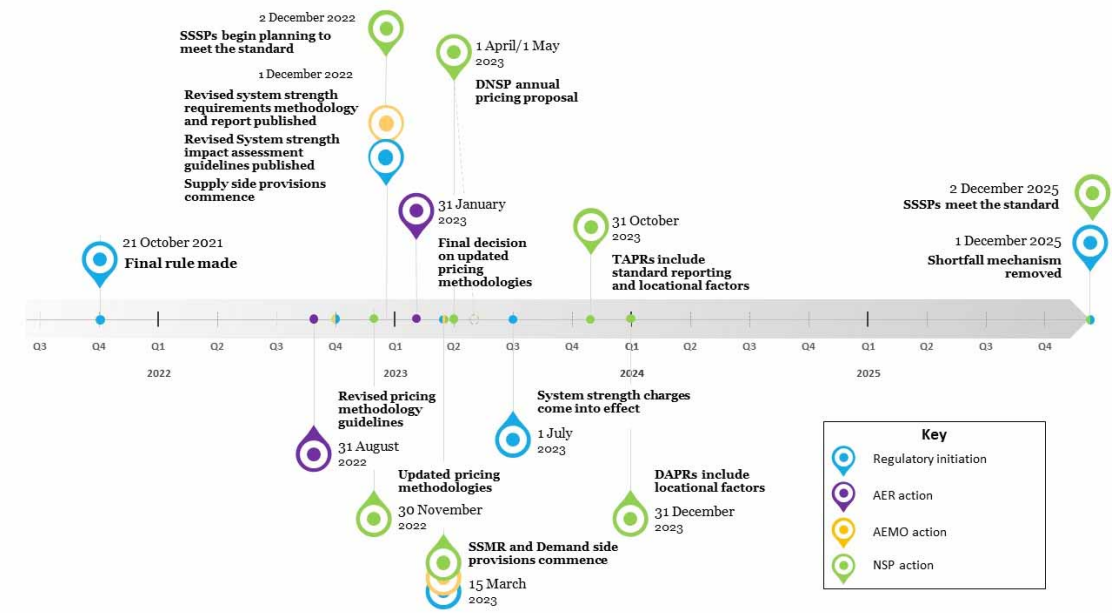
The final rule's approach to transitioning to the evolved framework is aligned with the draft rule. However, the Commission has made certain changes in response to stakeholder feedback. These cover:

- AEMO's documentation timings — to reduce costs of modelling for the supply side and improve implementation of new/amended processes by network service providers (NSPs) for the demand side and coordination arrangements.
- Revenue arrangements for SSS Providers in their first two regulatory control periods following the making of this final rule — to provide appropriate avenues for them to recover the costs of this new standard.

This Appendix describes the final rule's transitional arrangements that the Commission considers strike the right balance between the time needed for parties to prepare to meet their new obligations with the need for prompt implementation to realise the benefits.

Figure F.1 and Table F.1 below summarises the sequence of transitional arrangements for the full implementation of the evolved framework.

Figure F.1: Final rule: timeline of implementation



Source: AEMC

Table F.1: Final rule: Sequence of events to implement the evolved framework

DUE DATE	MILESTONE
21 October 2021	• Final rule made by the AEMC
31 August 2022	• AER makes the revised pricing methodology guidelines.
30 November 2022	• TNSPs (both who are SSS Providers and those who are not SSS Providers, including AEMO) update their pricing methodologies to include the new requirements under the final rule and submit it to the AER for approval. • AEMO to make system strength impact assessment guidelines (SSIAG).
1 December 2022	• AEMO makes the revised system strength requirements methodology. • AEMO publishes its first *system strength report* under the evolved framework including the binding system strength requirements for three years' time. • Provisions relating to the supply side commence - these include new obligations on AEMO on determining the system strength requirements, including the declaration of system strength node. • Transitional provisions to:

DUE DATE	MILESTONE
	• Deem existing fault level nodes to be system strength nodes. • Preserve the fault level shortfall framework for a period of three years.
2 December 2022	• Provisions relating to the supply side commence - these include new obligations on SSS Providers in relation to planning for the new standard.
31 January 2023	• AER must publish its final decision on the proposed amended pricing methodology for each TNSP and AEMO.
15 March 2023	• Provisions relating to the SSMR and demand side commence - these include new obligations on: • TNSPs to publish transmission prices that include the system strength charges. • New access standards commence, applying to new connections and all those connection applicants that are yet to submit an application to connect. Those that have submitted an application to connect do not have to comply with the new rules, but may elect to do so. • System strength mitigation requirement commences, replacing the existing 'do no harm' obligations, such that parties pay the system strength charge or self remediate.
1 July 2023	• System strength charges come into effect.
31 October 2023	• The SSS Provider's first transmission annual planning report (TAPR) with the system strength standard reporting requirements is published. • TNSPs publish the locational factors of all system strength connections points in its network as part of its TAPR.
31 December 2023	• DNSPs publish the locational factors of all system strength connections points in its network as part of its distribution annual planning report (DAPR).
1 December 2025	• Annual system strength report • The system strength shortfall mechanism is removed as it is now completely replaced by the new system strength standard.
2 December 2025	• SSS Providers must be using reasonable endeavours to comply with the new standard set out in S5.1.14 in accordance with the system strength requirements for 2025, determined by AEMO in its 2022 System strength report.

F.1 Supply side implementation — new system strength planning commences on 1 December 2022

AEMO must update or create certain materials that underpin the standard before other obligations commence. These materials underpin the nature of the obligation that SSS Providers — being TasNetworks, TransGrid, Powerlink, AEMO and ElectraNet — face in relation to the new system strength standard.

This section steps through what these are and how they would occur such that the new system strength standard can commence on 2 December 2022.

F.1.1 Commission's draft decision

The Commission's draft decision in relation to implementation of the new supply side had five aspects:

1. **Materials required for the standard to begin:**[314] This consisted of AEMO revising its system strength requirements methodology - in accordance with the rules consultation procedure under NER Clause 5.20.6(c) - and publishing it, along with the first system strength report under the evolved framework by 30 September 2022.[315]
2. **New provisions required to implement the standard:**[316] SSS Providers could begin planning to meet the standard from the date of the first system strength report under the evolved framework. As such, the provisions in the NER to commence the supply side reforms (being Schedule 2 of the Draft rule) would commence from 30 September 2022.[317]
3. **Initial compliance date for the new standard:**[318] The first SSS Provider compliance date of 30 September 2025 corresponds with the three-year time period from the standard being set, as per the specifications set by AEMO its in first System strength report under the evolved framework.[319] This time period was selected to allow sufficient time for the SSS Provider to plan, procure and implement the solutions required to meet the standard. However, the Commission considered in its draft determination that SSS Providers should aim to meet the requirements as soon as possible. This means they could meet the standard in advance of compliance with the standard being assessed three years after the requirements are declared by AEMO. The Commission considered that enabling the standard to be met as early as possible would result in the benefits relating to economies of scope and scale being realised.

314 Section E.1.1 of the Efficient management of system strength on the power system draft rule determination for more detail.
315 This date was changed to by 1 December 2022 under the final rule. See appendix F.1.3 for more information.
316 Section E.1.2 of the Efficient management of system strength on the power system draft rule determination for more detail.
317 This date was changed to 2 December 2022 under the final rule. See appendix F.1.3 for more information.
318 Section E.1.2 and E.1.3 of the Efficient management of system strength on the power system draft rule determination for more detail.
319 This date was changed to 2 December 2025 under the final rule. See appendix F.1.3 for more information.

4. **Maintenance of the shortfall mechanism:**[320] In the draft rule, the Commission determined to keep the existing shortfall mechanism up until 30 September 2025.[321] This is to account for the SSS Provider having three years to meet the system strength standard in clause S5.1.14, from the first time that AEMO sets the requirements for the standard. This three-year period is to allow for proper planning processes to take place, namely the consideration and investment in a diverse portfolio of (network and non-network) solutions to provide system strength to meet the standard. As it would take time to contract and / or build these assets, this preservation of the shortfall mechanism was considered necessary to ensure that the security of the system is maintained while the new planning standard is being implemented by SSS Providers. After this date, the shortfall mechanism would cease as by this time the system strength standard will be operational and providing the minimum fault levels required for security (as well as the additional amounts for IBR stability).
5. **First reporting under the new standard:**[322] Under the draft rule, the 2023 transmission annual planning report (TAPR) would be the first that has to include reporting on the new supply side requirements for SSS Providers (such as those on available fault level at each node) as well as those on TNSPs reporting on locational factors. Also, the 2023 distribution annual planning reports (DAPRs) are first to include reporting on locational factors. The Commission considered that the 2022 TAPR and DAPR did not need to include reporting on these requirements as there would be insufficient time to report such materials.

F.1.2 Stakeholder feedback to the draft determination

Energy Networks Australia (ENA) noted in their submission to the draft determination that, the September system strength report publication date made it difficult for SSS Providers to appropriately incorporate the latest findings into their transmission annual planning reports.[323] Further to this, the ENA also submitted that the 15 March 2022 requirement for NSPs to implement the required changes to the SSIAG would require additional time. The ENA proposed in its submission that AEMO be required to provide a draft forecast of system strength requirements and system strength standard specifications, by no later than 30 June each year.

Additionally, AEMO provided an addendum submission to the draft determination stating its request that the final rule changes the first (and all subsequent) system strength reports be published by 1 December each year.[324] It noted that this is necessary due to the sequential set of data inputs and power system analysis that is needed to perform the 5-year system strength assessment and produce the annual system strength report. As such, AEMO advised that providing a draft report by 30 June would not be possible, nor would publishing the system strength report by 31 August each year.

320 Section E.1.3 of the Efficient management of system strength on the power system draft rule determination for more detail.
321 This date was changed to 2 December 2025 under the final rule. See appendix F.1.3 for more information.
322 Section E.1.4 of the Efficient management of system strength on the power system draft rule determination for more detail.
323 ENA, Submission to the draft determination, p. 10
324 AEMO, addendum submission to the draft determination, p. 1,

F.1.3 Commission's analysis and final decision

The Commission has maintained the draft rule's approach to the supply side implementation, but has delayed the commencement dates following AEMO's addendum to its second round submission.[325] The Commission has sought to do this in a way that minimises the flow on impacts to the timing of the final rule coming into effect in order to realise the benefits from the framework as soon as possible.

The Commission agrees with AEMO that changing the enduring dates will avoid unnecessary duplication of modelling processes and the increased costs associated with such duplication. Other options to the dates were explored but were considered unsatisfactory, such as reducing the time the SSS Provider had to comply with the first system strength report under the evolved framework. Following discussions with AEMO and the ENA, the Commission considers the final rule appropriately balances the following factors:

- accuracy and costs of modelling requirements on AEMO
- ability for SSS Providers to take the first system strength report and create a meaningful initial system strength unit price for each of the deemed and declared system strength nodes
- costs implications that delaying the supply side implementation by approximately two months could have for consumers and the market.[326].

In addition to this, the Commission has consulted with stakeholders that previously identified an eagerness for earlier implementation and is confident that the delay will not have a material impact for these stakeholders. It is considered that the delays outlined below are relatively minimal and are necessary for facilitating the system strength requirements being based on the most accurate data available. This will decrease any inefficient costs to consumers and will better promote the NEO.

Therefore, the final rule implements the supply side's five aspects as follows:

- **Materials required for the standard to begin are published on 1 December 2022:** This means that by no later than 1 December 2022 AEMO must:
  - amend in accordance with the rules consultation procedures and publish the system strength requirements methodology to take into account the new rules including the amended cl 5.20.6.
  - use the amended methodology to publish its first system strength report under clause 5.20.7 of the final rule, including:
    - declaration of any new system strength nodes — noting that the existing fault level nodes would be deemed to be system strength nodes
    - the system strength requirements it has determined in accordance with clause 5.20C.1 of the final rule for both:

325 Ibid.

326 These cost implications come from the potential additional costs from AEMO interventions due to slower delivery of SSS Provider solutions.

1) the requirements that the SSS Providers must use best endeavours to meet within three years of them being declared, in order to comply with the S5.1.14 standard.

2) projections of what it expects to occur, providing the SSS Providers with an indication of what the requirement may be in the future (i.e. for years four to ten of the forecast period).

- **New provisions required to implement the standard start on 1 December 2022:**[327] SSS Providers could begin to plan to meet the standard from the date of the first system strength report under the evolved framework. As such, the provisions in the NER to commence the supply side reforms (being Schedule 2 of the final rule) would commence from 1 December 2022 and include the following:
  - system strength requirements methodology – clause 5.20.6 of the final rule
  - system strength report – clause 5.20.7 of the final rule
  - node declaration and system strength requirements – clause 5.20C.1 of the final rule
  - SSS Providers to make available system strength services – clause 5.20C.3 of the final rule
  - system strength services – clause 5.20C.4 of the final rule
  - the new system strength planning standard – clauses S5.1.1, S5.1.14 and S5.1a.9 of the final rule
  - coordination obligations specific to SSS Providers – clause 5.20C.3 and rule 5.14 of the final rule
  - RIT-T changes – clauses 5.15A and 5.16 of the final rule
  - system strength services and nodes (in relation to power system security in Chapter 4) – clauses 4.2.6, 4.4.5, 4.6.1 of the final rule.

  These changes allow the SSS Provider to begin planning to meet the standard from 2 December 2022 using AEMO's firsts System Strength Report under the evolved framework.
- **Initial compliance date for the new standard is on 2 December 2025:**[328] The first SSS Provider compliance date of 2 December 2025, corresponds with the three-year time period from the standard being set as per the specifications set by AEMO its in first System strength report under the evolved framework. This time period was selected following engagement with ENA and SSS Providers and still allows sufficient time for the SSS Provider to plan, procure and implement the solutions required to meet the standard whilst not requiring AEMO to duplicate its modelling processes in determining the system strength requirements. Therefore, the initial compliance date has been delayed in line with the delay of the first system strength report under the evolved framework.

327 Section E.1.2 of the Efficient management of system strength on the power system draft rule determination for more detail.

328 Section E.1.2 and E.1.3 of the Efficient management of system strength on the power system draft rule determination for more detail.

- **Maintenance of the shortfall mechanism is kept until 1 December 2025:**[329] The existing system strength shortfall mechanism would be removed from the NER on 1 December 2022 but would be preserved in the savings and transitional provisions for a further three year period; i.e. until 1 December 2025.[330] Further, the Commission expects the SSS Provider would be able to meet the new system strength planning standard from 1 December 2025, when the shortfall framework no longer applies, in the same way that it meets any of its existing shortfall obligations. This should not create any duplication in the provision of system strength, but rather, provide for a transition from one framework to the other.
- **First reporting under the new standard not until 2023 TAPRs and DAPRs:**[331] While the Rules will reflect the new requirements relating to reporting in the TAPR under clauses 5.12.2 and 5.20C.3(f) from 2 December 2022, the SSS Providers would not have to comply with the additional reporting requirements for their transmission annual planning reports until 31 October 2023 given the lack of time to sufficiently plan prior to its publication.[332]
    - This will provide these parties with 13 months to fully plan how they intend to meet the new standard over the 10-year planning horizon. This reflects the continuous and iterative nature of the transmission planning process, with required solutions being committed when needed, rather than through the planning report process.
    - These clauses also obligate TNSPs and DNSPs to report on the system strength locational factors for each of the system strength connections points in its network. This obligation is treated the same as the supply side reporting obligations noted above, in that they will be in the rules from 2 December 2022 but would not have to be included until each TNSP's or DNSP's 2023 TAPR or 2023 DAPR is published.

F.2 Pricing and revenue arrangements for NSPs

Network service providers need to make changes to their pricing and revenue arrangements. These are to provide for the additional costs imposed on them by the supply side arrangements, and how these costs are charged to consumers through transmission use of system (TUOS) charges and users of system strength services through the system strength charge. This section sets out the transitional arrangements for how NSPs make these changes.

329 Section E.1.3 of the Efficient management of system strength on the power system draft rule determination for more detail.
330 See clauses 11.143.13, 11.143.14 and 11.143.15 of the Final Rule.
331 Section E.1.4 of the Efficient management of system strength on the power system draft rule determination for more detail.
332 Clause 11.143.12 of the Final Rule.

F.2.1 The Commission's draft decision

The draft rule included proposed transitional arrangements for NSPs' pricing arrangements in relation to the evolved framework due to the staggered nature of NSP regulatory control periods[333] as well as the desire to not wait until the next regulatory control period to implement the rule. It did not include transitional arrangements in relation to the revenue aspects of NSPs' regulatory determinations.

As such, there were proposed transitional arrangements for:

- TNSPs who are SSS Providers in relation to their pricing methodology updates to incorporate system strength charges.
- Certain TNSPs who are not SSS Providers to include how the system strength charge will be incorporated into their pricing methodology.
- DNSPs for how they will pass through the system strength charges to the relevant connections in their network.

As it is under the existing arrangements, the TNSPs that are SSS Providers are TasNetworks, TransGrid, Powerlink, AEMO and ElectraNet. Current TNSPs who are **not** SSS Providers include Ausgrid, Directlink, AusNet, and Murraylink.

Revenue arrangements

The Commission did not include any transitional rules relating to the revenue arrangements for TNSPs who are SSS Providers.

The Commission considered there to be three possible ways under the existing rules/processes for SSS Providers to recover expenditure to meet the new system strength standard —revenue allowances, contingent project applications where provided for in a revenue determination, or through the regulatory change event cost pass through rules. The regulatory change event cost pass though provisions were expected to be the main way to recover costs during the current regulatory control period, with the contingent project process or revenue allowances likely to be most suitable for subsequent regulatory control periods.

Pricing methodology updates

The draft rule required the AER to amend and publish the pricing methodology guidelines under clause 6A.25.2 to account for the changes made by the draft rule by no later than 31 August 2022.

Following publication of the new AER guideline, the SSS Providers would all have to amend their pricing methodologies and submit them to the AER for approval by 30 November 2022. The savings and transitional provisions in the draft rule set out an accelerated process to enable revised pricing methodologies to be in place in time for prices to take effect in the 2023 pricing year.

---

333 See the AER's Regulatory determination timetable 2018-2030 for all TNSP and DNSP regulatory control periods and associated approval processes. Available at: https://www.aer.gov.au/system/files/AER%20Regulatory%20Determination%20Timetable%202018-2030%20%28updated%20September%202020%29%2811552971.1%29.pdf.

Further, the draft rule set out specific transitional arrangements for some TNSPs in relation to their pricing methodology updates as they would be undergoing a regulatory determination process when the new rules commenced.

TNSPs (and AEMO) would publish the system strength unit price for the first time on 15 March 2023 in accordance with the usual NER process for pricing publication.[334]

The draft rule also provided that certain TNSPs who are not SSS Providers would need to update their pricing methodology because they would have system strength connection points (that is, plant that connects to its network that will pay the charge). However, this update will not be as significant as those that are SSS Providers.

DNSP pricing processes

The draft rule did not set out explicit transitional arrangements for DNSPs to include the system strength charge into their pricing processes. However, for the avoidance of doubt, the draft rule transitional arrangements included a provision that a DNSP must submit an annual pricing proposal or initial pricing proposal (as applicable) by the relevant date required under clause 6.18.2 that complies with the requirements under the draft rule.[335] The key new requirement under the draft rule for DNSPs to comply with was clause 6.20.3A, which set out the billing to recover system strength charges, including how it should be done on a pass through basis that replicates as far as is reasonably practicable the amount, structure and timing of the charge billed to the DNSP by the SSS Provider.[336]

The Commission acknowledged that this would be a relatively short time for DNSPs to include this new system strength charge in its pricing processes however the Commission did not expect that there would be any system strength charge connection points to be billed at this stage because the requirement for connecting parties to pay a system strength charge does not commence until the date transmission prices are published, being 15 March 2023.

F.2.2 Stakeholder feedback on the draft decision

Revenue arrangements

Several submissions proposed additional transitional arrangements in relation to how SSS Providers would recover their costs of providing system strength services:

- The ENA noted that cost pass through arrangements are the only potential approach for SSS Providers to recover costs in the current regulatory period, but these provisions may not work as intended. The ENA considered that applicable cost pass-through trigger was not clear. For example, the ENA submitted that it was unclear whether this event was the making of the final rule, the publication of the AEMO annual system strength report in 2022 or the date the SSS Provider needs to meet the new service standard in S5.1.14. The ENA noted that a pass through application must be submitted within 90 business days of the relevant event, which would be problematic if the relevant event was the

334 Clause 6A.24.2(c) of the NER.
335 Clause 11.xxx.7 of the Draft Rule. Clause 11.143.7 of the Final Rule.
336 Clause 6.20.3A(b) of the Draft Rule (and now Final Rule).

making of the final rule as the SSS Provider would not be able to estimate its costs by that deadline.[337]

- The ENA also proposed a new transitional provision to deem capital investments to provide system strength services to be a contingent project, including deemed contingent project triggers that would apply for the purposes of existing revenue determinations.[338]
- Powerlink expressed a concern that SSS Providers may 'need to pay thermal synchronous plant for system strength services when wholesale energy market prices are low or negative. Each thermal generator that is contracted may have minimum loading constraints in excess of 100MW that will need to be compensated under low price conditions. Consequently, this may impose significant costs on TNSPs to ensure generators will provide these essential system services. Powerlink considers the AEMC should assess the implications of this situation, including the impact on SSS Providers working capital, before its Final Rule Determination.'[339]

Pricing methodology updates

There were no submissions on the transitional arrangements related to updating the pricing methodologies for SSS Providers or other TNSPs.

DNSP pricing processes

As discussed in section A8.2, Ergon and Energex considered that it was unclear whether DNSPs would recover system strength charges directly from eligible Network Embedded Generators (as suggested in clause 6.20.3A of the draft rule) or whether these charges should be included in network tariffs and DSNPs' pricing proposals (as suggested in the transitional arrangements).[340]

F.2.3 Commission's analysis and final decision

The Commission's final decision is broadly in line with the draft rule with some additional transitional rules in relation to cost pass through arrangements and contingent projects. These provisions will provide greater certainty to SSS Providers and the AER in relation to how SSS Providers can recover their efficient costs of providing system strength services in their current regulatory control period and the next regulatory control period. This and the Commission's response to other stakeholder concerns are set out below.

Revenue arrangements

Cost pass through arrangements

The Commission considered the submissions made by ENA in relation to cost pass through arrangements and contingent projects and held meetings and workshops with ENA, TNSPs and the AER to understand how these arrangements would operate for SSS Providers:

337 ENA, submission to the draft determination, p. 8.
338 ENA, submission to the draft determination, p. 9.
339 Powerlink, submission to the draft determination, p. 3.
340 Ergon and Energex, submission to the draft determination, pp. 2-3.

- during their current regulatory control periods; and
- during their next regulatory control period.

The Commission considers that the making of the final rule will constitute a regulatory change event under the current definitions in the rules. However, to increase certainty for all stakeholders, the final rule contains a new transitional provision clarifying that the making of the rule is a pass through event.

The AER already has a power to extend the 90 business day deadline for submitting a cost pass through application and has used that power in similar situations in the past.[341] However, to improve clarity and avoid the need for the SSS Provider to apply for and the AER to grant such an extension, the final rule contains a new transitional provision extending the deadline for submitting a cost pass though application until the earlier of:[342]

- the end of the SSS Provider's current regulatory control period; and
- the second anniversary of the transitional rules commencing (being 24 October 2023).

These changes will clarify that SSS Providers can use the cost pass through process to recover any efficient costs they incur to comply with the new rules during their current regulatory control periods. For future regulatory control periods, the Commission considers that other mechanisms such as the contingent project process and revenue determination allowances are a more appropriate way to recover the SSS Provider's costs.

Contingent projects

The Commission agrees with the ENA that there would be value in adding a new transitional provision to clarify the application of the contingent project provisions to system strength investments. This transitional provision would only apply to the next regulatory control period for each SSS Provider.

Contingent projects are generally used for large transmission investments where it is uncertain whether the project will occur, when it will occur and/or how much it will cost. For those types of projects, it is difficult for the AER to include an allowance for the forecast efficient costs of that project in the TNSP's revenue determination. It is more efficient to instead allow the TNSP to submit a contingent project application requesting the AER to amend its revenue allowance to cover the efficient costs of that project once this uncertainty has been resolved.

Contingent project applications are only permitted for projects where the forecast costs exceed the greater of $30 million or 5% of the maximum allowed revenue for the first year of the TNSP's regulatory control period.

Other than for actionable ISP projects, contingent projects must be set out in the TNSP's revenue determination. It may be possible without any transitional rules for the AER to include system strength investments as contingent projects in the next revenue determinations for each SSS Provider. However, the timing of the revenue proposals and

341 See for example https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/cost-pass-throughs/actewagl-cost-pass-through-extension-of-time-limit-to-submit-2016-application.

342 Clause 11.143.17 of the Final Rule.

determinations is likely to make that difficult for most SSS Providers given the rules requirements for what must be set out in the revenue proposal and determination and the matters the AER must be satisfied of before including a contingent project in the determination.

To be included as a contingent project in the determination:[343]

- the SSS Providers revenue proposal must specify the proposed contingent project, the 'proposed contingent project capital expenditure' and the proposed 'trigger events'
- the AER must determine that the proposed contingent project is a contingent project if certain requirements are met, which includes the AER being satisfied that the project is required in order to achieve the capex objectives in the NER, the proposed capex reasonably reflects the capex criteria and factors in the NER and exceeds the threshold, and the proposed trigger events are appropriate.

If a project is included as a contingent project in the determination and the trigger events occur, a TNSP may apply to the AER under clause 6A.8.2 to amend its revenue determination to include the forecast capex and opex that is required for each remaining year of that regulatory period to deliver the contingent project.

Given the timing of the next regulatory control periods, it is likely to be difficult for some SSS Providers and the AER to meet the requirements in clause 6A.8.1 for including a contingent project related to system strength in the upcoming determinations. In particular:

- Powerlink has already submitted its regulatory proposal and the AER has already made its draft determination.
- Several SSS Providers and the AER are likely to find it difficult to accurately estimate the 'proposed contingent project capital expenditure', which is required to be included in the SSS Providers regulatory proposal and the AER's determination.

The final rule addresses these issues by adding a new transitional rule that:[344]

- deems a system strength project proposed to be undertaken by a SSS Provider in its next regulatory control period to be a contingent project for the purposes of its revenue determination for that period;
- sets out deemed 'trigger events' for that contingent project;
- provides that the SSS Provider is not required to include the proposed contingent capital expenditure for this contingent project in its revenue proposal and the AER is not required to make a determination under clause 6A.8.1(b) in relation to this contingent project.

It is intended that the SSS Provider would be able to use this deemed contingent project to submit one or more contingent project applications in relation to system strength investments that may be required to meet the new system strength standard during the next regulatory control period.

343 Clause 6A.8.1 of the Final Rule.

344 Clause 11.143.18 of the Final Rule.

In its submission to the draft determination, TransGrid considered that 'the rules should allow for a reduced expenditure threshold or an aggregation of system strength projects, given the distributed nature of system strength services.'[345] The Commission does not consider that a transitional or permanent change to the rules is required to address this issue. The standard expenditure threshold should continue to apply, but nothing in the rules prevents a contingent project covering an aggregation of system strength projects (e.g. several investments to meet the standard at different nodes) and there are several precedents for the AER accepting such aggregated contingent project applications.

Other issues

The Commission notes Powerlink's concern that SSS Providers may need to pay significant amounts to generators for system strength services, which may have impacts on SSS Providers' working capital. The final rule does not contain any changes to address this issue. SSS Providers can recover these costs through the existing network support pass through provisions. This will minimise the impact on SSS Providers and allow them to recover their actual costs on an annual basis, although it is acknowledged there will still be a lag between when the costs are incurred and when they are recovered under that pass though process. The broader impact on working capital and the approach to working capital allowances in revenue determinations is a matter for the AER.

Pricing methodology updates

The transitional arrangements in the draft rule were intended to require an amended pricing methodology to be submitted by 30 November 2022 by every SSS Provider (i.e. TransGrid, ElectraNet, Powerlink, TasNetworks and AEMO) and every other TNSP who may have system strength connection points on its network (i.e. AusNet and Ausgrid). However, the Commission identified that the definition of 'applicable TNSP' in the draft rule omitted TasNetworks and Ausgrid. The final rule adds these TNSPs to this definition so that they will also submit an amended pricing methodology by 30 November 2022.

The final rule also inserts a definition of AusNet, which was omitted from the draft rule, and corrects a cross referencing error in the transitional provision related to Ausgrid's upcoming regulatory control period.

DNSP pricing processes

The final rule is the same as the draft rule with some drafting changes.

DNSPs are not required to itemise system strength charges for individual customers in their annual pricing proposals. However, in their pricing proposals that are due in April or May 2023 (as applicable), DNSPs must explain how they will pass through system strength charges in accordance with clause 6.20.3A, i.e. explain how they will replicate the amount, structure and timing of the SSS Provider's system strength charge as far as is reasonably practicable.[346]

345 TransGrid, submission to the draft determination, p. 4.

346 Clause 11.143.7 of the Final Rule.

F.3 Demand side and system strength mitigation requirement implementation - Commencement of access standards and SSMR on 15 March 2023

The new access standards in the final rule impose additional requirements on newly connecting plant,[347] and amend the requirements on network service providers when connecting or altering a generating system — establishing the SSMR framework by evolving the 'do no harm' obligation.[348] This SSMR framework — namely the addition of the ability for new connections to pay a charge instead of remediating — would incentivise efficient use of system strength and does so by building off from the basis of system strength used by each new connection as provided by the demand side access standards.

The Commission considers that it is best for these reforms to commence at the same time. This is because while the access standards act primarily as the "floor" to which the plant of a connecting party can perform, they also operate in concert with the SSMR to incentivise the connecting party to install plant that performs at a higher level than might otherwise occur.

F.3.1 Commission's draft decision

The Commission considered that the new access standards and SSMR should begin on 15 March 2023. By this date, the draft rule required the following to occur to allow a connection to negotiate its new access standards and make a fully informed decision regard how it would undergo the SSMR:

- AEMO to declare system strength nodes by 30 September in its first system strength report, with the existing fault level nodes being deemed system strength nodes under the evolved framework.[349]
- AEMO to update its SSIAG by 15 March 2023, such that there is:[350]
  - A methodology for the relevant NSP to calculate the:
    - System strength quantity and system strength locational factor for the system strength charge.
    - short circuit ratio for assessing the new SCR access standards — S5.2.5.15(b), S5.3.11(b) and S5.3a.7(b) — which form the basis of the system strength quantity of the system strength charge.
  - Guidance about the circumstances in which a system strength locational factor is not reasonably able to be determined or would be manifestly excessive.
  - Guidance and specified information on how a preliminary and full impact assessment should be carried out to determine the general system strength impact of a new connection (or alternation to an existing plant).

347 Clauses S5.2.5.15, S5.2.5.16, S5.3.11 and S5.3a.7 of the Draft Rule.

348 Clause 5.3.4B of the Draft rule.

349 This date has changed in the final rule to be 1 December 2022. See appendix F.1.3 for details. Clause 11.xxx.3 of the Draft Rule. Clause 11.143.3 of the Final Rule.

350 Clause 4.6.6 of the Draft Rule (and now Final Rule).

- The AER to make the new pricing methodology guidelines, and subsequently, the SSS Providers to have updated their pricing methodologies to account for the required changes to for the system strength unit price to be able to be calculated.
- TNSPs who are not SSS Providers to have also updated their pricing methodology to allow for the system strength charges to be passed through.
- TNSPs who are SSS Providers to have published the system strength unit price at system strength nodes as part of their prices for the first time on 15 March 2023.

Connections falling under the new obligation proposed under the draft rule

It its draft rule, the Commission proposed that on the date that the SSMR and new access standards commence, applicants who:

- Have submitted a connection enquiry but are yet to submit an application to connect, will come under the new SSMR and access standard arrangements.[351] That is, while their connection enquiry will be deemed to be valid under the new rules, the NSP would be required to notify the party of any additional information required to be provided in order to assess the enquiry in accordance with the new rules.[352]
- Have submitted an application to connect but not received an offer to connect will, by default, come under the existing arrangements (i.e. required to comply with 'do no harm' and not need to meet the new access standards),[353] but would have the option of being able to request to come under the new framework by notifying the NSP that it elects for the new rules to apply instead.[354] In this case, the NSP would be required to notify the party of any additional information required to be provided in order to assess the enquiry in accordance with the new rules.[355]

The Commission's rationale was that the rule would be made approximately 12-18 months prior to the new access standards and SSMR process commencing. The Commission considered that this provided sufficient time for prospective connections to understand the new arrangements and react to the differing obligations under the evolved framework. For those parties that are a substantial way through a connection process, this would give them sufficient time to conclude that process under the existing arrangements.

Additionally, the Commission expected some applicants may like to come under the new framework due to it potentially being more preferable to the existing framework with the option to pay a charge rather than remediate under 'do no harm'. That is, the new framework would be similar to the existing framework with the addition of an option to pay a charge instead of remediate in circumstances where the local system strength is at or below the minimum amount required, and where the connection's adverse system strength impact and its general system strength impact would be equivalent. For those parties wanting to use the

351 Clause 11.xxx.8(a) of the Draft Rule. Clause 11.143.8(a) of the Final Rule.
352 Clause 11.xxx.8(b) of the Draft Rule. Clause 11.143.8(a) of the Final Rule.
353 Clause 11.xxx.9(b) of the Draft Rule. Clause 11.143.9(b) of the Final Rule.
354 Clause 11.xxx.9(c) of the Draft Rule. Clause 11.143.9(c) of the Final Rule.
355 Clause 11.xxx.9(e) of the Draft Rule. Clause 11.143.9(e) of the Final Rule.

new framework, it was envisaged that they would still be able to progress aspects of their connection in anticipation of the changes.

F.3.2 Stakeholder feedback on the draft determination

The ENA noted during working groups that given changes made above in appendix F.1.2 the requirement on AEMO to publish a revised SSIAG should be brought forward. The rationale for this was the proposal under the draft rule had the SSMR commencing on the same date that the SSIAG was being released, which contained guidance to NSPs on how that framework should be implemented. The ENA were concerned that NSPs have sufficient time to implement the updated guidelines ahead of the SSMR's commencement.

F.3.3 Commission's final decision

The Commission's final decision is consistent with its draft decision. That is, the new access standards and evolution of the 'do no harm arrangement' into the SSMR commence together on 15 March 2023. The only difference from the draft rule is that the final rule brings forward AEMO's update of the SSIAG to 1 December 2022, the same date as when they will need to have declared system strength nodes by in its first system strength report.[356]

The Commission acknowledges having the SSMR commence on the same day as the revised SSIAG publication would be unworkable. It agrees with ENA on the need to bring forward AEMO's publication of the updated SSIAG to provide sufficient time for NSPs to implement the changes made due to this final rule determination.

As such, the publication of the updated SSIAG will be released on 1 December 2022 to align with AEMO's publication of materials required for the supply side implementation (namely the updated system strength requirements methodology and first system strength report). The Commission considers this still date provides AEMO with ample time to make the required changes to the SSIAG without delaying the implementation of the SSMR.

356 Clause 11.143.2(c) and clause 4.6.6 of the Final Rule.