

RULE

Australian Energy Market Commission

DRAFT RULE DETERMINATION

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

PROPONENT

TransGrid

29 APRIL 2021

INQUIRIES

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ABOUT THE AEMC

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

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SUMMARY

Our draft decision

- 1 The Australian Energy Market Commission (the Commission) has made a more preferable draft rule (the draft rule) in response to a rule change request from TransGrid. This draft rule proposes changes to the National Electricity Rules (NER) to deliver an evolved framework for system strength.
- 2 This draft rule is designed to deliver needed system strength in the system. It forms part of a suite of tools required to keep the power system stable and secure as it decarbonises. System strength is a critical service that supports inverter based resources (IBR), such as wind and solar generation as well as batteries, which are rapidly becoming a key part of the national electricity market generation mix.
- 3 Fundamentally, system strength is a service that keeps the grid stable. Historically, it has been supplied by synchronous generators, such as coal, gas and hydro. However, as these generators leave the market or reduce their operations, the supply of system strength has reduced. New IBR facilities, like wind and solar, some loads, batteries and hydrogen facilities, all create a demand for system strength. The combination of these two trends means that system strength has been declining in the system in recent years, at precisely the time when more is needed.
- 4 System strength is therefore central to enabling a smooth transition to a generation fleet with increasing IBR, to promote security of the system at least cost to consumers, promoting innovation in new types of resources and allowing consumers to experience the broader benefits that the transition brings.
- 5 This work in general, and this draft rule in particular, is fundamental to the redesign of the national electricity market currently being undertaken by the energy market bodies and the Energy Security Board (ESB).¹ The ESB's workstream on essential system services and scheduling and ahead mechanisms is considering how four key services are to be provided for the future power system: frequency control, operating reserves, inertia and system strength, all of which are critical to keeping lights on the national electricity market (NEM). The draft rule is consistent with the long-term direction for essential system services as set out in the ESB's Post 2025 work. This rule change delivers a key part of the ESB's system services work program.
- 6 The draft rule follows 10 months of engagement with stakeholders and technical working groups, building on the extensive consultation undertaken last year through the Commission's *Investigation into system strength frameworks* (the *Investigation*).
- 7 There are already frameworks in the NEM to provide system strength. These were introduced by the Commission in 2017. However, these frameworks have been shown in practice to be reactive and slow to provide system strength, resulting in a lack of this essential system service.

¹ The market bodies are the Australian Energy Market Commission (AEMC), the Australian Energy Market Operator (AEMO) and the Australian Energy Regulator (AER).

- 8 Not having enough system strength can cause major problems, both in terms of managing the security of the system but also in terms of how electricity is supplied, all increasing costs to consumers. Shortfalls of this essential service in recent years have resulted in delays in the connection of new IBR, as there has not been enough system strength in the system to allow them to connect securely. These delays, and the resultant uncertainty they create, impose costs on connecting new generation. These costs are ultimately passed through to customers. A lack of system strength in the system has also meant that lower-cost, lower emissions, renewable generators are being constrained off — again increasing costs to customers.
- 9 The Commission has therefore developed an evolved framework for the provision of system strength, which is consistent with the ESB’s essential system services work.
- 10 The framework addresses the urgent need to make it simpler, faster and more predictable for new generation, renewables in particular, to connect to the grid and keep supply as secure as possible. It does this by introducing:
- A new obligation on transmission network service providers, working with AEMO, to provide system strength when and where it is needed.
 - New access standards for relevant generators, loads and market network service providers to have minimum performance of plant in relation to system strength into the future.
 - A charging mechanism for system strength, so those parties who use the service pay for it.
- 11 The Commission considers that these changes would support the power system transition, which includes fast-rising levels of more variable, inverter based resources like batteries, wind and solar. The new arrangements are purposefully setting us up for the future and are intended to provide greater certainty that efficient levels of system strength will be available, when and where it is needed, while promoting flexibility that is needed as the system changes.
- 12 The Commission considers that these reforms are in the long term interests of consumers as they would support more efficient connection of new generation and deliver a more secure energy system. This would help to keep prices as low as possible for customers.
- 13 This draft determination sets out the draft rule, the Commission’s reasons for making its decision and how stakeholders can have their say and help shape our thinking during the final stage of this rule making process. The closing date for your submissions is **17 June 2021** and a final determination is expected on 29 July 2021.

System security challenges posed by market transformation

- 14 System strength is a difficult concept to define. It is an umbrella term that refers to a number of different issues. Electricity coming out of your powerpoint 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 Our power system is an alternating current (AC) system. 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.
- 16 System strength is vital to support the decarbonisation of the NEM, which is occurring as the mix of generators is changing: moving from a few large, synchronous units to many dispersed, non-synchronous, IBR. This shift is happening at the same time as we have fewer sources of system strength, as old, synchronous generators retire or operate less often.
- 17 Synchronous generators, like coal, gas and hydroelectric generators, tend to stabilise the voltage wave form as a “byproduct” of their power production. This is due to the fact they are physically coupled to the grid. At the moment, most IBR, like batteries, wind and solar, don’t do this, as they use electronics — computers and inverters — to couple with the grid. These non-synchronous, IBR need a smooth and stable voltage wave form to operate properly. In fact, when they connect, some of these resources can “use up” some of the available system strength by “demanding” it. This may change in the future as new technologies, such as “grid forming” inverters, become more widespread.
- 18 This draft rule addresses the transformation of our power system by making sure that there would be enough system strength provided, when and where it is needed, so that these IBR can operate stably. This will be crucial to support the rapid and ongoing transition to a power system with much higher volumes of these resources.

Why system strength is so important

- 19 A lack of system strength means the power system can become unstable, either during normal operation or following a disturbance like a lightning strike.
- 20 At a basic level, we need some system strength so the emergency protection equipment that keeps the system stable following a fault can operate properly. This basic level of system strength is known as ‘fault level’, and it is critical to ensuring that the power system doesn’t collapse following a major fault, like a lightning strike on a transmission tower.
- 21 Beyond this, system strength is also needed so that IBR can operate properly. When there isn’t enough system strength, the electronics in these non-synchronous, inverter connected generators can interact and feedback on each other, and small disturbances can get out of control very fast. The more system strength is provided, the easier it is to stop these feedback processes from getting out of control. This allows more inverter connected resources to join the power system, while keeping the whole system stable.
- 22 In order to prevent this from happening, the Australian Energy Market Operator (AEMO), as operator of the power system, sometimes turns off the non-synchronous, inverter connected resources pre-emptively, to reduce demand for system strength. Alternatively, or in conjunction with this, AEMO sometimes intervenes in the market to order the synchronous,

coal, gas and hydro generators to keep running, to increase the supply of system strength.

23 Over the longer term, a lack of system strength will make it harder for new generators connected to the grid to generate. This is a major problem, as our existing synchronous generation fleet is getting older, with many of the coal and gas generators expected to retire over the next two decades — or at the very least, operate less. We need to replace these retiring generators, and AEMO expects most of the new generators that replace them will be non-synchronous, inverter based resources, which are precisely the type of resources that instead of providing system strength, demand it.

Our work on system strength is consistent with the ESB's Post 2025 market design and our broader system security work program

24 The ESB through its Post 2025 market design project is currently advising on a long-term, fit for purpose market framework to support reliability, modifying the NEM as necessary to meet the needs of future diverse sources of non-dispatchable generation and flexible resources, including demand side response, storage and distributed energy resource participation.

25 A key part of this work is the workstream on essential system services and scheduling and ahead mechanisms. This workstream involves considering how four key system services are to be provided: frequency control, operating reserves, inertia and system strength. These services are critical to supporting the efficient transition to a decarbonised NEM.

26 The ESB has identified that system services are ideally procured through some form of spot market. However, for system strength, the ESB found that a spot market is unlikely to be achievable in the short to medium term given current technology limitations, and that system strength should instead be provided through some form of structured procurement. This could include the TNSP or AEMO buying the service, or a separate mandate that generators provide this service through a technical standard.

27 The AEMC's draft determination proposes arrangements to deliver the system strength component of this workstream, and is consistent with the direction of the ESB that due to current technological limitations, system strength should be provided through a structured procurement mechanism.

28 The Commission's evolved framework for system strength is also consistent with the other essential system services workstreams of the ESB. This includes other mechanisms being considered by the ESB, such as the unit commitment for security (UCS), and the synchronous services mechanism (SSM):

- The UCS is a proposed mechanism that would allow AEMO to commit additional resources to address shortfall of system security and reliability requirements at operational timeframe. Shortfalls could be for system services not traded in the real-time market. The key interaction with our evolved system strength framework is that the UCS could potentially schedule any contracts with synchronous generators entered into by a TNSP as a non-network solution, to meet its obligations under the system strength standard. This is only one type of contract that could be scheduled through the UCS.

- The SSM considers allowing AEMO to procure services acquired under structured procurement, such as inertia and system strength, as the power system transitions to higher volumes of IBR and experience with services-based provision develops. Such a scheduling mechanism could schedule and activate contracted resources and would link long-term contracts with dynamic system requirements in the commitment timeframe leading up to real-time dispatch.

29 The Commission is considering these mechanisms as part of its work on two rule changes: the *Capacity commitment mechanisms* rule change request submitted by Delta Electricity; and *Synchronous services market* rule change request submitted by Hydro Tasmania.

30 We will continue to coordinate these considerations across our work on these three rule changes, as well as with the ESB and the other market bodies.

What needs to be done to evolve the existing system strength frameworks

31 The Commission has made this draft rule determination to evolve and improve the existing frameworks for the provision of system strength. The current frameworks were introduced by the Commission in 2017 and included two key aspects:

- The 'do no harm' framework, which was designed to deliver any system strength needed to support new IBR generators and market network service providers, as they connect to the system. This obligation was imposed on each new connecting generator and market network service facility, to address their specific impact on system strength.
- The minimum system strength framework, which required TNSPs to provide system strength, where this was needed to maintain the basic levels for system security. Generally, the intent of this part of the framework was to address declining system strength as synchronous generators retired or reduced their output.

32 In effect, the existing frameworks require TNSPs to provide the 'basic' system strength fault level. Individual IBR generators are then required to provide the system strength needed to manage the feedback effect, to support their own operation.

33 As time has passed, we have engaged with stakeholders and have identified several problems that need to be addressed.

34 Since 2017, it has become apparent that these arrangements have created costs for consumers by slowing down the connection process. It has also become apparent that they are overly reactive in nature and are poorly co-ordinated. This has manifested in a number of ways:

- **Issues with connection:** Under the existing system strength frameworks, connecting parties must manage their own system strength impact – the so called 'do no harm' obligations. These assessments are undertaken on a case by case basis, requiring extensive modelling to determine the extent to which they create a system strength impact. This modelling can change as a connecting party goes through the connection process, depending on what other generators are connecting to the system nearby. In some areas of the system where many generators are trying to connect, this modelling process can be subject to many changes and can become very complex. In some

instances, this has resulted in AEMO imposing a process of sequential ordering of connection applications. These outcomes can add significant time and cost to the process of negotiating a connection agreement, with this ultimately impact on the price paid for energy by customers.

- **Issues with a lack of coordination, including operational, scale and scope inefficiencies:** The existing system strength frameworks do not facilitate a coordinated delivery of system strength, at least to the levels needed to facilitate effective IBR operation. This brings with it several inefficiencies, all of which impose additional costs on customers.
 - The do no harm arrangements tend to result in IBR generators having installed small, individually tailored assets to meet their own obligations. A typical example is for several solar farms connecting within a region to each install a small synchronous condenser — an asset used to provide system strength — and to operate those assets only when needed to facilitate their own export. This is likely to be inefficient. System strength can be provided by a number of means, not just building assets. For example, it can also be provided by retuning the electronics of IBR, or contracting with existing synchronous generators to provide system strength. Further, scale economies can be achieved by considering what solutions can be used to provide system strength in aggregate e.g. a smaller number of larger assets may be cheaper than a larger number of smaller assets.
 - Uncoordinated operation of schemes to provide system strength can in turn make it harder to operate the system efficiently; the private owners of these assets may operate them to maximise their own benefit, rather than to benefit the system.
 - The uncoordinated nature of the current frameworks means there is little opportunity for any scope economies that could arise from having the one party coordinate the provision of system strength. As noted above, there are a number of solutions to providing system strength, and these solutions may also help provide a number of other services, such as inertia and voltage control. The uncoordinated nature of the current frameworks means it is harder to capture the scope efficiencies of providing these various services from a single, efficiently designed asset.
- **Issues with reactivity:** AEMO is currently required to forecast *shortfalls* in the availability of system strength, which must be based around expectations of future patterns of generation dispatch. AEMO can then only require TNSPs to take action to manage these shortfalls, once they are clearly identified.
 - This approach is problematic, in that it has proven difficult for AEMO to identify these shortfalls sufficiently far in advance to allow TNSPs to undertake effective planning processes. This is largely due to the number of assumptions and the complexity of the modelling process itself, to accurately forecast future dispatch outcomes. While AEMO's processes of 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.
 - These issues can give rise to a degree of reactivity in the provision of system strength. As the pace of the transition accelerates, this brings with it a risk of higher

prices for customers. Any delay in identifying a need may mean shortfalls are not addressed in time, resulting in slower connections of new generation, or curtailment of existing generation. Any reduction in supply is likely to flow through into wholesale market price outcomes, which will then impact on the prices customers pay for energy.

The answer: a long-term solution to keep the power system working well

- 35 The Commission has considered these issues and has proposed an evolved framework for system strength to support the power system transition. The new arrangements are setting us up for the future and are intended to provide greater certainty that efficient levels of system strength will be available, when and where it is needed while promoting flexibility that is needed as the system changes.
- 36 The Commission considers that there are significant benefits associated with a purposefully forward-looking approach for system strength. This reflects the relative asymmetry of the costs of providing too much system strength, as opposed to not providing enough.
- 37 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 system strength identified above, as well as the fact that the provision of system strength is lumpy, this is unlikely to occur in practice.
- 38 This means that a choice needs to be made. Is it better to favour:
1. supplying system strength where demand is expected, but may not yet have arrived, or
 2. supplying system strength only when demand has arrived, or where its arrival is imminent.
- 39 The Commission considers that there is a clear asymmetry of risk that sits on either side of these options. While the second approach helps to reduce the risk of stranded assets for customers, it also brings with it the risks of material delays in the investment pipeline, curtailment of existing generation and inefficient investments to provide system strength services — ultimately resulting in higher costs for consumers.
- 40 In contrast, the second approach — 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 so decreasing costs to the system of providing a secure supply of energy. This is particularly important given the substantial transition that is occurring, and is expected to result in net benefits for consumers, outweighing any potential costs of this option.
- 41 This consideration has directly influenced the design choices we have made for the evolved framework. Primarily, it underpins our choice to adopt an AEMO and TNSP led coordinated solution for system strength, which draws on existing economic regulatory and planning frameworks. When coupled with an effective charging mechanism to facilitate efficient usage of this service, the evolved framework will address the key issues with the current frameworks, while keeping prices as low as possible for consumers. It also allows the

framework to be implemented relatively quickly, given it is building on existing arrangements.

42

The evolved framework consists of three main elements, which we have described as being relevant to the **supply, coordination** and **demand** for system strength:

- **Supply side:** A TNSP led procurement of system strength. TNSPs working closely with AEMO, would be responsible for providing efficient levels of system strength on a forward looking basis over the given timeframe. The provision of system strength by the TNSP would be provided as a prescribed transmission service, with the TNSP required to meet a standard at certain locations on its transmission network for the provision of system strength.
- **Coordination:** The system strength mitigation requirement, which would provide connecting parties with IBR a choice between paying to use the system strength provided by the TNSP, or providing their own system strength by remediating their impact. This mechanism would mean that while customers would bear some of the initial cost of providing system strength services, over time this cost will be recovered from connecting parties.
- **Demand side:** New access standards, to ensure that connecting parties with IBR would only use the efficient volumes of this valuable common pool resource.

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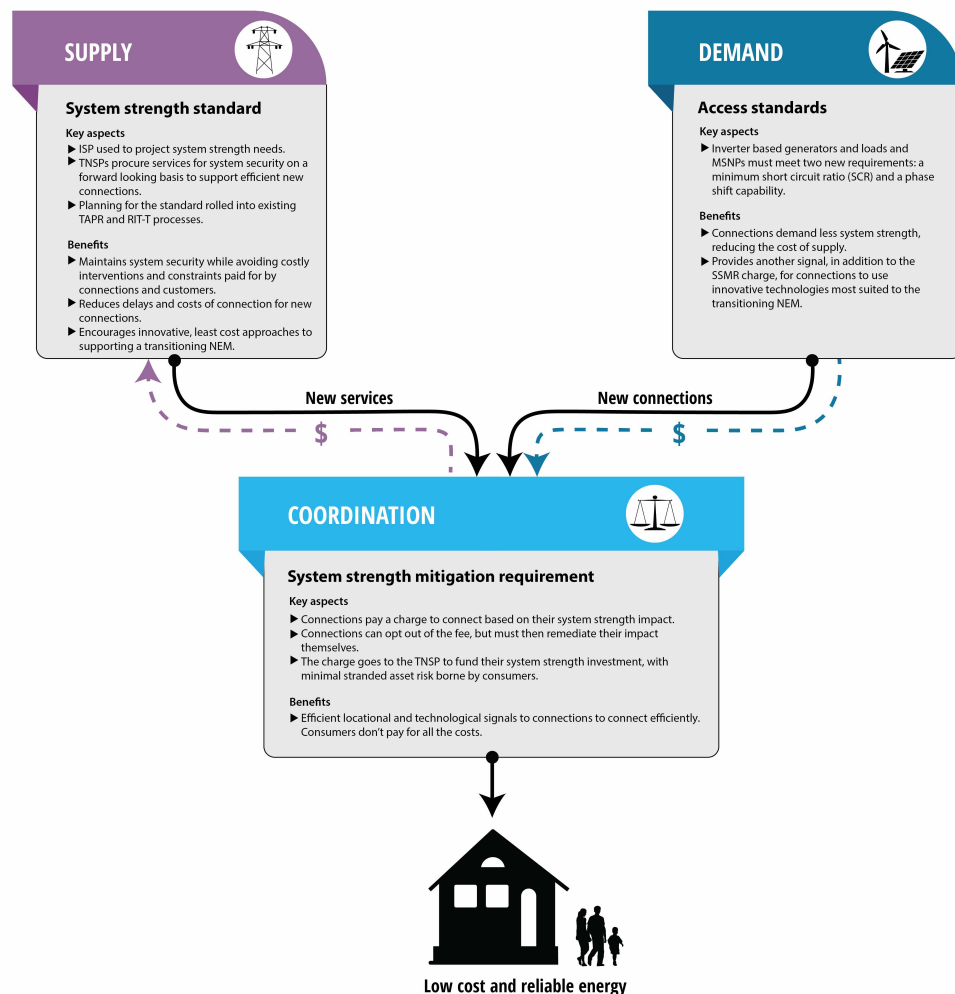
We consider that, for all of the reasons set out in the previous section, these elements will be sufficiently forward-looking so as to address the key issues with the current frameworks and promote the long-term interests of consumers:

- **Reduce investment and connection costs**, by providing connecting parties with the ability to choose between paying the charge or undertaking their own remediation to provide system strength. This would provide connecting parties with greater certainty as to how their connection process will proceed, which would help to reduce investment costs and bring on more supply. Both of these effects would help to reduce wholesale costs, flowing through to lower prices for customers.
- **Enhance scale, scope and operational efficiencies**, by making TNSPs responsible for delivery of the efficient amount of system strength. The evolved framework allows TNSPs to leverage the significant economies of scale and scope to deliver system strength at the lowest cost. TNSPs are also best placed to coordinate assets to maximise operational efficiency. These effects would help to reduce the costs associated with the provision of system strength, and would also support more efficient operation of the power system, which would flow through to customers in the form of lower wholesale and network charges.
- **Address the reactivity of the current frameworks**, by requiring AEMO and TNSPs to actively plan ahead for the provision of the efficient volumes of system strength. This would mean that system strength is provided when and where it is needed, which would help to address the bottlenecks in new connections, and curtailment of existing generation, which have occurred under the current frameworks. This should help to reduce the costs of new investment and bring on more supply, flowing through to lower wholesale prices and therefore lower costs for customers.

An effective coordination of the supply and demand for system strength: how will our evolved framework deliver?

- 44 The evolved framework is designed to effectively coordinate the supply of system strength with demand for this essential system service. It would do this by imposing a new obligation on TNSPs to provide this service by meeting a standard. The IBR that then make use of the service would pay a charge to do so. This would be underpinned by a new series of access standards, to manage demand and provide a 'backstop', to support system security.
- 45 Therefore, the new framework can be grouped into three components: the **supply side**, **demand side**, and a **coordination** mechanism.

Figure 1: Overview of evolved system strength framework



Source: AEMC

Supply side changes

- 46 A key element of the supply side of our evolved framework is that AEMO and relevant TNSPs (known as system strength service providers or SSS Providers) would work together to provide an efficient level of system strength, at the right place and at the right time. The efficient level would be represented as the amount of system strength needed to maintain system security and to support efficient levels of forecast IBR generation and load.
- 47 Though the planning processes, AEMO and the SSS Providers would work together to identify the key locations, and timing, for when system strength would need to be provided to achieve this outcome. AEMO would declare these locations to be system strength nodes.
- 48 The first element of the supply side of our evolved framework is a new system strength standard set out in the NER. This standard would form the basis of the SSS Providers obligations to plan for and provide system strength services at these system strength nodes. It would include an obligation to maintain minimum fault levels for security. Then, above this minimum fault level, SSS Providers would also be required to maintain stable voltage waveforms, so that expected volumes of IBR that connect to the grid can operate stably and remain synchronised.
- 49 AEMO would be responsible for identifying efficient levels of future demand for system strength, through its existing forecasting processes in the integrated system plan (ISP) and the system strength report process. Having identified the system strength nodes, the SSS Provider would then be required to meet the system strength standard at each node. AEMO would then identify:
- Minimum fault levels, measured in MVA, that must be provided at that node to maintain system security.
 - Forecast expected volumes of IBR plant that are expected to connect at or near that node and forecast expected volumes of non-IBR plant, in order to determine how much system strength would be provided at the node.
- 50 AEMO would also identify the time at which it is necessary for the SSS Providers to meet its obligations under the standard. The NER would set out clear timeframes for when and how this would occur, so that SSS Providers have adequate time to plan to meet their obligations.
- 51 A key difference between the current arrangements and the evolved framework is that AEMO would no longer be limited to identifying system strength shortfalls, by reference to assessing 'typical dispatch patterns'. Instead, AEMO would simply project the levels of system strength required, in accordance with the two elements of the system strength standard described above.
- 52 SSS Providers would be responsible for planning to meet the standard at the identified nodes, to account for the minimum fault levels and expected volumes of plant expected to connect forecast by AEMO. SSS Providers would be required to undertake joint planning exercises with AEMO and other network service providers (including distribution network service providers), when developing solutions to meet the system strength standard. SSS Providers would consider how to meet their obligations through the existing transmission annual planning review process, which involves consideration of a ten-year planning horizon. This

would involve considering different ways that system strength can be provided – such as through building network assets, contracting with existing synchronous generators, retuning existing generators or other solutions. The Commission expects that any solution would be a combination of these ways of providing system strength. The SSS Provider would then publish the results of its planning review in its transmission annual planning report (TAPR) each year.

53 Once specific solutions are identified, they would be progressed through individual regulatory investment test for transmission (RIT-T) processes. Importantly, because these solutions are used to meet a standard in schedule 5.1 of the NER they would be treated as reliability corrective actions, which means that while TNSPs still need to model net market benefits, a solution could have a negative net market benefit.

54 The system strength service provided by TNSPs would be a prescribed transmission service. This means it would be subject to the same forms of economic regulation as any other prescribed transmission service. As discussed below, the draft rule also introduces a new mechanism to recover some costs from IBR that consumes the service.

How would these supply side reforms improve outcomes for customers?

55 These supply side reforms would provide three key benefits, principally related to improvements to the connection process, providing more efficient outcomes and reducing total system costs.

56 Increasing the availability of system strength would help to simplify the connection process for new IBR plant. Plants that demand system strength would have the choice to connect at or near system strength nodes where the SSS Provider is providing the service, and would therefore not need to undertake to the same extent the extensive modelling and costly remediation work that occurs under the current arrangements.

57 The evolved framework is also purposefully forward-looking and coordinated. It would make AEMO's job easier, in terms of forecasting future system needs, as AEMO would no longer be required to consider 'typical dispatch patterns' when forecasting likely minimum fault levels in future. Instead, AEMO would project the minimum fault levels required, and this would form the basis of SSS Provider's obligation under the standard.

58 The evolved framework would also require AEMO and SSS Providers to actively plan for the delivery of efficient levels of system strength, over the long term timeframes considered in the current planning processes. In conjunction, this would help reduce the risk of shortfalls arising in availability of system strength. This would facilitate more efficient connection of new IBR and would reduce the risk of material curtailment of existing generators.

59 Finally, the evolved framework would support a more coordinated approach to the provision of system strength. SSS Providers would be able to effectively coordinate investment in assets to provide system strength, to capture efficiencies of scale and scope.

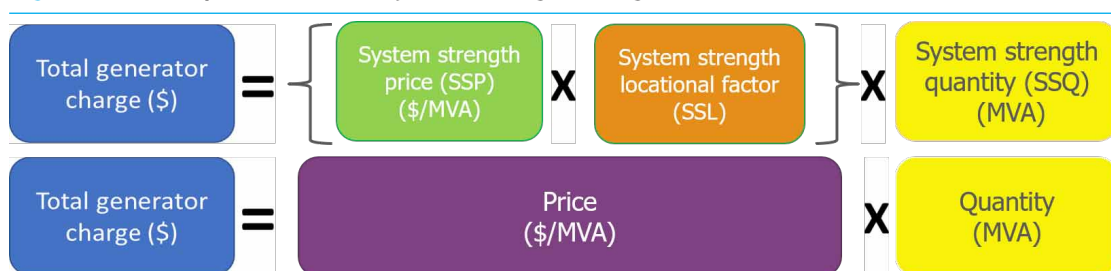
60 All of these outcomes can be expected to reduce the total of wholesale costs and network charges in comparison to the alternatives - such as not evolving the framework, which would flow through to lower prices for customers. In particular, by ensuring an adequate supply of

system strength is provided on a forward looking basis, the connection of new IBR resources would be supported, improving wholesale price outcomes for customers. Having TNSPs responsible for the coordinated provision of system strength should also better enable TNSPs to take advantage of scale and scope economies, which will help to reduce network charges for customers.

Efficient coordination of supply and demand sides

- 61 The key element of our coordination change is the introduction of the system strength mitigation requirement (SSMR). The SSMR would include a new charging mechanism for connecting IBR that make use of the system strength provided by the SSS Providers. This charge would be underpinned by a new set of access standards, which would allow for connected parties to reduce their exposure to this charge (discussed below).
- 62 These new mechanisms are designed to send effective signals to new connecting parties, to drive efficient usage of system strength services.

Figure 2: Components of the system strength charge



Source: AEMC

- 63 The charge itself would consist of three components. These components are:
- system strength unit price (SSUP), being the forward-looking cost incurred by the TNSP in providing the system strength service
 - system strength locational factor (SSL), being the volume of system strength demanded by the connecting IBR due to its electrical distance from the nearest system strength node
 - system strength quantity (SSQ), being the volume of system strength demanded by the connecting IBR due to the specific technical characteristics of the IBR plant itself.
- 64 Each of these components of the charge would be derived through different processes:
- The AER would play a central role in setting the SSUP, through the guidelines that it develops to inform TNSP pricing methodologies, which ultimately set the SSUP at each system strength node.
 - Similarly, AEMO would provide guidance on the SSL, through its system strength impact assessment guidelines.

- The SSQ would be based on the negotiation of individual performance standards, in accordance with current frameworks and guidance in AEMO's system strength impact assessment guidelines.

65 Each of these components of the charge is designed to incentivise parties to connect to efficiently use and demand system strength in the system.

66 The system strength charge is intended to send transparent price signals. To enable this, the AER, TNSPs and AEMO would provide various documents that can be used by connecting parties to estimate the costs of connecting, prior to submitting a connection enquiry. SSS Providers would publish the unit price at system strength nodes, as well as the locational factors at existing connection points. Using this information, connecting parties would be able to assess their own likely locational factor and unit price. Once a connection enquiry is submitted, the relevant NSP would then provide an estimate of the charge, to enable the connecting party to decide between paying the charge or self remediating.

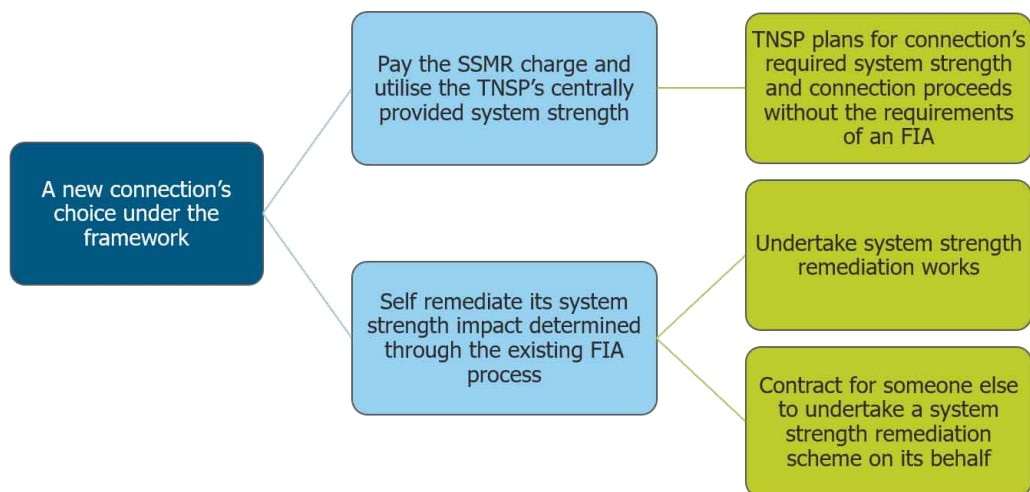
67 Connecting parties would face a choice. They can choose between paying the charge to utilise the system strength provided by the SSS Providers, or undertaking their own remediation actions. Parties who connect close to the system strength nodes should face charges that are lower than the costs of self remediation, and are therefore likely to pay the charge. Those parties that choose to locate further away would face higher charges, and may therefore elect to self remediate. This choice is consistent with an efficient approach to the provision and use of system strength, as it should reflect the relative marginal costs of providing the service to each IBR that connects.

68 If they select to pay the charge, connecting parties may reduce this charge after its connection by altering its plant to consume less system strength service using the amended clause 5.3.9 or new 5.3.12 process proposed under the draft rule. This is seen as a key benefit to the coordination at the supply and demand side as it incentivises efficient use of the service for the lifetime of the connection.

69 The evolved framework has integrated this choice into the connection process. Currently, all generators who connect are required to go through a preliminary impact assessment (PIA), and most are then required to go through a full impact assessment (FIA). We have heard that this FIA process is complex and time consuming, and in combination with any potential self remediation actions, can give rise to significant delays in the connection process.

70 Under our evolved framework, all generators will still be required to go through the PIA process. At this stage, connecting parties would then be able to determine the likely charge they would face, if they elect to use the system strength provided by the TNSP. A choice is then made, between electing to pay the charge, or moving into the next stage of the self-remediation process. Only those generators who elect to self remediate would go through the full FIA process.

Figure 3: Choice for a new connection under the SSMR – pay the charge or remediate



Source: AEMC

71 Only specific parties would be captured by the SSMR. Generally, the SSMR would apply to all parties — including IBR generators, IBR loads and MNSPs — that connect under Chapter 5 of the NER following the commencement of the rule. In practice, this means that those parties that *demand* system strength would pay the charge. Certain technologies, including synchronous generators and potentially grid-forming inverters, do not actively demand system strength. These technologies will therefore have a SSQ of zero, and so will therefore not face a charge.

72 The development of the system strength charge would be integrated into the existing regulated pricing frameworks. The system strength charge would be determined by the TNSP in accordance with the TNSPs pricing methodology. This pricing methodology must comply with the AER's pricing methodology guidelines. The AER's guidelines would themselves be required to reflect certain principles set out in the NER, to reflect concepts such as the desirability of applying long run marginal cost pricing to the development of the system strength unit price component of the charge.

73 Where possible, components of the charge are fixed; the SSUP and SSL components are fixed for a five-year period. This is intended to provide as much certainty as possible for connecting parties but also allow for flexibility over time as circumstances on the network change and to continually incentivise parties to consider ways of reducing their demand for system strength on the system.

74 How would these coordination reforms improve outcomes for customers?

75 This charge creates incentives for connecting parties to make efficient locational decisions, and install equipment that helps to reduce overall system costs. By trading off the incremental costs in the provision of system strength by the TNSP, reflected in the system

strength charge, with the costs and benefits of different locations and equipment, connecting parties are incentivised to make efficient investment decisions.

Demand side changes

- 76 New access standards would underpin the SSMR. These new access standards, would apply to the same parties that the charge would apply i.e. to IBR generators and loads, as well as MNSPs. These would require connecting parties to demonstrate that they can operate stably, down to a given level of system strength. These have the effect of requiring plants that demand system strength to minimise their demands for system strength on the system. This access standard would then form the basis of the SSQ component of the charge, and therefore the charge paid by a connecting generator.
- 77 IBR generators, loads and MNSPs would be able to actively reduce their demand for system strength — reduce their SSQ — by installing new equipment, or by changing the way they are ‘tuned’ to the power system. Where generators elect to do this, they would need to renegotiate their GPS, with specific reference to the new access standard for system strength.
- 78 IBR generators would face another new access standard, to ensure they remain stable during sudden changes in voltage (which is related to system strength). This standard would help to support general power system security. This new standard only applies to IBR generators, as they are the only party who physically responds to voltage changes in a manner that requires this standard to apply.
- 79 How would these demand side reforms improve outcomes for customers?**
- 80 While plant that demands system strength would face a charge reflecting an estimate of the marginal cost in the provision of system strength by the TNSP, the Commission considers it important to additionally place a minimum requirement on the technical standards of connecting equipment. The draft rule would achieve this by creating a new access standard as part of the technical requirements for connecting loads, MNSPs and generators, as well as an additional access standard related to voltage shift that applies only to generators.
- 81 These access standards act as a safety net, in addition to the price signals being sent by the system strength mitigation requirement, to prevent poor quality equipment from using up the system strength unnecessarily.

Transitional arrangements

- 82 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 proposed draft rule requires an inter-related sequence of events to occur for proper implementation.
- 83 As such, the Commission considers the proposed transitional arrangements set out in the draft rule strike a balance between the time needed for parties to prepare to meet their

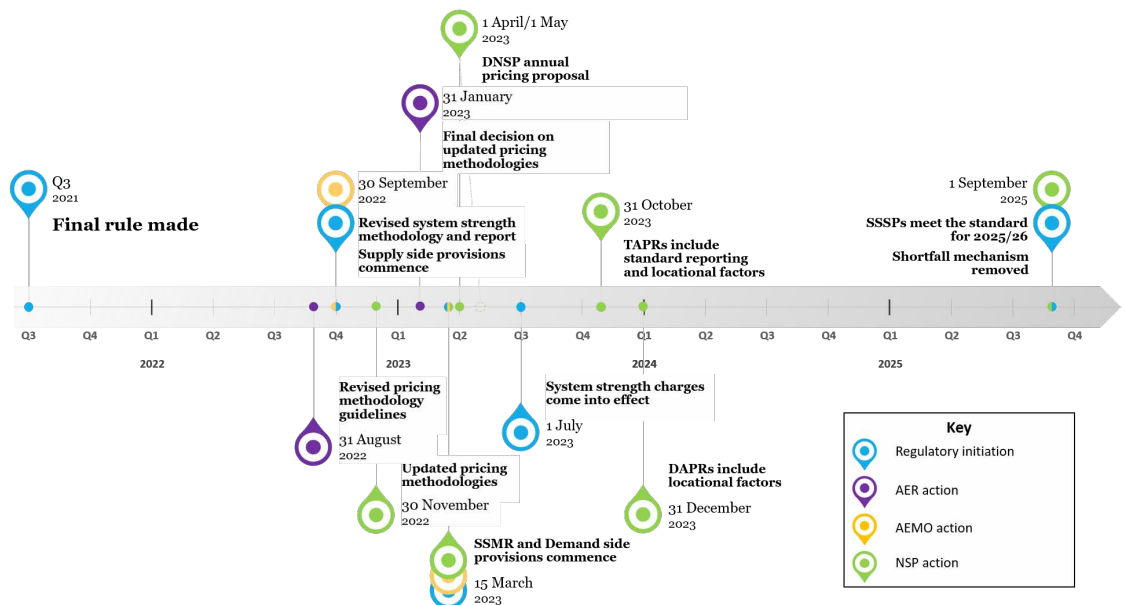
obligations under the evolved framework with the need to enable the new system strength framework to be implemented as soon as possible to realise the benefits.

84

Figure 4 below summarises the sequence of events that is proposed to occur to implement the evolved framework. This sequence can be grouped into three categories of transitional arrangements:

1. Supply side implementation — which involves the preparation of the materials such that the new system strength planning would commence on 30 September 2022. This also includes the maintenance of the shortfall mechanism until 1 September 2025
2. Pricing and revenue arrangements for NSPs prior to next regulatory determination, including the arrangements for SSS Providers, non-SSS Providers and DNSPs.
3. Demand side and system strength mitigation requirement implementation — which involves the preparation of the materials such that these frameworks would commence on 15 March 2023.

Figure 4: Proposed timeline of implementation



Source: AEMC

Engagement on this draft rule determination

85

This draft determination sets out the draft rule, the Commission’s reasons for making its decision and how stakeholders can have their say and help shape our thinking during the final stage of this rule making process.

86

We welcome stakeholder input and engagement. Please feel free to reach out to James Hyatt at james.hyatt@aemc.gov.au or on (02) 8296 0628.

87

The closing date for your submissions is 17 June 2021 and a final determination is currently

expected on 29 July 2021.

88

To assist this process, a public forum on this draft determination will be held on 6 May 2021, and you can register attendance on our website.

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1 TRANSGRID'S RULE CHANGE REQUEST

On 27 April 2020, TransGrid (the proponent) made a request to the Australian Energy Market Commission (AEMC or Commission) to make a rule regarding the management of system strength on the power system (rule change request).

System strength is an essential system service that relates to the stability to the voltage waveform. A more fulsome explanation of the service is provided in Chapter 2.²

In this Chapter:

- section 1.1 sets out a brief description of the current arrangements
- section 1.2 and section 1.3 sets out the rationale for and solution proposed by the proponent in the rule change request
- section 1.4 sets out the rule making process
- section 1.5 sets out the consultation on this draft rule determination
- section 1.6 sets out the structure of this determination.

1.1 Current arrangements

The Commission made a rule in September 2017 that introduced frameworks to help manage emerging issues with system strength. The *Managing power system fault levels* final rule established two new frameworks:

1. The minimum system strength framework, which obligates relevant transmission network service providers (TNSPs), known as system strength service providers (SSS Providers), to procure system strength services needed to provide the levels determined by the Australian Energy Market Operator (AEMO), if AEMO has declared a shortfall.³
2. The 'do no harm' obligation, which requires AEMO to develop system strength impact assessment guidelines that allow network service providers (transmission and distribution) (NSPs) and generators to assess the impact of a new generator or MNSP connection on system strength.⁴ From this, the new connection is required to 'do no harm' to the security of the power system, in relation to system strength. As such, if the new connection has a negative impact on the fault level (a measure of the level of system strength in that area), then that generator must remediate that impact by either implementing a system strength remediation scheme or having the network service provider carry out system strength connection works.⁵

² A full exploration of the evolved understanding of system strength as an essential system service is set out in Appendix A of our *Investigation into system strength frameworks in the NEM*: Final report, October 2020.

³ See rule 5.20C of the NER.

⁴ See clause 4.6.6 of the NER.

⁵ See clause 5.3.4B of the NER.

BOX 1: WHAT IS A SYSTEM STRENGTH SERVICE PROVIDER (SSS PROVIDER)?

System strength service providers (SSS Providers) are 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.

The TNSP's that are currently SSS Providers are TasNetworks, TransGrid, Powerlink, AEMO and ElectraNet.

1.2 Rationale for the rule change request

TransGrid lodged a rule change request on 27 April 2020 to amend the National Electricity Rules. The rule change request identified issues similar to those identified in the March 2020 Discussion paper of the AEMC *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:⁶

- The lack of ability to effectively coordinate solutions to address system strength issues across the 'do no harm' and minimum frameworks, as well as the lack of explicit linkages between both system strength frameworks and frameworks for the provision of other system services, particularly inertia services. This is because while all three frameworks interact, they are not formally connected, which creates the risk of feedback loops and inefficiencies.
- The additional time and cost for connection of new generation to the power system due to the system strength impact modelling and remediation requirements of the 'do no harm' obligation.
- The slow, reactive nature of the minimum system strength framework, which leads to increased risks of costly interventions in the operation of the energy market. This is due to the difficulties faced by AEMO in undertaking effective forecasting, which has resulted in declarations of system strength (and inertia) shortfalls when they already exist, rather than at least 5 years out as envisaged in the framework. This can mean that TNSP do not have sufficient time to procure the needed services, before AEMO has to intervene in the market using constraints or directions.

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.⁷

The TransGrid proposal involved:⁸

⁶ TransGrid, 2020, *Efficient management on system strength on the power system — Rule change proposal*, pp. 5-9, 27 April 2020.

⁷ *ibid*, pp. 10-11.

⁸ *ibid*, pp. 10-18.

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.
 - AEMO would retain responsibility for determining fault level nodes and the minimum fault level that is required at each node. This would be done in conjunction with TNSPs, as is currently the case through the minimum system strength processes.
 - A key difference with the current framework would be that when setting these levels, AEMO would also have to account for the potential future impact of new generation (using the ISP) in setting the minimum fault level for each node.
2. An independent body (such as the Reliability Panel) would set a probabilistic planning standard, which would define how often SSS Providers must be able to meet the required minimum levels of system strength. This standard could be similar in form to the current reliability standard of 0.002% unserved energy.
 - This standard could be applied globally/NEM-wide, regionally for each SSS Providers, or on a nodal basis.
 - TNSPs would meet this standard through their normal planning processes including contingent projects for more time sensitive issues.
3. SSS Providers would be obligated to maintain these system strength levels to the standard for each node defined in their network.
 - SSS Providers would be responsible for assessing if there was enough system strength provision to meet minimum levels in collaboration with AEMO.
 - SSS Providers would then provide the service, either through network or non-network options to maintain the standard.

AEMO would also be able to declare system strength shortfalls as a network support and control ancillary service (NSCAS) gap, where sufficient levels of system strength were not captured through longer term planning processes. AEMO would then act as procurer of last resort if the gap remained unmet by TNSPs.

TransGrid also proposed to amend the current minimum system strength framework such that it would be integrated into TNSPs' ordinary planning and regulatory frameworks. This would mean that system strength would become an extension of the existing NER defined regulatory standards for network planning and operation. A new regulatory obligation for SSS Providers would be imposed to provide system strength to meet the standard, in a similar manner to existing obligations for thermal capacity and for the provision of voltage control services.

In the place of 'do no harm', generator connection processes would still require each plant to negotiate and meet generation performance standards (GPS) to connect. This would mean that generators would not have to undergo the full impact assessment associated with the 'do no harm' obligation. TransGrid then stated that this may result in them being penalised when trying to meet their GPS, if they do not locate in optimal (strong) parts of the network. The proposal also expected the risk of constraints will provide a further locational signal.

1.3.1 **Costs and benefits of TransGrid's proposed solution**

In its rule change request, TransGrid noted a variety of possible benefits and costs to addressing system strength issues which TransGrid suggests, if considered in the manner it proposes, would yield a significant overall net benefit to system strength arrangements in the NEM.⁹

TransGrid suggested the main benefits of its proposed rule change would include:

- The facilitation of more coordinated, scale-efficient delivery of system strength services.
- A more efficient balance of costs incurred in the market, by having shortfalls addressed through provision of system strength services, as opposed to managing these issues through market interventions.
- The removal of requirements on generators to deliver bespoke remediation schemes through the 'do no harm' framework, allowing for more cost-effective grid connection and reducing unnecessary duplication of investment in service capability.
- Transmission networks being able to operate more efficiently, as they would be empowered by more flexible arrangements to respond to rapid changes in system strength on the power system.

TransGrid acknowledged that the proposed changes would incur some material costs. These included:

- Administrative and development costs incurred on AEMO when setting minimum fault levels at defined notes and in developing a new fault level standard. TransGrid noted some of this work has already been done, so costs may be reduced.
- Actual costs of procuring system strength services, incurred by SSS Providers. TransGrid noted that these incremental costs were likely to be lower than costs incurred by other market participants when remediating system strength impacts in an uncoordinated manner.
- Additional administrative costs incurred by SSS Providers in developing internal processes and frameworks required to implement the proposed changes.

1.4 **The rule making process**

On 2 July 2020, the Commission published a consultation paper covering multiple rule change requests that all related to system services, including this TransGrid rule change request.¹⁰ 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 are discussed and responded to throughout this draft rule determination. These submissions are available on our website.

On 10 December 2020, the Commission extended the period of time for making the draft determination to 29 April 2021.¹¹ This followed an earlier decision on 24 September 2020 to

⁹ *ibid*, p. 19.

¹⁰ This notice was published under s.95 of the National Electricity Law (NEL).

¹¹ This notice was published under section 107 of the National Electricity Law (NEL).

extend the time for making of a draft determination. The Commission considered this extension to be necessary due to the complexity of the issues raised in the rule change request and in stakeholders' submissions to the Consultation paper. Several stakeholders also requested that additional time be allowed for consideration of these issues and further consultation. The extension has provided additional time for the Commission to undertake stakeholder consultation and analysis of the issues prior to this draft determination. It has also allowed for further collaboration with the other market bodies, and dovetailing with ESB processes.

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 nine technical working group sessions over the course of the review and rule change process. Views set out at these meetings have been taken into account.

1.5 Consultation on draft rule determination

The Commission invites **submissions** on this draft rule determination and draft rule, by **17 June 2021**.

Any person or body may request that the Commission hold a hearing in relation to the draft rule determination. Any request for a hearing must be made in writing and must be received by the Commission no later than 6 May 2021.

Submissions and requests for a hearing should quote project number ERC0300 and may be lodged online at www.aemc.gov.au.

Further, to assist this process the Commission will be holding a **webinar briefing** on the draft rule determination on **6 May 2021**. You can register for this on our website.

We also welcome any and all stakeholders to get in touch regarding this draft rule determination to discuss anything of interest. Please feel free to reach out to James Hyatt at james.hyatt@aemc.gov.au or on (02) 8296 0628.

1.6 Structure of this determination

The structure of this determination is set out such that the context, decision and rationale for the draft rule has been provided in the body of the determination. The appendices of the determination provide greater detail on the changes being made in the draft rule. As such, the structure of the determination is:

- Chapter 2: Relevant context — an overview of past and ongoing reviews relevant to this rule change request.
- Chapter 3: Draft rule determination — setting out an overview of the draft rule and the rationale for how the proposal contributes to achievement of the NEO.
- Appendix A: Legal requirements — sets out the AEMC's rule making powers and relevant considerations of the Commission in relation to making this draft rule.
- Appendix B: Supply side — establishing a new system strength planning standard.
- Appendix C: Demand side — new access standards for generator, loads and MNSPs.

- Appendix D: Efficient coordination of the supply and demand sides — system strength mitigation requirements.
- Appendix E: Transitional arrangements — a sequenced implementation of the evolved framework.

2 RELEVANT CONTEXT — SYSTEM SECURITY IS A PRIORITY WITH SYSTEM STRENGTH AN IMPORTANT, IMMEDIATE REFORM

The NEM was a power system designed around a generation fleet that consisted of a small number of large, synchronous,¹² centrally located generators, such as coal, gas and hydroelectric. These generators kept the system stable due to their inherent physical characteristics (e.g. inertia, system strength) provided simply as a by-product of generating electricity. However, as these generators leave the market or reduce their operations, the supply of these essential system services has reduced.

Further, new inverter based resources¹³ facilities, like generators, some loads, batteries and hydrogen facilities, can create a demand for system services, rather than supplying these services automatically as a byproduct of their operation.

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

The market bodies — AEMC, AER and AEMO — are working together through the Energy Security Board's (ESB) Post 2025 market design work, to develop new measures to procure and operationalise these essential system services.

This chapter describes how system strength fits into the broader frameworks for system security and stability:

- section 2.1 discusses what system strength is and how it fits into power system security.
- section 2.2 discusses the ESB's Post 2025 market design project, which is providing the long term vision for the NEM, including how to evolve power system security and the provision of essential system services.
- section 2.3 discusses the AEMC work program on system security supporting and implementing the immediate reforms of the ESB's vision.
- section 2.4 discusses previous work the AEMC has done on system strength, which has informed the Commission's thinking for this draft determination.

12 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.

13 Inverter based resources 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

2.1 Changing generation mix is driving a change in approach to system services

The power system is described as being 'secure' when certain technical parameters are:

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

These technical parameters are centred around managing system voltage and frequency, which includes the services of inertia and system strength.

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 byproduct of generation that control the key system parameters of frequency and voltage, including various types of active power reserve, reactive support, system strength and inertia.

The delivery of these services was dependent on the specific technical design characteristics of the asset, such as the mass of the rotor.

These physical asset characteristics also determined how the power system has been developed and operated over time, reflecting both the technology and location of these assets:

- that individual synchronous generating assets tended to respond in a specific, predictable way to given disturbances on the system e.g., the way that a particular synchronous generator responds to a fault will then be used to determine other key system limits, such as transient stability limits.
- the specific location of these synchronous assets was also relevant to supporting power transfer from one part of the system to another e.g., a synchronous asset located at one end of a large interconnector will have a direct impact on how much power can be transferred, reflecting its particular location and physical characteristics, including its inherent provision of inertia and system strength.

However, the generation mix is changing. We are moving away from these types of assets to more flexible, dispersed, smaller, non-synchronous¹⁴ and inverter based resources (IBR), such as wind, solar and batteries.

IBR resources do not necessarily demonstrate the same innate physical interactions with the power system as synchronous generators. Instead, the interactions are defined by the particular control software used to manage their operation.¹⁵

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

¹⁴ 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.

¹⁵ The Commission recognises that emerging 'grid forming' may mean this changes in 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.

specific services that are needed, and what innate responses to system disturbances are required.¹⁶

However, as this transition occurs, it also means that it is necessary to think about how to manage the retirement, or changed operation, of the synchronous assets that have traditionally played a key role in system operation, due to their specific location in key parts of the grid.

We need new ways to actively source these essential system services as the power system continues to transition.

These trends are influencing the ESB and market bodies work programs.

2.2 Developing new ways of procuring system services

We are working towards a model of providing system security outcomes based on the provision of specific services, rather than specific assets as described above. This will help us establish clear procurement mechanisms for the critical system services that are needed to manage the system.

The ESB's Post 2025 work has set out that the direction for essential system services is to use co-optimised, market-based procurement where possible, and where, not possible, structured procurement approaches.

This shift to a service-based model involves learning about what needs to be done to keep the system secure, and what system operators need to do, in order to keep the power system stable and operable. As understanding grows, it may become necessary to refine existing service definitions, as well as potentially define other new services.

A services model for security services helps to support innovation in the provision of system services. Given the transition described above, services are no longer being delivered based on the specific characteristics of a given asset, but instead on the specific requirements of the system. Moving away from provision by specific assets allows new parties to provide the service, opening up scope for innovation and competition in the provision of new services.¹⁷

A services-based model for system services therefore 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 of providing these system security services, as compared to the traditional asset based approach.

However, given the trends occurring and the need to keep the system secure as the transition occurs it may be the case that the physical requirements of system operation may mean that it may still be necessary to retain certain elements of the asset based model, as a transitional mechanism. Specifically, it may be necessary to procure specific assets, when and

¹⁶ 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.

¹⁷ 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': <https://arena.gov.au/projects/?project-value-start=0&project-value-end=2000000000&technology=system-security-reliability>.

where they are needed, to maintain system stability and provide operational flexibility through the transition. Such mechanisms are under consideration in the ESB's Post 2025 work program, both in relation to resource adequacy and essential system services. This is discussed in more detail in section 2.4.2 below.

This draft determination is consistent with the ESB's work, and the direction set out above. In particular the Commission:

- has defined system strength as a specific system service (see below), which is consistent with general shift towards a services-based model, and is based around creating a framework for how to 'supply' and 'demand' system strength provided clarity about what a system strength service is, and
- what it is used for, to make it easier for AEMO and TNSPs to effectively plan and procure efficient volumes of the service relates the system strength service to specific system needs meaning that TNSPs can consider a wide range of solutions to manage inverter driven instability in order to procure tailored solutions to meet those needs.

2.3 What is system strength, and how does it relate to power system security

System strength is a key system security parameter that needs to be carefully managed as the power system transitions to this new generation mix as described above. System strength is a difficult concept to define. It is an umbrella term that refers to a number of different issues. Electricity coming out of your powerpoint 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.

Our power system is an alternating current (AC) system.¹⁸ 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.

Like other system services, system strength was historically provided for free as a "byproduct" of synchronous generator production. Similarly, 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.

¹⁸ 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.

However, IBR plant connected with grid following inverters require system strength in order to operate properly. When there isn't enough system strength, the electronics and control systems in these IBR plant can interact with each other, and small disturbances can get out of control quickly, leading to escalating instabilities across the system. The more system strength is provided, the easier it is to stop these feed-back processes from leading to instabilities. This allows more inverter connected generators to connect to the power system, while keeping the whole system stable.

A lack of system strength can result in instabilities in the power system. 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.

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, including its ability to return to a stable state after disturbance events like faults, as well as the extent to which it stays stable under normal conditions. See Box 2 for further information.

BOX 2: EVOLVING THE UNDERSTANDING OF SYSTEM STRENGTH THROUGH THE INVESTIGATION

Stakeholder engagement in the *Investigation* found that there are different perspectives as to the exact definition and meaning of system strength, with this changing over time as new power system phenomena are observed and discovered over time.

The final report set out an evolved understanding of system strength that incorporated the core physical phenomena and most material power system issues, setting out that system strength is fundamentally related to the stability of the power system voltage waveform. There are three key concepts relevant to the overall stability of the voltage waveform:

1. **Voltage waveform provision:** This is the *supply* of a 'strong' voltage waveform into the power system. It can be described as the 'source' of system strength and historically has been provided by synchronous machines (like coal, hydro and gas generators, or synchronous condensers). In future, it may be provided by new technologies. This is effectively the 'backbone reference signal' on which the system voltage is based.
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. This stabilisation occurs through the actions of both network equipment and connected generating plant. Of particular importance as the power system transitions is that we make sure the control systems of IBR plant are effectively tuned. This means their interactions with other inverters and the rest of the power system are stable, and effectively contribute to the damping of any instabilities. However, low levels of system strength can make it harder to manage these inverter control system interactions, which can result in an unstable system.

3. Network stability management: Network plant and generators include equipment that is designed to protect the individual plant from disturbances on the system, such as mechanisms for clearing faults on a transmission line. These protection systems, which are critical to the safe operation of the power system, 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.

This definition of a system strength service also recognises that while it is a core part of maintaining general system stability and operability, system strength is just one part of that overall picture. This is important, as it acknowledges that other services, or solutions, may be needed in addition to system strength services, in order to maintain general stability and operability.

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

2.3.1

Interactions between system strength and power system stability

The above definition of a system strength service also recognises that while it is a core part of maintaining general system stability and operability, system strength is just one part of that overall picture. This is important, as it acknowledges that other services, or solutions, may be needed in addition to system strength services, in order to maintain general stability and operability of the power system.

The Commission considers system strength and power system stability as separate but overlapping concepts:

- System strength is an essential system service for the stability of the power system's voltage waveform, to ensure the correct operation protection systems and stable operation of inverter-based resources
- Power system stability is a description of the state of the power system due to numerous factors being within the parameters for the system operating in a secure and stable manner.

The provision of system strength services can assist in the overall stability of the power system. For example, the dispatch of a synchronous generator that is procured by the TNSP to provide a system strength service, is also likely to support the general operability and stability of the power system. Similarly, operation of a network asset designed to provide system strength, such as a synchronous condenser, will also support general power system stability.

However, as identified above, this contribution to general power system stability is not the purpose, or objective function, of the evolved system strength framework. This means that while over time, the provision of system strength services is likely to support improvements in general power system stability, other complementary services and mechanisms may be

needed to ensure that the general stability of the power system is maintained, such as those described below.

2.4 Interactions with other work underway

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.

2.4.1 **Post 2025 market design project — providing the long-term future vision of the NEM**

The ESB has been tasked by the Energy Ministers Meeting (formerly Council of Australian Governments Energy Council or COAG EC) to advise on a long-term, fit for purpose market framework to support reliability, modifying the NEM as necessary to meet the needs of future diverse sources of non-dispatchable generation and flexible resources, including demand side response, storage and distributed energy resource participation. The essential system services and scheduling and ahead mechanisms workstream is a key part of the ESB's Post 2025 work. System strength is one of the four key services that the ESB is considering through this work and the development of evolved system strength arrangements are an immediate priority area for reform.

Therefore, this rule change provides us with an opportunity to complement the thinking and assessment done in the ESB work program, as well as technical input from AEMO through its Renewable Integration Study.

This draft rule to evolve the system strength frameworks is consistent with the preferred framework developed for procurement of system services as set out in the essential system services market design initiative in the ESB's Post 2025 work, and has taken into account feedback provided through the ESB process.

2.4.2 **Interaction between structured procurement in investment timeframes and flexibility in operational timeframes**

This rule change is also inter-related and being coordinated with one other key workstream from the ESB's essential system services work program, which is related to the consideration of a unit commitment scheduler (UCS) and system security mechanism (SSM). The consideration of these two elements is being progressed through the Commission's consideration of two rule changes:

- *Capacity commitment mechanism for system security and reliability services* Delta rule.¹⁹
- *Synchronous services market* rule change request from Hydro Tasmania.²⁰

Bearing in mind these mechanisms are still being developed, the below sets out a high-level overview of these concepts and how they relate to this draft determination. The ESB and Commission will continue to advance and progress consideration of these matters, including the interactions with this rule change, with stakeholders over the coming months. Stakeholder comments and views on the interactions are welcome.

¹⁹ See: <https://www.aemc.gov.au/rule-changes/capacity-commitment-mechanism-system-security-and-reliability-services>.

²⁰ See: <https://www.aemc.gov.au/rule-changes/synchronous-services-markets>.

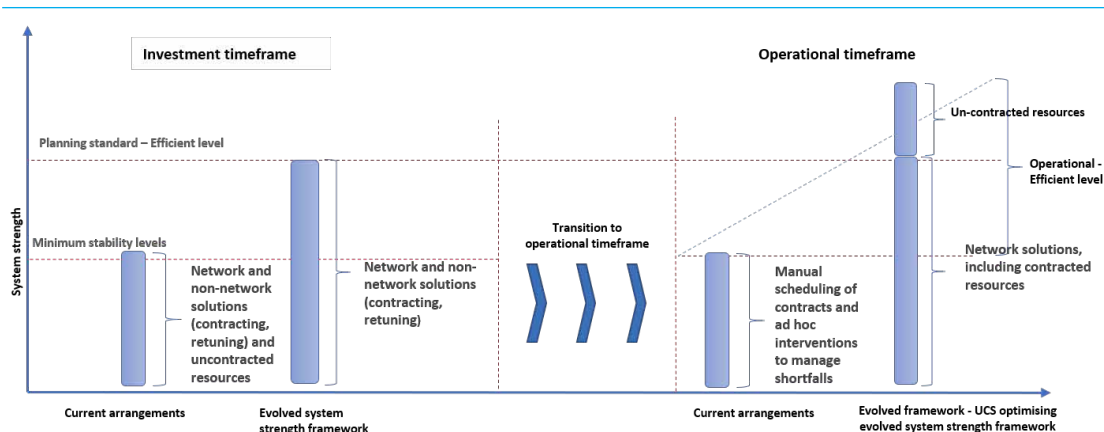
Interactions with the UCS and SSM

The UCS is a proposed mechanism that allows AEMO to commit additional resources to address shortfall of system security and reliability requirements at operational timeframes. This would effectively schedule system service contracts and optimise them with available energy offers.

Any system strength contracts procured by the TNSP under the evolved framework described in this determination, as a non-network solution to meet its system strength obligations, could therefore be scheduled by the UCS (if implemented). It may also be possible to procure and schedules other contracts in the operational timeframe, as discussed in more detail below.

A preliminary, indicative indication of how structured procurement of system strength could map from investment to operational timeframes is set out below.

Figure 2.1: Structured procurement of system strength – indicative process from investment to operational timeframe



Source: AEMC

Note: For illustrative purposes only.

In the above figure, in the investment timeframe:

- Under the current arrangements for system strength, minimum levels of fault level (system strength) required for security are maintained by contributions from a combination of network and non-network solutions (contracting, retuning) and uncontracted resources.
- Under the evolved framework for system strength implemented through this draft rule, TNSPs would have to meet the new system strength planning standard by deploying either network or non-network solutions. This would involve procuring system strength above the minimum level required, up to the 'efficient' level of the service needed to provide a stable voltage waveform, to support the stable operation of connected IBR plant.

In the operational timeframe,

- Under the current arrangements, minimum fault levels (system strength) required for security are maintained by AEMO (in consultation with the relevant TNSP) manually organising contributions from contracted generators to manage a declared shortfall, or using ad hoc interventions to manage real time gaps in the provision of system strength, and to maintain the general stability and operability of the power system.
- Mechanisms for the operationalisation of any system strength contracts struck through the evolved system strength framework are still being developed through the processes described above of the two rule changes. This is described further in Appendix B.6.4 and B.6.5. These interactions will be considered further over the coming months.

The specific design of such an SSM is still being progressed by the ESB, the current proposal is that the SSM would be a structured procurement mechanism used in the operational timeframe to procure services that are not provided through a spot market e.g. inertia, system strength. These interactions will be considered further over the coming months as described above.

2.4.3

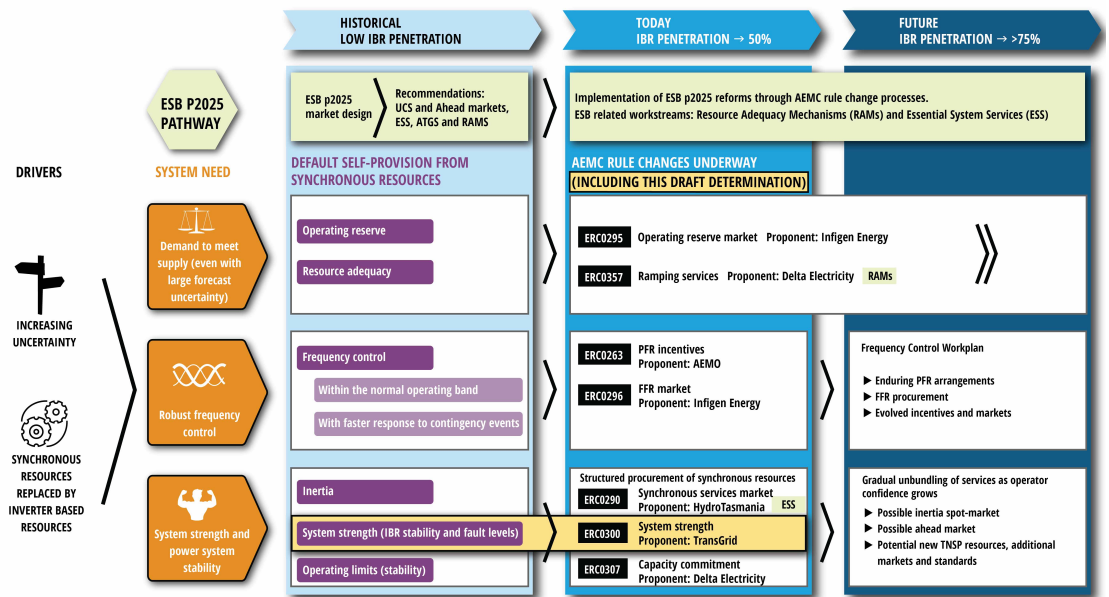
AEMC work program on system security — Seven system services rule changes progressing the ESB Post 2025 work

The AEMC is currently considering seven rule change requests related to system services, of which this rule change request from TransGrid is one. Collectively, the AEMC refers to these rule requests as the “system services” rule change requests. These rule changes relate to the four workstreams that the ESB is progressing:

- Frequency response:
 - [Fast frequency response market ancillary service](#) (Infigen Energy)
 - [Primary frequency response incentive arrangements](#) (AEMO)
- Operating reserves:
 - [Operating reserve market](#) (Infigen Energy)
 - [Introduction of ramping services](#) (Delta Electricity)
- System strength — the subject of this draft rule determination
- Synchronous services:
 - [Capacity commitment mechanism for system security and reliability services](#) (Delta Electricity)
 - [Synchronous services markets](#) (Hydro Tasmania).

These rule change requests are not only closely related to the issues being explored by the ESB in its ongoing Post 2025 market design work as described above, but also closely related to each other. This is set out further below.

Figure 2.2: Interaction of AEMC security rule changes and ESB work program



Source: AEMC

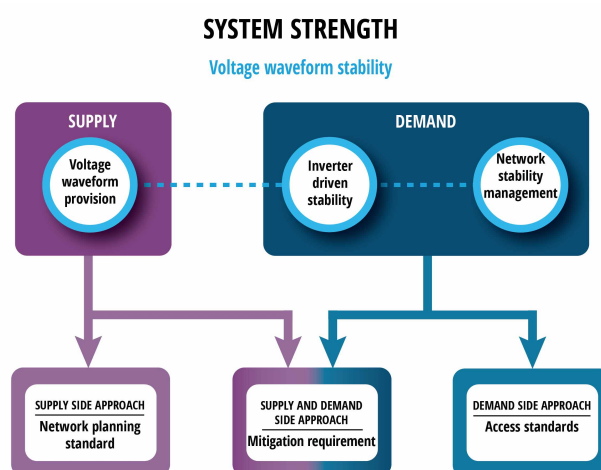
We are considering the interactions between issues raised in the different rule changes so that any new frameworks developed in response to the rule change requests will be focused on delivering the most efficient outcomes for consumers, as well as that the various rules complement each other to promote the long-term interests of consumers, rather than being seen as substitutes.

This work is a continuation of the AEMC's years of work on system security. This includes the work the AEMC's *Investigation into system strength frameworks in the NEM* undertaken throughout 2020.

Investigation into system strength frameworks in the NEM

This report made a series of recommendations to evolve the existing system strength framework, which would help facilitate the power system transition in the long term interest of consumers. These recommendations have been progressed through this determination, with the appendices providing further detail on the recommendations.

Figure 2.3: Overview of the recommended evolved system strength framework



Source: AEMC

The three recommendations were:

1. **Supply side — establishing a new system strength planning standard:** The recommendations underpin a coordinated model for the delivery of system strength. TNSPs, working with AEMO, would face an obligation to proactively provide the volumes of system strength needed to maintain security, and to facilitate the effective connection and operation of expected volumes of new IBR generation. By drawing on the existing integrated planning frameworks and the established system engineering practice of meeting a defined system standard, this coordinated supply side model is designed to deliver efficient volumes of system strength, while managing costs by utilising the existing NEM economic regulatory frameworks.
2. **Demand side — two new generator performance standards:** The recommendation is to incorporate two new technical standards that would apply to all new generators connecting to the power system, such that they use efficient amounts of system strength. This would help to make the best use of this limited, common pool resource, which in turn helps keep costs low for consumers.
3. **Effective coordination between the supply and demand sides — the system strength mitigation requirement:** In order to make sure that the demand and supply side arrangements are working effectively with each other, the recommended system strength mitigation requirement shares the costs of providing system strength between customers and generators. Consumers would pay for system strength from the supply side, reflecting that they derive a benefit from its provision. Generators would also pay a contribution to these costs as they are causing some increased need for these services, which would then reduce the total amount that customers pay through their TUOS charges. This would result in the effective utilisation of the system strength that is supplied, as well as making sure it is balanced with levels that are demanded.

These recommendations were developed further in this rule change process and have evolved into the draft rule that is the subject of this draft rule determination.

2.4.4 AEMO's Engineering Study

AEMO is currently developing an Engineering Framework.²¹ The Engineering Framework is the next step in a multi-year plan to deliver an integrated roadmap for the NEM. It builds on the RIS Stage 1 which delivered the first step. The Engineering Framework seeks to go beyond the renewable 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.

A report on this was recently published.²² This technical input will be valuable input for both the ESB and our work.

In particular, in relation to system strength it sets out the work currently underway. This includes work that AEMO has been doing to develop standard operational processes, control room tools and operating training to intervene for system strength services under the current framework.

It also notes that there is ongoing work to improve inverter control systems across the NEM and the globe, including leveraging existing technology (such as synchronous devices) to solve system strength-related problems. AEMO considers that grid forming IBR capability is also showing promising potential to support operation of the power system at increasing penetrations of IBR and lower levels of synchronous machines, with a number of trials supported by ARENA aiming to support and test this new technology.

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

22 March 2021 NEM Engineering Framework report is available here: <https://aemo.com.au/-/media/files/initiatives/engineering-framework/2021/nem-engineering-framework-march-2021-report.pdf?la=en&hash=3B1283D31B542115CC56E0ECCDFB3D69>.

3 DRAFT RULE DETERMINATION

This Chapter discusses in:

- Section 3.1 the draft rule determination made by the Commission
- Section 3.2 the rule making test for changes to the NER, including:
 - contributing to achieving the national electricity objective (NEO)
 - the more preferable rule test
 - the Commission's consideration in deciding whether to make a uniform or differential rule in accordance with the Northern Territory legislation adopting the NEL²³
 - other requirements under the NEL
 - declared network functions
- Section 3.3 the assessment framework for considering the rule change request
- Section 3.4 the summary of reasons for making the rule, including the Commission's consideration of the more preferable draft rule against the national electricity objective.

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

3.1 Draft rule determination

The Commission's draft rule determination is to make a more preferable draft rule (draft rule). The draft rule is attached to this determination.

This section sets out an overview of the evolved system strength framework that would be put in place by this draft rule. In summary, it implements the following three broad components, which together should result in a more secure power system, facilitate easier and faster connections to the grid, and lower costs for consumers:

- **Supply side:** The rule introduces a new system strength standard for a subset of TNSPs, known as system strength service providers (SSS Providers).
- **Demand side:** It also introduces two new access standards for generators and one for market network service providers (MNSPs) and certain loads that connect under Chapter 5 of the NER.
- **Efficient coordination of supply and demand side:** The system strength mitigation requirement (SSMR) evolves and expands the current 'do no harm' arrangements.²⁴ This evolution acts as a coordination mechanism that charges these parties for their use of the centrally provided system strength.

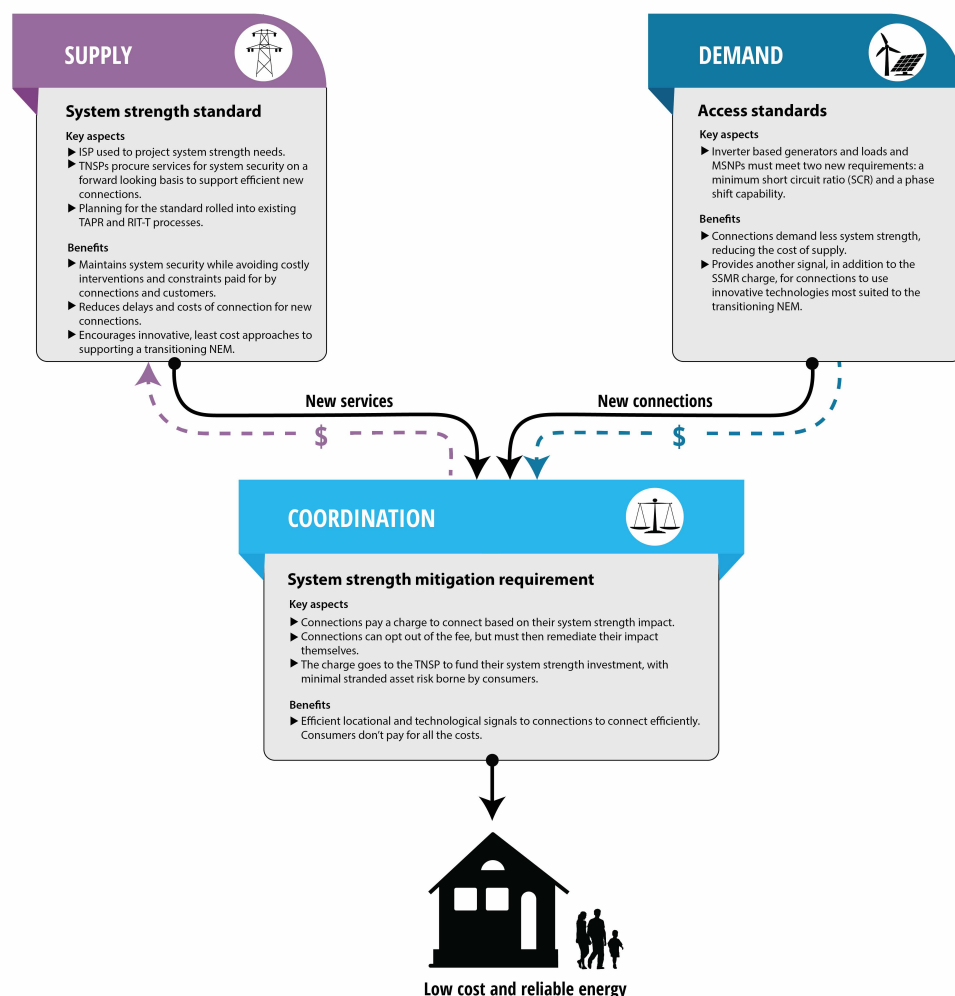
²³ National Electricity (Northern Territory) (National Uniform Legislation) Act 2015.

²⁴ Broadly, the 'do no harm' arrangements refer to obligations under Chapter 5 of the NER for network services providers to carry out a 'system strength impact assessment' for each proposed new connection and where that assessment indicates the connecting plant will have an 'adverse system strength impact', for the connecting party to remediate its impact either by implementing a 'system strength remediation scheme' or having the NSP carry out 'system strength connection works'. See clause 5.3.4B of the NER.

- Implementation:** The transitional arrangements for this draft rule require a sequence of events to occur for the evolved framework to be implemented as soon as possible so that the benefits of the evolved framework can be realised. This involves sequencing of three general areas of the draft rule: supply side implementation, pricing and revenue arrangements, and demand side and SSMR implementation.

This evolved framework is set out in Figure 3.1 below.

Figure 3.1: Overview of the evolved framework proposed under the the draft rule



Source: AEMC

The Commission's reasons for making this draft determination are set out in section 3.4. Further details of the more preferable draft rule, and the Commission's reasons for making it, are provided in Appendices B to E of this draft rule determination. The following outlines the three components of the rule in more detail.

3.1.1 Supply side — Establishing a new system strength standard

The draft 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 as forecast by AEMO. That is, to:

- maintain the minimum three phase fault level — representing the minimum level of system strength required for system security, and
- to achieve stable voltage waveforms to support the stable operation of IBR and market network service facilities — representing the efficient level of the service i.e. that which maximises the net benefits to consumers, inclusive of the costs, of system strength in the system.²⁵

As the needs of the power system are changing rapidly due to the transition that is underway, the standard relies on AEMO forecasting the system strength requirements, which include the system strength standard specifications.²⁶ These specifications are:

- the location where the standard will apply — the system strength nodes
- the forecast amount of the:
 - minimum fault level required to be provided by the SSS Provider for security — which relates to the first part of the standard.
 - the level and type of inverter based resources and market network service facilities — which relates to the second part of the standard where the SSS Provider is required to be able to achieve a stable voltage waveform while these forecast IBR plant are operating.

These specifications change the magnitude of the new standard, but not its intention which is set out in the NER. These specifications are determined by AEMO each year in its system strength report²⁷ using its system strength requirements methodology.²⁸

The SSS Providers require time to be able to plan and design their networks, especially so that they can do so maximising the net market benefits as determined through the regulatory investment test for transmission (RIT-T) process. Therefore, AEMO's forecast of the standard's specifications would be binding three years in advance. That is, the SSS Provider would be required to plan and design its network to meet the standard according to the specifications set by AEMO three years in advance of the date of delivery. This means that if AEMO's forecasts change between three years ahead and the actual year, the SSS Provider would only be obligated to meet the standard as per the specifications as published by AEMO in the system strength report three years prior.

²⁵ Clause S5.1.14(b) of the Draft Rule.

²⁶ Clause 5.20C.1 of the Draft Rule.

²⁷ This report must be published in accordance of Clause 5.20.7 of the Draft Rule.

²⁸ This methodology must be created and maintained in accordance of Clause 5.20.6 of the Draft Rule.

AEMO would still be able to provide updated forecasts as well as the required minimum three phase fault level due to a material change to the power system which will affect these requirements. However, these changes would not affect the obligation placed on a SSS provider under the new standard. It would allow AEMO to make the necessary changes in real time to ensure the power system is secure.²⁹

This component of the draft rule builds on the proposal in the rule change request, but changes it to enhance its application for example, the component has system strength standard being determined by AEMO, rather than the Reliability Panel, to better leverage off existing processes. Further detail on this aspect of the draft rule, including stakeholder views on these issues and the Commission's analysis is set out in Appendix B.

3.1.2 Demand side — new access standards

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

1. A minimum access standard that applies to all new inverter based resources (i.e. those resources that 'demand' system strength), which would require the plant to have capability to meet its performance standards at a short circuit ratio of 3.0. This would apply to new connecting asynchronous generators,³⁰ inverter based loads,³¹ and MNSPs³² with the purpose of these access standards to manage the system strength requirements of grid following plant 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.
2. An access standard that applies only to asynchronous generators and is a minimum access standard 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. There is no corresponding automatic access standard reflecting that this is a safety net standard providing clarity to what is expected of a generator. An automatic standard would introduce unnecessary complexity and administration from what the standard is trying to achieve.

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 draft rule, including stakeholder views on these issues and the Commission's analysis is set out in Appendix C.

²⁹ AEMO faces obligations to ensure the minimum three phase fault level for system security is maintained in operational timeframes under clauses 4.2.6(g), 4.4.5(a) and 4.6.1(b) of the NER, which have been amended under the draft rule to reflect the change from fault level nodes to system strength nodes.

³⁰ Clause S5.2.5.15 of the Draft Rule.

³¹ Clause S5.3.11 of the Draft Rule. See the new definition of 'inverter based load' introduced by the Draft Rule in Chapter 10.

³² Clause S5.3a.7 of the Draft Rule.

3.1.3 **Efficient coordination of supply and demand side: The System strength mitigation requirement**

The draft 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 would allow a new connecting generator, inverter based load or MNSP to choose between:

- Paying the system strength charge, which is an amount that reflects an estimate of the forward-looking cost the connecting party imposes on a system strength service provider (SSS Providers) in meeting the system strength standard as a consequence of the connection (and not undertake any remediation); or
- Remediating its general system strength impact in a similar way to the existing framework, such that the relevant NSP undertakes a full impact assessment and the connecting party either implements a system strength remediation scheme or has the NSP carry out system strength connection works in order to remediate its general impact on system strength.³³

If they elect to pay the charge, connecting parties may reduce this charge after its connection by altering its plant to consume less system strength service using the amended clause 5.3.9 or new 5.3.12 process proposed under the draft rule. This is seen as a key benefit to the coordination at the supply and demand side as it incentivises efficient use of the service for the lifetime of the connection.

This component of the draft 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.³⁴

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

3.1.4 **Transitional arrangements — Implementation of the evolved framework**

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 as described in Appendices B, C and D. Evolving the framework as quickly as possible would promote the long term interest of consumers. However, the proposed draft rule requires an inter-related sequence of events to occur for proper implementation.

As such, the Commission considers the draft rule strikes a balance between the time needed for parties to prepare to meet their obligations under the evolved framework with the need to enable 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

³³ 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.

³⁴ TransGrid, *Efficient management of the power system*, rule change request, p. 11, April 2020.

implementation, pricing and revenue arrangements, and demand side and SSMR implementation. These are summarised below.

Supply side implementation – new system strength planning commence on 30 September 2022

Materials required for the standard to begin, namely AEMO's update to the System strength requirements methodology and publication of the first system strength report under the evolved framework are due to be completed by 30 September 2022. 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 30 September 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, a three-year period is required from AEMO's first System strength report for SSS Providers to be able to take into account the forecast standard specifications for 2025. As a result, the shortfall mechanism of the existing arrangements is maintained in the Rules until 30 September 2025. This would allow AEMO to declare system strength shortfalls that SSS Providers must procure services to meet the gap which occur up until that time that the new standard can be relied upon to deliver these services.

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 draft rule until its 2023 TAPR. Similarly, DNSPs and TNSPs would not be required to report on locational factors until their 2023 TAPRs and DAPRs.

Pricing and revenue arrangements for NSPs prior to next regulatory determination

This draft rule includes transitional arrangements for NSPs' pricing and revenue arrangements in relation to the evolved framework due to the staggered nature of NSP regulatory control periods³⁵ as well as the desire to not wait until the next regulatory determination to implement the rule. As such, the follow transitional provisions are required in relation to NSP pricing and revenue arrangements.

The revenue arrangements for TNSPs who are SSS Providers³⁶ rely on existing provisions in the NER for these parties to be able to recover the money spent to meet the new system strength standard ahead of their next regulatory determinations. TNSPs may be able to add the cost of meeting the new standard into an ongoing regulatory determination process, or a contingent project. In the situation where this has not been possible, the Commission views the regulatory change event cost pass through process in the rule to be sufficient and fit-for-purpose.

35 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>.

36 The TNSPs that are SSS Providers are TasNetworks, TransGrid, Powerlink, AusNet, AEMO and ElectraNet. These are the 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 (Clause 5.20.3(a)).

Additionally, SSS Providers would need to update their pricing methodology to implement the system strength charge, including the cost recovered from that charge to offset consumer network charges. This involves the AER updating its transmission pricing methodology guidelines by 31 August 2022. Subsequently, SSS Providers would have to update their methodology by 30 November 2022 with the AER making a decision on its suitability by 31 January 2023. This would then all allow for the publication of the system strength unit price for the first time on 15 March 2023.

TNSPs who are not SSS Providers³⁷ would also need to update their pricing methodology to comply with the changes made under the draft rule.

No explicit transitional arrangements are required for DNSPs to comply with the changes made under the draft rule. These parties will be required to include the system strength charge as a pass through as part of its 2023 prices through the usual processes set out in the NER.

Demand side and system strength mitigation requirement implementation

The Commission proposes that the access standards and SSMR commence on 15 March 2023. By this date, all guideline updates would have occurred to allow a connection to negotiate its new access standards as well as the information required for a connecting party to make a fully informed decision regarding how it will undergo the SSMR. This includes:

- AEMO's update to the system strength impact assessment guidelines, which includes:
 - A methodology for the relevant NSP to calculate the:
 - system strength quantity and system strength locational factor for the SSMR.
 - 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).
- Publication of the system strength unit price as part of their prices for the first time on 15 March 2023.

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

Which connections will fall under the new obligation proposed under the draft rule?

The Commission proposes that on this date that the SSMR and new access standards commence, applicants who:

³⁷ TNSPs who are not SSS providers include Ausgrid, Directlink and Murraylink, although the Commission does not consider that any other than Ausgrid will have system strength connection points and therefore need to update its pricing methodology.

- Are yet to submit a connection application would come under the new SSMR and access standard arrangements.
- Have submitted a connection application would come under the old/existing ('do no harm' and no access standard) arrangements by default, but would have the option of being able to request to come under the new framework.

3.2 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 national electricity objective (NEO).³⁸ This is the decision making framework that the Commission must apply.

The NEO is³⁹:

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".⁴⁰

3.2.1 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.

In this instance, the Commission has made a more preferable rule. The reasons are summarised below in section 3.4.

3.2.2 Making 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 draft rule against additional elements required by the Northern

³⁸ Section 88 of the NEL.

³⁹ Section 7 of thence.

⁴⁰ TransGrid, *Efficient management of system strength on the power system rule change request*, p. 21.

Territory legislation.⁴¹ The Commission has determined not to make a differential rule. However, as chapters of the NER apply in the Northern Territory, the amendments made by this rule change will have some application in the Northern Territory. The Northern Territory modification regulations modify the application of these chapters in the Northern Territory, and therefore, further changes may be required to those regulations as a result of this rule change. The Commission will engage with the Northern Territory government in this regard.

3.2.3 Other requirements under the NEL

In making this draft 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'.⁴² 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 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, i.e. items 15 to 24 of Schedule 1 to the NEL. In general, the Commission has sought in the development of the draft rule to meet the revenue and pricing principles by applying the existing economic regulatory framework to the greatest extent possible. This framework is designed to be consistent with these principles. The Commission's full consideration of the revenue and pricing principles is set out in Appendix A.2.2.

3.2.4 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.⁴³

The more preferable draft rule is compatible with AEMO's declared network functions because it is consistent with those functions. The draft rule is capable of working in harmony with AEMO's performance of those functions. While the draft 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.

⁴¹ 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.

⁴² The form of regulation factors are set out in section 2F of the NEL.

⁴³ Section 91(8) of the NEL.

3.3 Assessment framework

In assessing the rule change request against the NEO the Commission has considered the following principles, which were set out in the consultation paper for the initiation of this rule change request:⁴⁴

- **Promoting power system security:**⁴⁵ Having regard to the potential benefits associated with improvements to system security brought about by the proposed rule changes, weighed against the likely 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.
- **Transparent, predictable and simple:** 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.

3.4 Summary of reasons

The Commission considers that, having regard to the issues raised in the rule change request, that the more preferable draft rule will, or is likely to, better contribute to the achievement of the NEO than the current arrangements, the proposed rule or alternatives suggested by the proponent and stakeholders in that it would:

- **Reduce the cost, time and risk for parties to connect** to the network because parties connecting in areas where the TNSP is providing system strength would have greater confidence in the costs they will bear, and would have reduced administrative costs associated with the connection process. This is achieved through a:
 - coordinated and centralised approach to the provision of system strength under the new system standard and transmission network standard for system strength that the TNSP must meet, as well as their other obligations and

⁴⁴ 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. These included considering the capability of different services to be supplied from various levels of the system, from DER to transmission scale (ARENA, p. 3), considerations of liquidity of markets, proportionality of implementation costs to benefits and post-implementation reviews (Energy Australia, p. 6), practicality of implementation (Energy Networks Australia, p. 17) and minimisation of costs to consumers (Brickworks, p. 4, Energy Queensland, p. 7). 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.

⁴⁵ System security underpins the operation of the energy market and the supply of electricity to consumers.

- predictable and transparent charging regime for connecting parties to use that service under the system strength mitigation requirement.
- **Harness economies of scale** through the aforementioned coordinated and centralised approach to the provision of system strength by the TNSP with their other obligations.
- **Reduce the costs associated with the inefficient under-provision of system strength** by requiring TNSPs to provide the service as a prescribed service.
- **Incentivise the efficient use of system strength** provided by the TNSP via the system strength mitigation requirement — that allows the *choice* to remediate a connection's general system strength impact or pay a charge for using the centrally provided system strength — as well as through two new access standards which act as a floor to ensure a minimum level of performance into the future to deliver efficient outcomes.
- **Harness economies of scope** in the provision of system strength by the TNSP and some of the other system services provided by the TNSP.

Each of these is discussed in turn below.

3.4.1 Improved connection process

Issues with existing arrangements

The current 'do no harm' provisions require connecting generators to address their adverse system strength impact on the power system by implementing a system strength remediation scheme or system strength connection works.⁴⁶

The Commission has observed that in practice the implementation of these schemes has tended to be poorly coordinated, with both:

- One another — individual generators tend to remediate their own individual impacts on system strength through piecemeal investments⁴⁷
- TNSP's own actions to meet their system strength requirements of meeting any shortfalls declared by AEMO.

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.⁴⁸

⁴⁶ Clause 5.3.4B of the NER.

⁴⁷ Submissions to the *Investigation into system strength frameworks* Discussion paper: Innogy, p. 2, ElectraNet, p. 3, AGL p. 1, Enel Green Power, p. 2, CEC, p. 5.

⁴⁸ Submissions to the *Investigation into system strength frameworks* Discussion paper: Innogy, pg. 2, ElectraNet, pg. 6, AGL pg. 1, Enel Green Power, pg. 3, CEC, pp. 3-4, CEIG pg. 2, Infigen, pg. 1.

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 also means 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 needed models 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.

How the draft rule addresses these issues

Under the draft rule, the central provision of system strength by TNSPs at system strength nodes through the establishment of a new system strength standard,⁴⁹ and coordination of the use of this system strength service through the use of a charge via the system strength mitigation requirement,⁵⁰ has been designed to address these issues with the connection process.

Under the draft rule, the price of the system strength service paid by connecting parties would be relatively stable over time at any given location, and unaffected over short time frames by the connection of other parties. This means that connecting parties connecting in a part of the network where system strength is being provided by the TNSP would 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.

Under the draft rule, the system strength charge would apply typically for the system strength charging period (typically five years),⁵¹ and during this period, the system strength unit price and the locational factor cannot change.⁵² 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.

49 Schedule 5.1a.9 and Schedule 5.1.14 of the Draft Rule.

50 Clause 5.3.4B of the Draft Rule.

51 Based on the current duration of transmission regulatory control periods, this will be a five-year period. The 5-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 Draft 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 would be based on estimated costs.

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

The evolved framework set out in the draft rule 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 system strength mitigation requirement.

The burden on connecting parties to model their system strength impact, and various remediation options, would also be reduced because a connecting party could 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 would be carried out using simple, isolated modelling — being a single machine infinite bus model. Should a connecting party elect to remediate its actions (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 timely full impact assessment process — as per the current arrangements — is required to determine the remediation requirement. In this case, the connecting party has elected 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 and reduce uncertainty associated with the costs and risks of connection to the power system for connecting parties.

Each NSP would also be required to publish the locational factors for each system strength connection point for which it is the relevant NSP, and the corresponding system strength node. This would 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.⁵³

Under the draft rule, any connecting party could choose to remediate their own system strength requirements in order to avoid the system strength mitigation requirement, 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 would likely face a very high system strength remediation charge for the use of the system strength service provided by the system strength service provider (see section 3.4.4 below and Appendix D for details about the design of the charge).

This approach would 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 cost of the system strength service provider. This is in recognition that the circumstances of connections can greatly vary as well as to maintain discipline on system strength providers to keep pace with the expected innovation in the provision of system strength to drive down costs.

⁵³ Clause 5.12.2(c)(13) and Schedule 5.8(o) of the Draft Rule.

The requirement would 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.⁵⁴

3.4.2

Coordinated, scale-efficient provision of system strength as a prescribed service by TNSPs

Issues with existing arrangements

In addition to the impacts on the connection approach, the piecemeal approach described above also appears to have delivered additional inefficient outcomes because scale efficiencies in the provision of system strength have not been realised.

The combined cost of multiple generators individually remediating their own impacts on system strength, plus the actions of TNSPs' addressing any shortfalls, appears likely to be higher than the efficient cost which would be realised through a smaller number of appropriately scaled investments.

How the draft rule addresses these issues

Economies of scale realised through central provision of system strength

The draft rule promotes scale-efficient approaches given that TNSPs have to provide system strength to meet a new system standard and transmission network standard, lowering the cost to provide system strength by centrally coordinating the provision of system strength at certain locations. TNSPs would be required to plan, design, operate and maintain its transmission network in order to meet network performance requirements at the locations on its network that AEMO has declared to be system strength nodes.⁵⁵

TNSP as the party to centrally provide system strength

The Commission 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.⁵⁶

On balance, the Commission's preference as reflected in the draft rule is for SSS Providers (TNSPs) to be responsible for delivering against the standard in the planning timeframe given the other obligations that TNSP's face and that solutions to system strength, may also help meet these other obligations. Such an arrangement is also consistent with the existing framework as, outside of Victoria, it utilises the financial incentives placed on SSS Providers through the economic regulation framework to efficiently meet the standard. In turn, the benefits of this efficiency flows to consumers.

The approach leverages off the SSS Providers' existing skills and experience in the delivery of the minimum system strength requirements, and the SSS Providers' knowledge of its own

54 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.

55 Schedule 5.1a.9 and Schedule 5.1.14 of the Draft Rule.

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

network, addressing the engineering complexities of delivering system strength services across a network (discussed in section 3.4.5, below), allowing central coordination as well as the benefits that this provides from having one party plan the network.

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 would run competitive tenders when a solution (or portfolio of solutions) is identified.⁵⁷ 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 would still eventuate in Victoria.

Further, by remaining consistent and leveraging off the existing approach for transmission planning and economic regulation both within and outside of Victoria, the Commission expects that the framework should be faster to implement.

There would 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 draft 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.⁵⁸

System strength as a prescribed service

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.⁵⁹

In the case of system strength, solution therefore lies in the coordinated, mandatory and forward looking provision of the service by one party — something more suited to a prescribed transmission service.

In making this decision, the Commission has considered the TransGrid proposal that AEMO should have a reserve obligation to declare a system strength shortfall as a Network Support and Control Ancillary Service (NSCAS) gap.⁶⁰ The Commission views the decision to exclude system strength from the NSCAS framework remains appropriate and should be maintained for this draft 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 this framework is looking to provide timely procurement of system strength solutions to facilitate the transition of the power system.

⁵⁷ How the new standard applies to AEMO's declared network functions in Victoria is expanded in Appendix A.

⁵⁸ Clause 5.14.3(b) and 5.14.4(d) of the Draft Rule. The Commission considered Clause 5.14.1 already sufficiently covers DNSP and TNSP joint planning adequately without the need to add an explicit clause regarding system strength.

⁵⁹ There are a range of reasons that lead you to include which of these could be appropriate, as discussed in Appendix A.2.1 in the form of regulation factors.

⁶⁰ TransGrid, *Efficient management of system strength on the power system* — rule change request, April 2020.

Therefore, the draft rule defines the provision of system strength by the TNSPs who are system strength service providers (SSS Providers) to meet the standard in clause S5.1.14 as a system strength transmission service.⁶¹ This service is part of prescribed TUOS services,⁶² and therefore, the costs of providing that service are allocated to the annual service revenue requirement for prescribed TUOS services and recovered from prescribed TUOS service charges.⁶³ By making the service a prescribed transmission service, the TNSPs are therefore 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.

3.4.3

Reduced costs and risks associated with under-provision of system strength

Issues with existing arrangements

The Commission is also concerned that the existing *minimum* system strength framework, in conjunction with the 'do no harm' arrangements', is resulting in system strength levels that are lower than the efficient level, when considering total system costs. That is, levels of system strength provided under the current arrangements appear to be:

- resulting in higher than efficient dispatch costs, as IBR plant may be constrained in their dispatch by system strength limits
- further delaying the connection process, as prospective generators consider whether investments are appropriate given the level of system strength constraints.

Over time, it is possible that a workably competitive market could emerge to efficiently deliver solutions which are both scale efficient and deliver the efficient level of system strength, as an alternative to regulating the provision of the service by the TNSP. However, it has been three years since the current system strength frameworks were introduced, and there has been limited evidence of a suitable market based solution emerging for the provision of this system strength. Further investigation is needed on potential future technical solutions to provide system strength.

The Commission is concerned that continuing to wait for such a solution to emerge risks a substantial further increase in the costs and inefficiencies in the connection of new assets and operation of exiting assets, as identified above. Given expectations of future investments in IBR technologies, there is a significant risk that issues relating to the current arrangements become more material. The Commission's analysis of such risk asymmetry of total costs between under and over procurement of the service, using a simplified model, was provided in the *Investigation* final report. A summary of this analysis that the Commission accounted for when making this decision is set out in the Box below.

61 See the new definition of 'system strength transmission service' in the Draft Rule.

62 See the amended definition of 'prescribed TUOS services' in the Draft Rule.

63 See clauses 6A.22.2, 6A.23.2(e), 6A.23.3(e)(7), 6A.23.3A and 6A.23.4(a)(6) of the Draft Rule.

BOX 3: 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 likely 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 some 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.

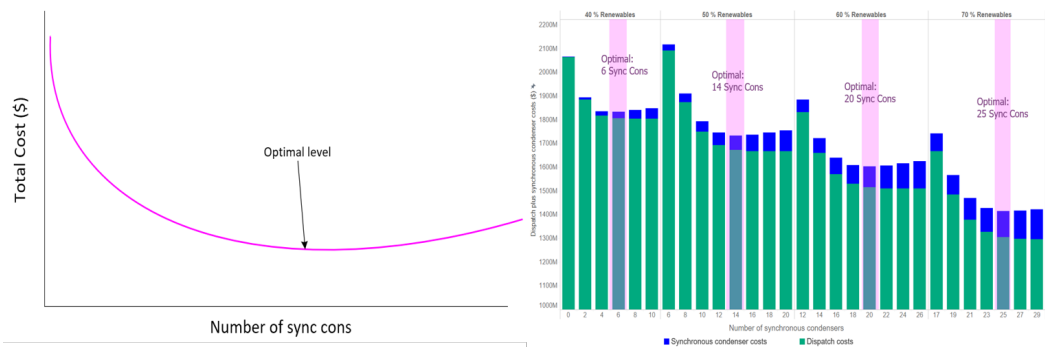
There are two key observations from the modelling.

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 we increase the number of synchronous condensers, 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 we combine the cost curves for dispatch costs and synchronous condenser costs, it yields the total cost curve shown in Figure 1.1. We can see that the total cost curve falls sharply as we approach the optimal level – ie, the point on the curve where total costs are minimised – and then slowly start to rise again.

Figure 3.2: 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 more beneficial 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.

How the draft rule addresses these issues

The Commission considers that the approach taken under the draft rule promotes the NEO, by requiring the provision of system strength on a forward looking basis as a prescribed service by TNSPs. The TNSP would be required to use reasonable endeavours to maintain the minimum three phase fault level and to achieve stable voltage waveform for the level and type of inverter based resources projected by AEMO in steady state conditions and following credible contingency events.⁶⁴ 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).

To maintain a secure and stable power system, a number of core power system requirements need to always be met, through the provision of certain technical capabilities, which can be described as essential "system services". One of these services is system strength, which is critical to maintaining overall power system security. The availability this 'service' allows the system to operate effectively; any shortfall in its provision will change the way that the system is operated, to ensure that it remains secure.

⁶⁴ Clause S5.1.14(b) of the Draft Rule.

The rapidly changing mix of resources on the grid is impacting the availability of the resources that have traditionally provided the essential system strength service. The current arrangements deliver this service through, among other things, a combination of mandatory requirements on generators (the 'do no harm' framework) to remediate their use of system strength, as well as a requirement for TNSPs to deliver 'minimum' levels of system strength. This rule change request concerns the appropriateness of the existing framework in the delivery of the essential system strength service.

In consideration of the assessment principles discussed in section 3.3, the Commission recognises that the approach taken in this draft determination means that while new connecting plants that utilise the system strength service contribute to some costs of the provision of system strength by TNSPs, the approach allocates the stranded asset risk associated with the provision of system strength in large part to consumers, as opposed to connecting parties more generally. That is, 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, the costs associated with these investments will be recovered from consumers.

However, we consider that 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.

3.4.4 Efficient use of system strength

Issues with existing arrangements

A fundamental tenet of good market design is that where possible, connecting parties should bear the marginal costs associated with their investment and operational decisions. Where they bear the marginal cost of their actions, they can trade off the private benefit they derive from a particular course of action with the total, system wide cost of that action, and hence are incentivised to act where the overall marginal benefits exceed the overall marginal costs. That is, they are incentivised to act economically efficiently.

The current arrangements are inconsistent with the principle of pricing based on marginal costs in at least two respects. Firstly, some connecting IBR parties may not be required to remediate (because they are not judged to have caused an adverse impact on the minimum level of system strength) but will nevertheless impose marginal costs on the system (as they are 'using up' some of the available system strength) — including bringing forward the cost of future investments to provide system strength. Under the current arrangements they do not bear these costs.

Secondly, where TNSPs incur marginal costs in the delivery of minimum system strength, these marginal costs are not recovered from those that cause them to be incurred. That is, the marginal costs of providing minimum system strength is caused by the retirement or

reduced operation of existing synchronous plant, which may be different if they were paid for the service due to the additional revenue stream.

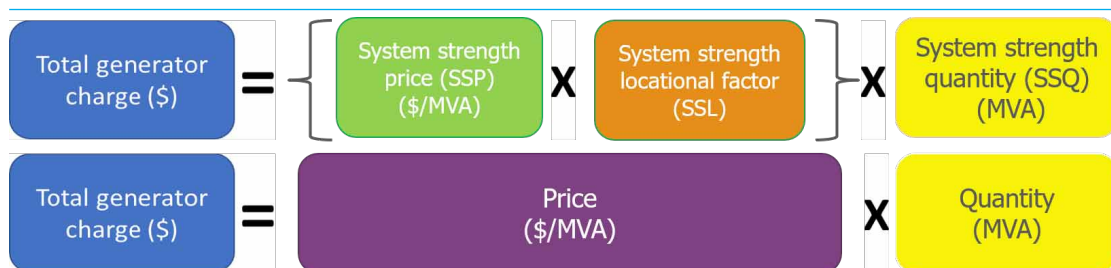
How the draft rule addresses these issues

Price of system strength service incentivises efficient use

Consistent with this principle, the draft rule charges for the use of the system strength service provided by the TNSP (acting in its capacity as a SSS Providers), via the system strength mitigation requirement, which sets a system strength charge for those who 'consume' system strength. This aims to align the privately profitable actions of parties connecting to the power system with those that are economically efficient.

Introducing the system strength standard under the draft rule without also introducing the system strength mitigation requirement would represent moving further away from the principle of marginal cost pricing. Instead of being required to remediate their impact on system strength, some connecting parties would instead utilise the system strength provided by the SSS Providers, with those costs being recovered from other parties (ie, end-consumers).

Figure 3.3: Components of the system strength charge



Source: AEMC

The system strength charge is set at a price per MVA. The price is based on an estimate of the forward-looking cost of the provision of the service at declared system strength nodes (the system strength unit price (SSUP) component),⁶⁵ adjusted by a locational factor (the system strength locational factor (SSL) component).⁶⁶ The quantity of system strength service used (system strength quantity (SSQ) measured in MVA), is a function of the particular technical characteristics of the equipment being connected, as determined by the relevant performance standards,⁶⁷ and may be zero if the participant does not use any system strength service (for example if it is a synchronous generator, or if it chooses to remediate its system strength impacts directly as opposed to using the service provided by the TNSP). These three components (the system strength unit price, locational factor and quantity) are multiplied together to derive a total dollar charge (SSC).⁶⁸ Therefore, the charge

⁶⁵ Clauses 6A.23.5(e) and 6A.25.2(h) of the Draft Rule.

⁶⁶ Clause 6A.23.5(h) of the Draft Rule.

⁶⁷ Clauses 6A.23.5(j), S5.2.5.15, S5.3.11 and S5.3a.7 of the Draft Rule.

is represented by the formula: $SSC = SSUP \times SSL \times SSQ$. The charge applies to the relevant participating connection point.⁶⁹

This charge creates incentives for connecting parties to make efficient locational decisions, and install equipment that helps to reduce overall system costs. By trading off the incremental costs in the provision of system strength by the TNSP, reflected in the system strength charge, with the costs and benefits of different locations and equipment, connecting parties are incentivised to make efficient investment decisions.

The AER will determine the methodology of how the TNSP incremental cost will be derived — that is, whether it is done 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. But rather than prescribe the marginal nature of the charge, we have provided this flexibility in the draft rule because in some circumstances the LRMC is equal to the LRAC, with the latter being easier to administer (and therefore more transparent and cheaper). These circumstances include the lumpy nature of investments and the shape of the demand curve. However, these circumstances are not expected to consistently occur across the NEM as well as into the future. 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.

The Commission is of the view that IBR type loads should be included under the SSMR when connecting under Chapter 5 of the NER and face the same incentives under the mechanism, as they create demand for system strength services in the same way that inverter based generators do. As such, these loads would face similar decisions regarding their use of system strength as generators would 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 given it means that whatever resources 'demand' system strength are incentivised in the same way. It is also consistent with the direction of the ESB's demand side participation workstream of the Post 2025 market design project for a two-sided market and a trader-services model. The trader services model also takes steps towards the Rules being more focused on services as opposed to being based on assets, such as providing for greater regulatory flexibility supporting innovation by attaching obligations to services at connection points as opposed to attaching them to registration categories and assets. As such, loads that require system strength to connect to the system should be treated equally to those

⁶⁸ Clause 6A.23.5(e) of the Draft Rule.

⁶⁹ See the new definition of 'system strength connection point' in the Draft Rule.

generators and MNSPs that need the service. This is done through the inclusion of a new access standard that applies to inverter based loads⁷⁰ that consume system strength.⁷¹

Access standards acts as backup to price signals

While plant that demands system strength would face a charge reflective an estimate of the marginal cost in the provision of system strength by the TNSP, the Commission considers it important to additionally place a minimum requirement on the technical standards of connecting equipment. The draft rule achieves this by creating a new short circuit ratio (SCR) access standard as part of the technical requirements for connecting loads, MNSPs and generators;⁷² as well as an additional access standard related to protection systems tripping due to voltage phase shifts that applies only to generators.⁷³

These access standards act as a safety net, in addition to the price signals being sent by the system strength mitigation requirement, to prevent poor quality equipment from using up the system strength unnecessarily.

The process for determining the price signals represent a trade-off between cost and complexity, and accuracy. Having 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.

Additionally, the Commission did not consider that entirely removing the 'do no harm' obligations and relying on existing generator access standards alone would provide a sufficient investment and locational signal, as proposed by TransGrid in the rule change request.⁷⁴ This is because the locational signals provided by the negotiation of generator performance standards is a complex process and is bilateral between the connection party and the relevant NSP.⁷⁵ Further, a specific charge delivers the most accurate reflect of actual costs resultant from the connection of new IBR and allows for these costs to offset the centrally coordinated provision of the service.

Therefore, the Commission has made a more preferable rule that evolves the 'do no harm' obligation into the system strength mitigation requirement. The new requirement sends 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.

The Commission has also proposed a voltage phase shift access standard as part o the evolved framework. This access standard was not originally proposed by TransGrid in its rule

70 See the new definition of 'inverter based resource' and 'inverter based load' in the Draft Rule.

71 Clauses 5.3.4B(a)(2) and S5.3.11 of the Draft Rule.

72 Clauses S5.2.5.15, S5.3.11 and S5.3a.7 of the Draft Rule.

73 Clauses S5.2.5.16 of the Draft Rule.

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

75 AEMO is also involved for those access standards that are AEMO advisory matters.

change request, but is expected to better contribute to meeting the security aspect of the NEO as it:

- provides clarity to the requirements of S5.2.5.5⁷⁶ as a similar requirement is likely to be required by a connecting generating system so that it is able to meet the requirements of that standard
- provides a minimum performance level of the future power system such that the system is resilient to any larger voltage phase angle shifts
- is consistent with international and Australian best practice regulation, as set out by the IEEE and Australian standards.

Charges will not apply retrospectively

The system strength charge and new technical access standards would only apply to new connecting plant.⁷⁷ The Commission considered that applying the new access standards to existing parties would require renegotiation of performance standards and therefore, re-opening 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 draft rule is not intended to alter the terms or contractual rights or obligations of the parties to existing connection agreements. Appendix E provides further detail on the transitional and implementation arrangements.

3.4.5

Coordination of system strength with other system services provided by the TNSP

Issues with existing arrangements

The current piecemeal approach to the provision of system strength described above may also create operational issues, resulting in inefficiencies and potentially system security risks.

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 the NSPs as well as AEMO. Aside from increasing the complexity of managing the power system faced by AEMO and NSPs, the proliferation of these uncoordinated individual schemes may itself be creating, rather than mitigating, system security risks.

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 through a single TNSP procurement may help unlock scope economies and drive beneficial outcomes for customers.

How the draft rule addresses these issues

⁷⁶ This requirement is for newly connecting generator systems to be able to maintain continuous uninterrupted operation in response to disturbances following contingency events. As such, having a protection system trip for a voltage phase shift of less than 20 degrees may be implicitly covered in this access standard. However, having this explicitly set out in a separate standard provides clarity on what is expected.

⁷⁷ See the savings and transitional provisions of the Draft Rule.

The draft rule would promote greater efficiency of the power system's operation by centralising the delivery of these services through a single procurer and operator, being the TNSP who is the SSS Provider given their other obligations. This would improve economies of scope in the provision of system strength, noting that AEMO and the market as a whole is still learning how to operate the system through the use of services rather than using a known combination of assets.

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	electromagnetic 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

SSUP

TAPR

TNSP

TUOS

UCS

System strength service providers

System strength unit price

Transmission annual planning report

Transmission network service provider

Transmission use of services

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 draft rule determination, which includes:

- the Commission's power to make this more preferable draft rule determination
- the Commission's considerations in making this draft 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 Draft rule determination

In accordance with s. 99 of the NEL the Commission has made this draft rule determination in relation to the rule proposed by TransGrid.

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

A copy of the more preferable draft rule is attached to and published with this draft 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 draft rule. The Commission's reasons for making a more preferable rule are summarised in Chapter 3 and set out in further detail in appendices B to E.

A.1.2 Power to make the rule

The Commission is satisfied that the more preferable draft rule falls within the subject matter about which the Commission may make rules. The more preferable draft rule falls within s. 34(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 draft 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 round consultation
- consultation undertaken during the *Investigation* and the findings of the Final report
- stakeholder feedback received during nine 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 specifies an electricity network service as a prescribed network service⁷⁸
- the revenue and pricing principles.⁷⁹

There are no current Ministerial Council on Energy (MCE) statements of policy principles.⁸⁰

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.⁸¹ 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.⁸² In its draft rule, the Commission has provided for the new system strength transmission service to be a prescribed transmission service.⁸³

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

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

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

80 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.

81 Sections 88A of the National Electricity Law.

82 Section 2B of the National Electricity Law.

83 See amendment to paragraph (b) of the definition of 'prescribed transmission service' in the Draft 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	<p>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. These are discussed in Chapter 2. 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.</p>
(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	<p>There appears to be strong interdependencies between the provision of the system strength transmission service and other services also provided by the SSS Provider.</p> <p>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.</p> <p>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.</p> <p>SSS Providers are well-placed to capture these scope economies through their existing planning processes</p>

FACTOR	HOW AEMC HAS TAKEN INTO FACTOR ACCOUNT
	for meeting other system standards. These issues are discussed in Appendix B.
(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	<p>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.</p> <p>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 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.</p>
(e) the presence and extent of any substitute, and the elasticity of demand, in a market for an electricity network	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 transmission service

FACTOR	HOW AEMC HAS TAKEN INTO FACTOR ACCOUNT
<p>service in which a network service provider provides that service;</p>	<p>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.</p> <p>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.</p>
<p>(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)</p>	<p>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.</p>
<p>(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</p>	<p>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.</p>

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.⁸⁴

The revenue and pricing principles are set out in section 7A (subclauses 2 to 7) of the National Electricity Law. The following discusses how the AEMC has taken into account the principles in making this draft rule.

In general, the Commission has sought in the development of the draft 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.

⁸⁴ Section 88B of the National Electricity Law.

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

PRINCIPLE	HOW AEMC HAS TAKEN INTO PRINCIPLE ACCOUNT
<p>(2) A regulated network service provider should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs in</p> <p>(a) providing direct control network services; and</p> <p>(b) complying with a regulatory obligation or requirement or making a regulatory payment.</p>	<p>Under the draft 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.</p>
<p>(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—</p> <p>(a) efficient investment in a distribution system or transmission system with which the operator provides direct control network services; and</p> <p>(b) the efficient provision of electricity network services; and</p> <p>(c) the efficient use of the distribution system or transmission system with which the operator provides direct control network services.</p>	<p>Under the draft 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</p> <p>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 draft rule² require pricing methodologies to have regard to the desirability of providing signals for efficient investment and service utilisation decisions by users of the service.</p>
<p>(4) Regard should be had to the regulatory asset base with respect to a distribution system or transmission system adopted—</p> <p>(a) in any previous—</p>	<p>The draft rule does not affect the existing processes by which the regulatory asset based is determined.</p>

PRINCIPLE	HOW AEMC HAS TAKEN INTO PRINCIPLE ACCOUNT
<p>(i) as the case requires, distribution determination or transmission determination; or</p> <p>(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</p> <p>(b) in the Rules.</p>	
<p>(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.</p>	<p>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.</p>
<p>(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.</p>	<p>Consistent with the discussion relating to principle (3), under the draft 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.</p>
<p>(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</p>	<p>The risks and costs of under- and over-utilisation is addressed under the draft rule which provide price incentives for potential users of the system strength transmission service to use the system more efficiently.</p> <p>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</p>

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 Draft Rule. [3] See the standard in clauses s.5.1.14 and s.5.1a.9 of the Draft 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.⁸⁵ The more preferable draft 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 draft 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.⁸⁶ The Commission considers that the draft 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.⁸⁷ However, like other TNSPs, AEMO has a pricing methodology approved by the AER.⁸⁸ 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.⁸⁹

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,⁹⁰ so that it remains consistent with the performance of AEMO's declared network functions. The draft rule is consistent with AEMO's declared network functions because AEMO is responsible for allocating the ASRR for prescribed TUOS services,⁹¹ and the new system strength transmission service forms part of prescribed TUOS services.⁹² Specifically, the draft rule:

85 Section 91(8) of the NEL.

86 Section 91(9) of the NEL.

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

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

89 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

90 See clause S6A.4.2(k) item 2 of the Draft Rule.

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

92 See the amended definition of 'prescribed TUOS service' in the Draft Rule.

- inserts a modified definition in item 1 in S6A.4.2(k) for 'system strength charging period' for the purposes of clause 6A.23.5 of the draft rule.⁹³ 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.⁹⁴ This amendment made by the draft rule enables a system strength charging period to apply to AEMO.
- inserts a modification in item 2 in S6A.4.2(k) to reflect the same amendment made in the draft rule to clause 6A.24.1(e), which is modified in its application to AEMO in S6A.4.2(k).
- inserts a modified 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.⁹⁵ 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 draft 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:⁹⁶

- a reference to a network service provider is, in relation to the provision of *connection services*,⁹⁷ 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*,⁹⁸ to be read as a reference to AEMO.

While the draft rule introduces new obligations on network service providers (and connecting parties) during the connection process,⁹⁹ 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.

⁹³ See clause S6A.4.2(k)1 in the Draft Rule, which is a modification to clause 6A.23.4 of the NER as it applies to AEMO.

⁹⁴ It is modified by clause S6A.4.2(k)8(b) of the NER.

⁹⁵ See the amended definition of 'regulatory control period' in Chapter 10 of the Draft Rule.

⁹⁶ See for example, clause 5.1A.1(d) and rule 5.3B of the NER.

⁹⁷ 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).

⁹⁸ 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).

⁹⁹ 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.¹⁰⁰ Under rule 5.20C, the network service provider is also the system strength service provider.¹⁰¹ This has not been amended by the draft 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 draft rule against additional elements required by the Northern Territory legislation.¹⁰²

The Commission has determined not to make a draft differential rule. However, as chapters of the NER amended by the draft rule apply in the Northern Territory, the amendments made by this rule change will have application in the Northern Territory. The application of the draft 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 engage with the Northern Territory in this regard.

¹⁰⁰ Clause 5.1A.1(f)(8) of the NER.

¹⁰¹ Clause 5.20C.3(a).

¹⁰² 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,¹⁰³ 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 has indicated it supports these recommendations.

¹⁰³ <https://www.aemc.gov.au/regulation/energy-rules/civil-penalty-tools>

Table A.3: Civil penalty provision recommendations for the draft 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
	<p>assessment in accordance with the system strength impact assessment guidelines and paragraph (a3); and</p> <p>(2) determine in accordance with paragraph (a4) whether a system strength locational factor can reasonably be determined; and</p> <p>(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.</p>			<p>result in inadequate administrative processes which may not promote efficient investment in electricity services for the long term interest of consumers.</p>
New clauses				
5.3.4C(a)	<p>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:</p> <p>(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</p> <p>(2) agreement being reached under clause 5.3.12 to vary the performance of plant at an</p>	N/A	Tier 2 Market Administration	<p>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.</p>

CLAUSE	CONTENT DESCRIPTION	CURRENT CLASSIFICATION	PROPOSED CLASSIFICATION	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
	<p>(1) a description of the nature of the alteration and the timetable for implementation;</p> <p>(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;</p>			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.

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 NEL be classified as conduct provisions.

The draft 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 draft rule be classified as conduct provisions.

B SUPPLY SIDE: ESTABLISHING A NEW SYSTEM STRENGTH PLANNING STANDARD

BOX 4: SUMMARY OF KEY POINTS

The evolved framework for system strength establishes a new system strength standard and would be integrated into the existing planning and economic regulatory frameworks.

The draft rule would introduce a mechanism for the centrally coordinated provision of efficient levels of system strength by relevant TNSPs — known as system strength service providers (SSS Providers) — to support system security, ongoing operational efficiency and supporting the efficiency of new connections. Under this rule, SSS Providers would plan to procure the efficient level of system strength needed to meet the system strength requirements projected by AEMO for different parts of the power system.

The draft rule would introduce a system standard in Schedule 5.1a of the NER. This system standard would be realised through a set of specific obligations placed on SSS Providers through the network standards established in Schedule 5.1 of the NER, which describe how they are required to meet the standard.¹

SSS Providers would be obligated under the standard to use reasonable endeavours to maintain the standard at specified locations (called system strength nodes) and for an amount determined by AEMO. The standard would contain two key parts: maintaining the **minimum three phase fault level** and achieving **stable voltage waveforms** for inverter based resources and market network service facilities. Therefore, the standard would require each SSS Provider to use reasonable endeavours to plan, design, maintain and operate its transmission network, or make system strength services available to AEMO, to meet the following requirements at the system strength nodes on its transmission network:

1. **Minimum fault level requirement:** maintain the minimum three phase fault levels specified by AEMO in the system strength requirements required for plant and network protection systems.
2. **Stable voltage waveforms:** achieve stable voltage waveforms such that the efficient amount of IBR and market network service facilities projected to be connected by AEMO will remain stable in steady state conditions and remain synchronised following credible contingency events.

SSS Providers are defined under the draft rule as being the TNSP in the region, or where there is more than one TNSP in the region as the jurisdictional planning body for that region. This reflects the Commission's decision to not have all TNSPs and DNSPs meet the standard. Having a single provider of system strength services in a region would minimise complexity. The SSS Providers are considered to be the party best placed to meet the standard and manage the associated risks, given their technical expertise and the physical characteristics of

distribution and transmission networks.

While the draft rule does not include DNSPs as SSS Providers, it does allow for solutions that provide system strength services to be located in other networks, such as another distribution network, or indeed, another transmission network not operated by the jurisdictional planning body by enhancing the existing joint planning arrangements.

The SSS Provider and AEMO obligations and processes to meet the proposed standard under the draft rule are summarised below.

- **AEMO's planning obligations** — AEMO would be responsible for declaring system strength nodes and projecting both minimum fault levels and forecast new connections over the next 10 years at these nodes. AEMO would leverage the ISP and other relevant planning processes to make such projections on an at least an annual basis. AEMO would publish the system strength nodes and projections in its annual system strength report. AEMO would no longer be required to identify and declare shortfalls that an SSS Provider must meet, as this would be superseded by the ability to define minimum required levels as described above.
- **SSS Provider planning obligations** — The SSS Provider that is the jurisdictional planning body for the region would be the SSS Provider for the nodes in its region. The SSS Provider would assess how it should meet its obligations under the system strength standard alongside the SSS Provider's other existing obligations, as part of its annual planning review process. AEMO's system strength report would inform what system strength needs the SSS Provider must consider. The SSS Provider would be required to publish a description of the activities undertaken or planned to satisfy its obligations under the standard in relation to each system strength node in its annual planning report, including a timeline of projected investments in system strength solutions, as well as forecasts of the available fault level at each node.
- **Use of the RIT-T** — TNSPs who are SSS Providers would use the existing RIT-T process to determine the net-beneficial option to meet the proposed system strength standard. As the SSS Provider is meeting a standard under S5.1, any investment would represent a reliability corrective action, which means that while the SSS Provider would still need to model net market benefits, a solution could have a negative net market benefit to meet the identified need.

The draft rule also applies in Victoria, where AEMO would be the SSS Provider for the region.

The Commission considers that the draft rule would support more efficient connections by supporting the delivery of the right amount of this essential system service, where and when it is needed. This would deliver lower cost outcomes for consumers.

Increasing the availability of system strength would help to simplify the connection process for new IBR plant. Plants that demand system strength would have the choice to connect at or near system strength nodes where the TNSP is providing the service, and would therefore not need to undertake to the same extent the extensive modelling and costly remediation

work that occurs under the current arrangements.

The evolved framework is also purposefully forward-looking and centrally coordinated through the SSS Provider and AEMO. It would help to make AEMO's job easier, in terms of forecasting future system needs, as AEMO would no longer be required to consider 'typical dispatch patterns' when forecasting likely minimum fault levels in future. Instead, AEMO would project the minimum three phase fault levels required, and this would form the basis of the SSS Provider's obligation under the standard. This should help to avoid the reactivity of the current frameworks, which have seen critical system strength shortfalls arise due to the difficulty of forecasting for system strength.

The evolved framework would also require AEMO and TNSPs to actively plan for the delivery of efficient levels of system strength, over the long-term timeframes considered in the current transmission planning processes. In conjunction with the above, this would help reduce the risk of shortfalls arising in availability of system strength on the power system. This would facilitate more efficient connection of new IBR and would reduce the risk of material curtailment of existing generators due to system strength issues.

Finally, the evolved framework would support a more centrally coordinated approach to the provision of system strength. TNSPs would be able to effectively coordinate investment in assets to provide system strength, with the TNSP's other obligations, in order to capture economies of scale and scope associated with these.

All of these outcomes can be expected to reduce the total of wholesale costs and network charges in comparison to the alternatives - such as not evolving the framework, which would flow through to lower prices for customers. In particular, by ensuring an efficient supply of system strength is provided, the connection of new IBR would be supported, improving wholesale price outcomes for consumers. Having TNSPs responsible for the coordinated provision of system strength should also better enable TNSPs to take advantage of scale and scope economies, that are associated with them fulfilling their obligations, which will in turn help to reduce network charges for consumers.

Note: [1] The system strength standard is described as a system standard in S5.1a, with S5.1 detailing more pragmatic but still binding obligations on SSS Providers. From hereon, the AEMC describes these clauses collectively as 'the standard'.

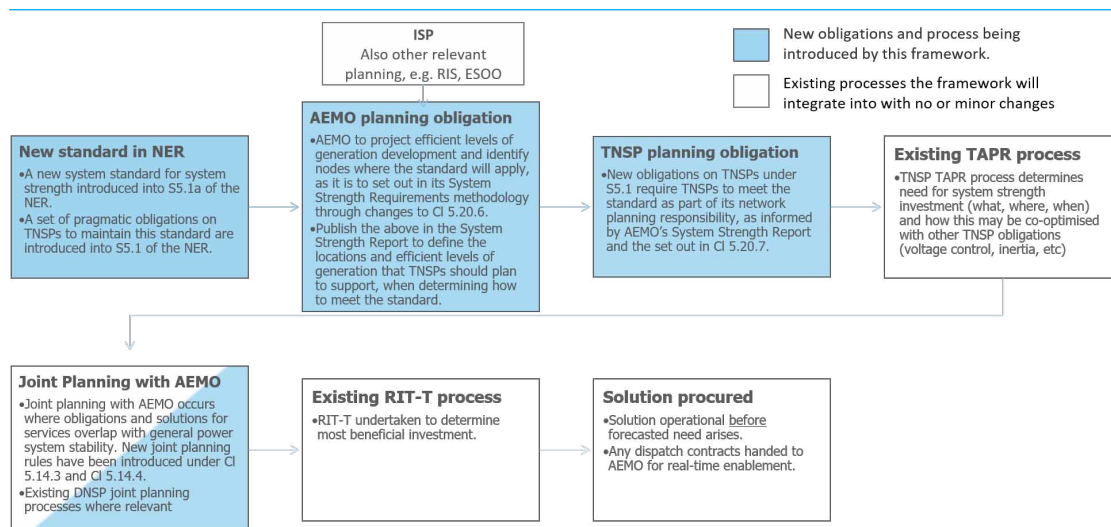
This Appendix provides detail on:

- Appendix B.1 and appendix B.3 sets out the current arrangements and the Commission's view on the issues with the current arrangements
- Appendix B.2 sets out the proponent's views on these issues and its solution
- Appendix B.4 sets out the stakeholder's views on these issues as well as the proponent's proposed solution
- Appendix B.5 sets out the Commission's recommendations from the *Investigation*
- Appendix B.6 through appendix B.9 sets out the Commission's draft rule and determination, including the specific design decisions on:
 - the Commission's draft decision

- integration of the standard into AEMO's planning processes
- integration of the standard into SSS Providers planning processes
- integration of the standard into the existing TNSP economic regulation frameworks
- Appendix B.10 sets out the differences of its application in Victoria as an adoptive jurisdiction.

An overview of the processes involved in applying the proposed standard is provided in Figure B.1 below.

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



Source: AEMC

B.1 Current arrangements

This section summarises the key decisions of the 2017 *Managing power system fault levels* final rule, and the current arrangements for system strength that it introduced, as relevant background. This includes the two current frameworks that rule established, which are the main areas of the NER that this aspect of the draft rule is amending and evolving:

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.¹⁰⁴ This obligation was imposed on each new connecting generator and market network service facility, to address their specific impact on system strength and 'do no harm' to system strength levels as a result of them connecting.
2. The minimum system strength framework, which requires TNSPs to provide system strength, where this was needed to maintain the basic levels for system security.¹⁰⁵

¹⁰⁴ Generally covered by clause 5.3.4B of the NER.

¹⁰⁵ Generally covered by rule 5.20C of the NER.

Generally, the intent of this part of the framework was to address declining system strength as synchronous generators retired or reduced their output over time.

The 2017 rule defined 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 — known as 'fault level nodes'.¹⁰⁶ This means that currently 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 a system strength requirements methodology.¹⁰⁷ 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.
- TNSPs to procure system strength services needed to meet the required level as determined by AEMO where a system strength shortfall exists and has been declared by AEMO.¹⁰⁸ These services are then enabled operationally by AEMO as needed.¹⁰⁹

The NER provides that a TNSP is not required to undertake a regulatory investment test (RIT-T) for the relevant transmission investment if both:¹¹⁰

- AEMO requires the system strength services to be provided less than 18 months after the publication of the notice
- The TNSP is not already under an obligation to provide system strength services for that fault level node.

In relation to the 'do no harm' framework, the NER obligates the necessary system strength required by a new generator or market network service provider (MNSP) connection to be self provided as they connect to the power system, either through:

- self-remediation (system strength remediation scheme), that is building assets behind its connection point, or
- contracting with a third party — including the NSP — to provide this service for them (system strength connection works).

As such, this obligation is imposed on each new connecting generator, to address its individual impact on the local system strength in the network to which it is connecting. That is, new connecting generators must 'do no harm' to the security of the power system.¹¹¹

This requirement applies regardless of whether AEMO has declared a system strength shortfall in a region.

¹⁰⁶ See the relevant definitions in Chapter 10 of the NER.

¹⁰⁷ Clause 5.20.6 of the NER.

¹⁰⁸ Clauses 5.20C.2, 5.20C.3 and 5.20C.4 of the NER.

¹⁰⁹ Clause 4.4.5 of the NER.

¹¹⁰ Clause 5.16.3(a)(11) of the NER.

¹¹¹ Clause 5.3.4B of the NER.

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

TransGrid submitted a rule change request to amend the NER to be more proactive in provision of system strength in the NEM.¹¹² The request proposes to abolish the 'do no harm' obligation and amend the minimum system strength requirements. This follows issues observed by the proponent with the existing system strength framework that have arisen since it was put in place in 2017.

These issues include the inability for new connections to coordinate the procurement of system strength services. This is leading to piecemeal remediation resulting in additional time and cost for connection of new generation to the power system, as well as increased risks of costly interventions in the operation of energy markets and the power system; all of which are leading to higher costs for consumers.

The TransGrid proposal involves:¹¹³

1. AEMO setting the system strength requirement for identified fault level nodes in the system. That is, AEMO will define the level of system strength is required for each sub-region in the NEM.
 - AEMO would retain responsibility for determining fault level nodes and the minimum fault level that is required at each node. This would be done in conjunction with TNSPs, as is currently the case through the minimum system strength processes.
 - A key difference with the current framework is that when setting these levels, AEMO would also have to account for the potential future impact of new generation (using the ISP) in setting the minimum fault level for each node.
2. An independent body (TransGrid proposes the Reliability Panel) would set a probabilistic planning standard, which would define how often TNSPs must be able to meet the required minimum levels of system strength. This standard could be similar in form to the current reliability standard of 0.002% unserved energy.
 - This standard could be applied globally/NEM-wide, regionally for each TNSP, or on a nodal basis.
 - TNSPs would meet this standard through their normal planning processes including contingent projects for more time sensitive issues.
3. TNSPs are obligated to maintain these system strength levels to this standard for each node defined in their network.
 - TNSPs would be responsible for assessing if there is enough system strength provision to meet minimum levels in collaboration with AEMO. TNSPs can then provide the service either through network or non-network options to maintain the standard.

AEMO would also be able to declare system strength shortfalls as an NSCAS gap in cases that sufficient levels of system strength are not captured through longer term planning processes. AEMO would then act as procurer of last resort if the gap remained unmet by TNSPs.

¹¹² TransGrid, 2020, *Efficient management on system strength on the power system* — Rule change proposal, 27 April 2020.

¹¹³ *ibid*, pp. 10-18.

TransGrid also proposes to amend the current minimum system strength framework such that it is integrated into TNSPs' ordinary planning and regulatory frameworks. That means that system strength would be an extension of the existing NER defined regulatory standards for network planning and operation. This would make system strength the same as those that exist for thermal capacity and for the provision of voltage control services.

This proposal — if adopted — would abolish the 'do no harm' framework. In its place, generator connection processes would still require each plant to negotiate and meet generation performance standards (GPS) to connect. TransGrid state this means that generators would not have to undergo the full impact assessment associated with the 'do no harm' obligation. TransGrid then state that this may result in them being penalised when trying to meet their GPS if they do not locate in optimal (strong) parts of the network. The proposal expects the risk of constraints to provide a further locational signal.

TransGrid suggests an array of benefits, including:¹¹⁴

- A more efficient balance of costs incurred on the market by procuring system services to address shortfalls ahead of time as opposed to 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.
- A more streamlined and cost effective connection process and the reduction of unnecessary duplication in investment in system strength providing assets through the removal of impractical requirements on generators to deliver bespoke remediation schemes as a consequence of 'do no harm'.
- 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.

B.3 Commission's view of issues with the current arrangements

Through the *Investigation* and consultation on TransGrid's rule change, the AEMC has identified several issues related to the supply of system strength under the current frameworks. These include the following:

1. **The current arrangements do not support the efficient connection of new generation.** The current arrangements are currently split between the 'do no harm' frameworks and the minimum framework. These two frameworks are not coordinated and are reactive in nature — as such, they have not provided the levels of system strength needed to support the efficient connection of new IBR. In conjunction with the issues around the 'do no harm' framework, this fundamental lack of this essential system service has led to material delays in the connection of new generation.
2. **The current frameworks are reactive in nature.** This is due to the fact that difficulties faced by AEMO in undertaking effective forecasting to identify system strength shortfalls based around expectations of future generation dispatch patterns, which are

¹¹⁴ National Electricity Rule changes proposal, Efficient management of system strength on the power system, TransGrid, April 2020, p. 19.

highly unpredictable and difficult to forecast. This has resulted in some declarations of system strength shortfalls being made only shortly before they occur, rather than at least five years out as envisaged in the current framework. This can mean that the TNSP has no time to procure efficient system strength services required to meet system strength needs and has resulted in AEMO manually intervening in the power system through constraints and directions.

3. **There is a lack of coordination of how system strength is delivered.** There is a lack of ability to effectively coordinate solutions to address system strength. For example, the 'do no harm' elements of the current frameworks result in piecemeal and often cost inefficient solutions for system strength, undertaken by each new connecting generator through their remediation actions. These multiple individual remediation actions can also lead to operational inefficiencies, as they are not operated in a coordinated manner. Greater scale and operational economies could therefore be enabled if there was a single provider of system strength services. Scope economies can also be provided by better coordination of system strength services with other network services.

Appendix B.6.1 below provides a summary of how the proposed supply side reforms of the evolved framework are intended to address each of these issues.

B.4 Stakeholder's views

Stakeholder submissions to the consultation paper regarding TransGrid's rule change request were broadly supportive of a planning standard for system strength and that it would provide useful and timely locational and financial signals to new entrants to some extent.¹¹⁵ Some emphasised that it needed to be clear and forward-looking.¹¹⁶

CS Energy consider that both TNSP conducted competitive tenders and retaining the 'do no harm' provision would send appropriate financial and locational signals to generators.¹¹⁷ Meridian Energy Powershop agreed that financial signals and timeframes could be improved but it would depend on the parameters of the rule change.¹¹⁸

EnergyAustralia communicated scepticism that the proposal would provide any new incentives to new entrants.¹¹⁹ OMPS Hydro similarly noted that the proposal focused on new generation development primarily and "does not provide incentive for new system strength provider entrants."¹²⁰

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.¹²¹ That is, that the current definition of SSS Provider

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

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

117 CS Energy, Submissions to the consultation paper, p. 17.

118 Meridian Energy Powershop, Submission to the consultation paper, p. 10.

119 EnergyAustralia, Submission to the consultation paper, p. 17.

120 OMPS Hydro, Submission to the consultation paper, p. 13.

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

should be broader to include DNSPs such that they face the system strength standard proposed by TransGrid. They considered "[i]f DNSPs are not included in the NSP-led solution, it may result in sub-optimal solutions".¹²²

In terms of existing system strength assets, some stakeholders were supportive of transferring ownership of system strength assets to TNSPs only if this was clearly negotiated and by agreement of the parties.¹²³ TasNetworks considered such a transfer would be complex and potentially problematic, particularly if the TNSP could not refuse to take on a certain asset.¹²⁴ CS Energy suggested that the assets could be contracted to TNSPs through a competitive tender.¹²⁵

Finally, AEMO expressed "some concerns the TransGrid proposal may have too little incentive to utilise synchronous generation or future technology".¹²⁶ Particularly, AEMO advised against limiting the scope for NSPs to invest just to a minimum level or limiting contracting options due to potential ahead market requirements.¹²⁷ Similarly, EnergyAustralia considered there "is potential for inefficiency, network augmentation bias and free-rider issues"¹²⁸ in a centrally coordinated model as proposed by TransGrid and advocates for TNSPs to undertake a transparent cost benefit analysis of network and non-network options, and for connecting generators to retain the right to institute their own system strength solutions.¹²⁹

B.5 Recommendations of the *Investigation*

In the *Investigation* final report, the AEMC recommended a centrally coordinated model for the delivery of system strength. TNSPs, working with AEMO, would face an obligation to proactively provide the volumes of system strength needed to maintain security, and to facilitate the effective connection and operation of expected volumes of new IBR plant. By drawing on the existing integrated planning frameworks and the established system engineering practice of meeting a defined system standard, this coordinated supply side model was designed to deliver efficient volumes of system strength, while managing costs by utilising the existing NEM economic regulatory frameworks.

At a high level, the AEMC considered that system strength should be supplied as a prescribed transmission service. This was due to the shortcomings of the existing 'do no harm' framework, coupled with the reactive nature of the minimum shortfall framework, being able to effectively supply the necessary system strength required for the connection of IBR plant to the power system in a timely and efficient manner.

Additionally, the considerable amount of system strength services required to facilitate the speed and size of the power system transition underway efficiently in the long term interest

¹²² *ibid*, p. 7.

¹²³ Submissions to the consultation paper, Maoneng, pg. 6; OMPS Hydro, pg. 13; Walcha Energy, pg. 9.

¹²⁴ Submission to the consultation paper, pp. 5-6

¹²⁵ Submission to the consultation paper, pg. 8

¹²⁶ AEMO, Submission to the consultation paper, p. 18.

¹²⁷ *Ibid*.

¹²⁸ Submission to the consultation paper, pg. 17

¹²⁹ *Ibid*, pg. 16

of consumers was determined to be best achieved by prescribing its provision from SSS Providers, given the asymmetry of risk towards procuring more being less costly than procuring less of the service.

B.6 Commission's draft decision — establish a new transmission prescribed transmission service standard for provision of efficient level of system strength

The draft rule proposes the introduction of a new system strength standard in the NER to apply to those TNSPs who are system strength service providers (SSS Providers) who must use reasonable endeavours to plan, design, maintain and operate their transmission networks to provide the system strength required to assist the transition of the power system.¹³⁰ This means SSS Providers would be required to use reasonable endeavours to have the most cost-effective portfolio of network and non-network services available such that the system strength standard remains met over time.

BOX 5: WHAT IS A SYSTEM STRENGTH SERVICE PROVIDER (SSS PROVIDER)?

System strength service providers (SSS Providers) are either the TNSP for the region, or where there is more than one TNSP for a region, they are the TNSP (or in the case of Victoria, AEMO) who is the jurisdiction planning body for that region, as defined in clause 5.20.3(a) of the NER. The proposed system strength standard would apply only to TNSPs who are SSS Providers.

The current TNSPs that would be SSS Providers are TasNetworks, TransGrid, Powerlink, AEMO and ElectraNet.

The Commission has qualified the standard with the use of the words 'reasonable endeavours' to reflect the consideration that SSS Providers should not undertake activities, at all costs, to meet the standard at all times and in all circumstances.¹³¹ For example, we consider it in the long term interest of consumers that AEMO might constrain off (or down) some IBR plant if stable voltage waveform is not able to be achieved through the investments made by a SSS Provider at all times and in all circumstances, rather than have potential over-investment by the SSS Provider. That is, if the costs required to meet the standard would not be what a prudent and reasonable operator would do, it may not be 'reasonable' for the SSS Provider to meet the standard just in time, as opposed to slightly later, for example.

The proposed standard would result in SSS Providers procuring the whole amount of system strength required to meet the requirements of the standard. That is, a SSS Provider must coordinate the procurement of a portfolio of solutions to satisfy the standard, and it cannot

¹³⁰ Clause S5.1.14(b) of the Draft Rule.

¹³¹ This is to be distinguished with alternative words like 'best endeavours' and without any qualification if the standard stated that the SSS Provider 'must plan, design, maintain....' Similar approaches are taken in other standards in Schedule 5.1 of the NER, e.g. S5.1.5 for voltage fluctuations.

rely on any system strength services that may be coincidentally provided by generators as a result of them being dispatched in the energy markets in the operational timeframe.

This would ensure that market participants, and AEMO can be confident that the system strength services required to meet the standard has been reliably and transparently procured by the SSS Provider and avoids reliance on the operational decisions of generators in the energy market for the provision of essential system services.

It would also avoid the need for complex market modelling to determine the expected dispatch patterns of generators many years into the future, which the Commission understands has been a limiting factor causing reactive declaration and management of system strength shortfalls by AEMO and TNSPs under the current arrangements. AEMO would no longer be declaring system strength shortfalls under the draft rule, following a transitional period during which this will be preserved.¹³² The Commission considers that the service would be provided in a coordinated manner as a result of this decision, rather than being provided through multiple different frameworks.

The Commission also considers that allocating the SSS Providers and creating a single party responsible for the provision of system strength in each region would be in the long term interests of consumers. This is on the basis that having a centrally coordinated approach to provision of system strength is best enabled where there is one party responsible over a particular area. SSS Providers (as TNSPs) are uniquely positioned to leverage economies of scale and scope associated with provision of system strength, given the other obligations that they need to manage, to help bring costs down for consumers. SSS Providers can also exercise a degree of natural countervailing power when buying non-network solutions for the provision of system strength, which would also help to drive down the cost of system strength services for customers. Finally, SSS Providers (as TNSPs) are also subject to economic regulation through the existing NER processes, which incentivises the most efficient delivery of services to meet their obligations in order to help manage costs for consumers.

SSS Providers would be a sub-set of TNSPs and this is a concept maintained from the 2017 rule.¹³³ The SSS Providers would be defined as being the TNSP for the region that is the jurisdictional planning body for the relevant jurisdiction in order to clearly define who is the single procurer for the service in that region.¹³⁴

The Commission decided to not expand this definition to include other TNSPs or any DNSPs. The ability to have a single procurer, being the SSS Provider, was determined to be the most efficient way for system strength to be provided in each region. This framework could also still utilise solutions in other NSPs networks where necessary, by using the existing joint planning processes. As such, these processes have been clarified and strengthened under this draft rule — as set out in appendix B.7.4.¹³⁵

¹³² Clause 11.xxx.13, 11.xxx.14 and 11.xxx.15 of the Draft Rule.

¹³³ AEMC, *Managing power system fault levels*, final rule determination, September 2017.

¹³⁴ Clause 5.20C.3(a) of the NER.

¹³⁵ See clauses 5.14.3 and 5.14.4 of the Draft Rule.

The Commission also set out its analysis on the role distribution networks can play in the evolved framework in the *Investigation* final report, and considers that this remains valid in the context of this decision.¹³⁶

The draft rule proposes the system strength standard would be set out in two parts in the NER: firstly, through the form of a *system standard* in Schedule 5.1a of the NER (S5.1a) and then secondly, 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).

- The *system standard* itself can be considered 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.¹³⁷
- The *network standard* 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 can and should be practically and reasonably be achieved by SSS Providers in relation to system strength, given the complexity of the issue of system strength.

Therefore, the system strength standard can be considered to include both the *system* and *network* standards.

The SSS Providers' obligations under the system strength standard are further described by reference to the two key physical aspects of system strength.¹³⁸ Firstly, providing minimum fault levels, and secondly, supporting the stable operation of IBR, both of which must be met to maintain the standard at each system strength node, as determined by AEMO.¹³⁹

1. **Minimum fault level requirement:** maintain the minimum three phase fault levels specified by AEMO in the system strength requirements required for plant and network protection systems.
2. **Stable voltage waveforms:** 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.

Together, these two physical aspects of system strength should effectively encompass all system strength issues and solutions for the purposes of both maintaining system security and supporting efficient new connections of plant, allowing effective planning of the provision of system strength in the investment timeframe. Further, these components would allow the standard to evolve and adapt over time to the most current thinking on system strength (through changes to the relevant AEMO system strength requirements methodology) resulting in a robust framework that minimises costs to consumers.

¹³⁶ AEMC, *Investigation into system strength framework in the NEM*, Final report, Chapter 7: Consideration of distribution networks in the evolved framework, October 2020.

¹³⁷ See the purpose of system standards expressed in clause S5.1.a.1 of the NER.

¹³⁸ 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*, and described in Chapter 2 of this draft determination.

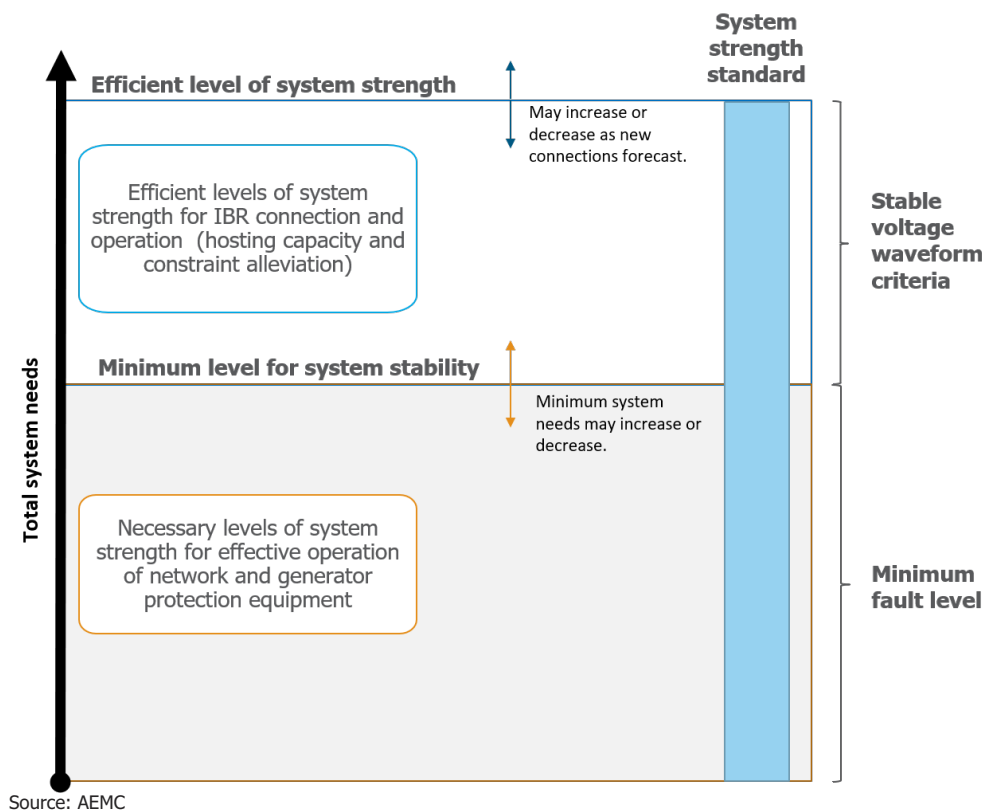
¹³⁹ Clauses 5.20C.1 and S5.1.14(b) of the Draft Rule.

To meet its obligations under the standard, SSS Providers would be informed by AEMO's projections of the system strength needs of the power system and expected connections (both those expected to be IBR and so that demand system strength, as well as those non-IBR and so that supply system strength). AEMO would be required to publish these in the system strength report.

The projections for expected connections would be derived from the forecasts in AEMO's Integrated system plan (ISP) through the use of the optimal development path.¹⁴⁰ This provides consistency between the NEM planning process undertaken by AEMO in the ISP and this evolved system strength framework. SSS Providers would integrate planning for the standard into its existing TNSP planning and economic regulation frameworks.

The way these obligations would map to the relevant system needs to allow for the provision of the efficient level of system strength is shown in Figure B.2 below.

Figure B.2: New system strength planning standard under Schedule 5.1 of the NER



¹⁴⁰ See rule 5.22 of the NER.

B.6.1 Benefits and role of the supply side framework reforms in the evolved framework

As discussed in Chapter 3, the AEMC considers the system strength standard best promotes the long-term interests of consumers, given the assessment framework set out in Chapter 3. This assessment is based on the Commission's aims for the supply side reforms, as set out in the *Investigation*.¹⁴¹ The way the proposed standard contributes to the effectiveness of the overall system strength framework, and by extension the NEO, is set out below.

Table B.1: How the proposed standard meets the AEMC's aims for the supply side workstream

AIM OF THE AEMC'S SYSTEM STRENGTH SUPPLY SIDE WORK STREAM	HOW THE DRAFT STANDARD CONTRIBUTES TO THESE GOALS
<p>Effectively identify and address low levels of system strength as they arise in NEM regions, to help maintain system security at the lowest possible cost</p>	<p>The SSS Provider would be the single procurer for system strength in the planning timeframe and must procure the total efficient level of system strength in a coordinated fashion given TNSP's other obligations, avoiding costly reactive solutions to system security issues and higher confidence for operators and IBR developers about the levels of system strength in a future operating environment. The proposed framework would also avoid the complexity and uncertainty of requiring AEMO to forecast for future dispatch patterns, which is a complex process that can result in delays in through the existing frameworks.</p>
<p>Support the coordinated provision of system strength at levels needed to support efficient connection of new generation in specific parts of the system</p>	<p>Longer term planning processes involving collaboration between AEMO and SSS Providers, such as the ISP, would be leveraged to project and procure efficient levels of system strength. The components of the system standard would provide SSS Providers and AEMO with flexibility to account for new technologies and new learnings. The way that this standard is applied in practice would be able to reflect the most up-to-date thinking on system strength as possible without the requirement for a rule change to take place.</p>
<p>Assist efficiency of the connection process by removing some uncertainty faced by new connecting generators</p>	<p>Through our evolved framework, efficient levels of system strength would be provided on a coordinated, reliable and well-documented basis, through the SSS Provider planning processes. Connecting plants would receive clear information as to where to locate and what services will already exist to support them. In these locations, plants that demand system strength can opt to pay the charge introduced in the System strength mitigation requirement (see Appendix D) and avoid the delays, and potentially higher costs, of undertaking their</p>

¹⁴¹ AEMC, *Investigation into system strength final report*, p.v

AIM OF THE AEMC'S SYSTEM STRENGTH SUPPLY SIDE WORK STREAM	HOW THE DRAFT STANDARD CONTRIBUTES TO THESE GOALS
	own remediation process required under the current 'do no harm' framework. Connecting around system strength nodes where the SSS Provider has coordinated the procurement of system strength should also lessen the extent of iterative connection modelling required, further decreasing both the delays to and costs of the connection process.
Value the system strength required by the power system	All necessary system strength provision would be directly valued, providing the most efficient, technology neutral signals for existing plant to potentially provide system strength services (whether through actively supplying system strength, or undertaking a demand response type service through retuning), or for investment in new solutions that provide system strength. The proposed approach would allow SSS Providers to value, compare and procure the most cost efficient of all types of system strength providers or methods for demand reduction, as appropriate for a technologically neutral framework looking to facilitate a smooth transition in power system technologies.

B.6.2

Purpose of the two physical aspects of the standard

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 respective sections below.

The minimum fault level requirement

The SSS Provider would be obligated to meet the minimum three phase fault level requirement at the node as determined by AEMO. This would provide a base level of system strength throughout the network required to make the system secure. That is, the amount required for the correct operation of plant and network protection systems that are triggered when a certain fault level is detected.

The methodology that AEMO would use to determine these minimum requirements would be at its discretion, and set out in its published methodology.¹⁴² The AEMC understands that AEMO may undertake full power system stability studies to determine these minimum fault levels, in a way similar to the current minimum fault levels framework. Under this approach,

¹⁴² Clause 5.20.6 of the Draft Rule.

minimum fault levels are expressed in MVA. This approach may change as innovation and understanding of system strength as a service develops during the power system transition as described in Chapter 2 — hence the flexibility to allow AEMO to change its procedure when required.

SSS Providers would coordinate with AEMO (as well as with DNSPs and other TNSPs, where relevant) to determine the most efficient way to meet this minimum, including co-optimisation of investment across the standard to reduce the need for minimum synchronous units. More information on joint planning arrangements is explained in appendix B.7.4. Further information as to how the assets from the investment timeframe could be coordinated with and optimised in the operational timeframe is set out in Chapter 2.

The stable voltage waveforms criteria

The stable voltage waveforms criteria would require SSS Providers to plan for the provision of system strength services to meet the standard. This would be on the basis that this would enable the efficient level of system strength to meet projected IBR, taking into account non IBR plant, as per AEMO's ISP, to operate stably and remain synchronised to the system following a credible contingency event. AEMO, as part of the System strength requirements methodology must provide a description of:¹⁴³

- what is meant by stable voltage waveforms
- matters that may be taken into account by System Strength Service 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). We expect 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.

Specifically, under the draft rule, the standard would require SSS Providers to plan to achieve stable voltage waveforms in their networks such that:¹⁴⁴

1. **IBR do not create, amplify or reflect instabilities in response to small signals in steady state conditions.** This requirement speaks to a network environment where voltage changes are appropriately damped and there is a strong, relatively 'noise free' voltage waveform for IBR to 'read' and respond to. Provided the IBR plant have met their access standards, including those newly proposed by this rule, this principle should substantially decrease the risk that poor plant interactions and instabilities occur that require long duration constraints on IBR output/input.
2. **IBR remain synchronised following a credible contingency event.** In a manner similar to the above, this requirement speaks to the ability of the network's voltage waveform to 'bounce back' from a large disturbance caused by a credible contingency event, in a controlled manner. Connected IBR, in particular their phase locked loop (PLL)

¹⁴³ Clause 5.20.6(f)(4) of the Draft rule.

¹⁴⁴ Clause S5.1.14(b)(2) of the Draft Rule.

controllers, should be able to follow where the voltage deviates from and returns to its normal operating range and respond with the appropriate operating mode, all without tripping or otherwise disconnecting from the power system completely.

This criteria gives SSS Providers both the flexibility and the obligation to account for the nuanced impacts and interactions of individual connections on 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.

B.6.3 Treatment of AFL and minimum fault levels — two key changes in approach from the Investigation into System Strength Final report

The draft rule makes two key changes in terms of the form of the system strength standard, in relation to how the standard was described in the final report of the Investigation. These differences, which are relevant to the way that the standard is implemented by AEMO and SSS Providers, is explored in this section.

The general form of the system strength standard remains in principle the same as proposed in the *Investigation*. That is, SSS Providers would be responsible for planning for and procuring the efficient level of system strength in the investment timeframe, including the 'minimum fault levels' that are required for system security.

Following the publication of the high-level proposal in the *Investigation* final report, the Commission engaged broadly with stakeholders to develop the detailed proposal described by the draft rule. This engagement included numerous briefings, five sessions with our technical working group, bilateral meetings with interested stakeholders, multiple workshops with TNSPs to understand their processes to leverage, and working closely with the ESB as well as AEMO and the AER. Through this extensive engagement program the Commission's findings from the *Investigation* final report have evolved in response to this feedback.

From this, the Commission has made two key changes to the overall policy framework set out in the *Investigation*:

- 1. The system strength standard does not include an AFL requirement.** The Commission has determined that available fault level (AFL) as a metric is more useful as a planning and reporting *tool* rather than a system requirement in itself. This is because adding a positive AFL requirement to the system standard would make the standard inflexible to considering system strength issues that are not fault current related or potential system strength solutions whose contributions cannot be directly measured in terms for fault current. Therefore, the Commission considers inclusion of AFL in the standard could inhibit SSS Providers from procuring the most efficient solutions. Including the AFL requirement would also not result in a higher level of obligation that the combination of the minimum fault level requirement and the stable voltage waveform

criteria already require, making it superfluous to include. Instead, the draft rule includes a requirement for:

- a. SSS Providers to report forecast AFLs for each node in its TAPR publications.¹⁴⁵ The publication of the results of both AFL projections and how AFL may change with SSS Provider investment is valuable information that developers can use early on in their investment decision processes.
- b. AEMO to include in its system strength impact assessment guidelines guidance for how AFL is calculated at nodes to allow consistency across the NEM, such that investors can easily access the information it needs to assess potential connection opportunities in a similar format.¹⁴⁶

The draft rule would not prevent a SSS Provider from using AFL analysis in whatever way it sees fit to apply in its planning processes. For example, SSS Providers could elect to use AFL analysis for first pass assessments of the adequacy of the level of system strength forecast at each node.

2. **Inclusion of minimum fault levels in the system strength standard.** The Commission has determined to include minimum three phase fault levels as an explicit requirement as part of the total efficient level of system strength the power system requires. These minimum fault levels would serve as a proxy for minimum power system stability requirements, recognising that the stability of IBR alone is not the only factor relevant to the adequate provision of system strength.

B.6.4

How investment to meet the standard may change over time

System strength is a complex issue, with understanding of what it is, how it is defined, and how it affects power system operation varying over time as described in Chapter 2. AEMO and SSS Providers' understanding and modelling capabilities of the power system will improve over time, and new technologies and techniques become available that can provide system strength and maintain power system stability. AEMO and SSS Providers have both recognised that we will need to be able to operate a system with both:¹⁴⁷

- non-energy suppliers of system strength for zero/negative demand conditions
- without synchronous generators due to market dynamics and economics resulting in their retirements quicker than expected.

Effective joint planning between SSS Providers and AEMO — as well as DNSPs and other TNSPs that are not SSS Providers — should mean that AEMO is able to maintain system stability and operability as the transition occurs, both through planning and operational time frames. Initially traditional suppliers of system strength service, such as synchronous generators, are likely to play a role in a portfolio of services procured by SSS Providers to provide the efficient level of system strength, in addition to the traditional installation of network equipment of synchronous condensers. Over time, however, other solutions may become available that meet the requirements of the system strength standard, and also

¹⁴⁵ Clause 5.20C.3(f) of the Draft Rule.

¹⁴⁶ Clause 4.6.6(a)(2) of the Draft Rule.

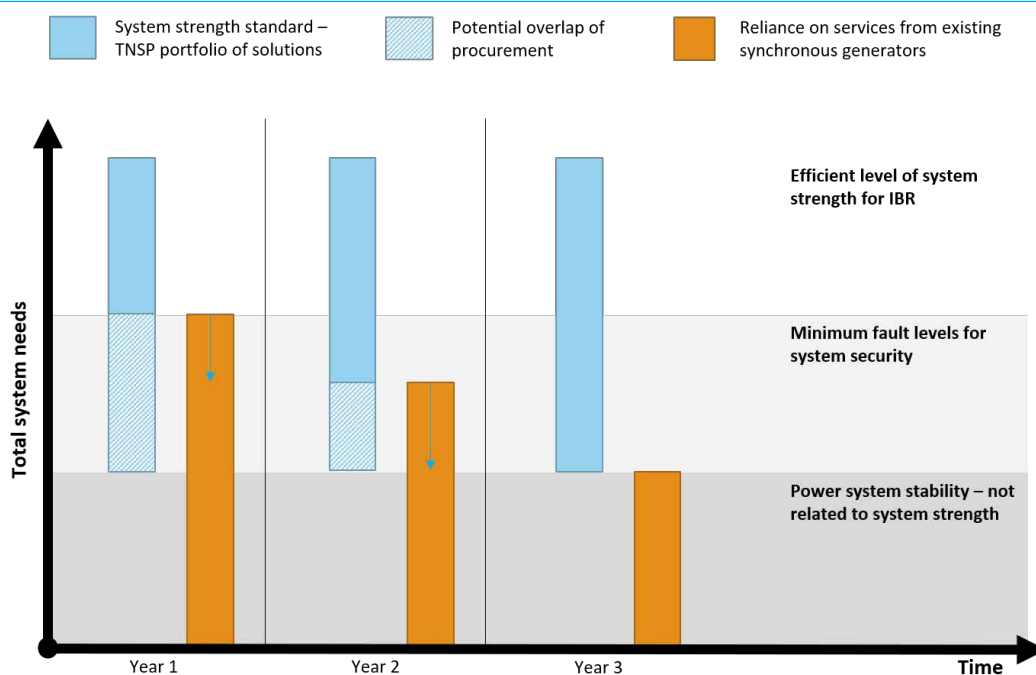
¹⁴⁷ AEMO, *2020 System strength and inertia report*, December 2020, pg. 4

maintaining general operability of the power system as technology continues to evolve and innovate.

Working with AEMO and DNSPs, other TNSPs through the joint planning processes, SSS Providers would plan for and procure a range of solutions to meet the system strength standard while maintaining the general stability of the power system. These joint planning obligations are discussed further below in appendix B.7.4.

For example, the figure below demonstrates how SSS Provider investment in network or non-network solutions for system strength may change over time. The figure above represents an indicative system strength node where there is a demand for system strength.

Figure B.3: How system strength investment should change over time



Source: AEMC

The figure can be interpreted as follows, comprising the:

- white area (top third of the graph), which represents the system strength needed to manage inverter driven instability. This is the system strength that would facilitate the stable operation of IBR plant in the system.
- light grey area (middle third of the graph), which represents the minimum levels of system strength needed for system security — these are the minimum fault levels needed to maintain the effective operation of protection equipment
- dark grey area (bottom third of the graph), which represents the broader system stability requirements. This is the general stability and operability of the system that has traditionally been provided by specific assets, as described in section 2.3.

In year 1, the SSS Provider may find (working with AEMO, DNSPs and other TNSPs through the joint planning process) that the dispatch of existing synchronous generating units is the only option available to effectively meet the minimum fault level requirement at this node — the light grey area.

The SSS Provider may therefore enter into contracts with these units — which is the portion of the orange bar that falls over the light grey layer in year 1. Contracting with this synchronous generator (or combination of generators) would therefore also provide a benefit in terms of the broader power system stability — as shown by the portion of the orange bar that falls over the dark grey layer.

The SSS Provider may also procure other network solutions to meet the IBR hosting portion of the system strength requirement — such as collective retuning, or building a synchronous condenser — as shown by the blue bars. There may be some overlap between these solutions, and the system strength provided by the synchronous generators — as shown by the light blue portion of the blue bar.

Over time, the SSS Providers works with AEMO (as well as DNSPs and other TNSPs) to develop new solutions to meet the minimum system strength requirements, it may be possible to reduce the number of synchronous units that are procured, and to replace these with other solutions — this is represented by the falling orange bars in years 2 and 3.

Over time, it may be possible to meet all minimum system strength requirements through the use of solutions other than synchronous generators, as represented by the blue bar in year 3. However, as described in Chapter 2, system strength is separate to the maintenance of general power system stability and operability. It is therefore possible that some synchronous generation may still be needed, even where the SSS Provider is meeting all of its system strength obligations through non-synchronous generation solutions.

This figure is intended to demonstrate that, as AEMO's and SSS Providers' understanding of the power system and different solutions to system strength improves, the SSS Provider may move towards a portfolio of network and non-network solutions to meet the both minimum fault levels and efficient levels of system strength in a co-optimised manner. That is, without overlaps in procurement or needing to rely on existing synchronous generation only for a certain portion of the service it procures. Existing synchronous generation may of course still be selected as part of an SSS Providers portfolio of solutions to provide the efficient level of system strength if least cost.

The AEMC notes that this figure is generalised for an indicative node only, and indicative timeframe. Depending on circumstances, an SSS Providers reliance on existing generation to provide part or all of the efficient level of system strength may change much more quickly, or much more slowly, or there may not be such a reliance at all. Also, at a real node, the total demand for system strength (the minimum fault level and efficient level) is likely to change over time as the local power system and its projections of connections evolve.

B.6.5 System strength services above the minimum three phase fault level

The draft rule maintains the ability for AEMO to enable system strength services for the minimum three phase fault level required to maintain system security. This is the level of system strength as described in the first 'limb' of the new system strength standard in S5.1.14.

It does 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 limb 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, system strength to meet the second limb of the standard through resources contracted by the TNSP 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 in order to deliver system strength above minimum levels in operational timeframes. In effect this means system strength can be provided above the minimum to meet the second limb of the standard.

The draft rule does not include the ability for AEMO to enable system strength contracted services for the second limb given that there are ongoing parallel processes that are 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 occurring through the ESB Post 2025 work on essential system services and the AEMC's consideration of the *Capacity commitment mechanism* proposed by Delta Electricity and the *Synchronous services market* proposed by Hydro Tasmania.

The Commission considers it is important for the ESB and other AEMC work to continue in order to determine whether these other reforms can develop a more fulsome solution to the issue about how such contracts can be most effectively used in operational timeframes.

In the absence of these parallel processes addressing this issue, the Commission considers that there are two other options for how these contracts could be enabled:

1. **Retain the approach taken in the draft rule** and only allow for non-network solutions that do not require AEMO to issue instructions to be used in operational timeframes, such as those to meet the minimum three phase fault level. If there are contracts entered into by SSS Providers to meet the second limb of the standard, then these wouldn't be enabled by AEMO. However, the contract itself could set up by TNSPs such that generators make themselves available in dispatch via self-commitment into the wholesale market in order to meet their conditions in the contract. In effect this would mean these contracts would be able to be used in operational timeframes to provide system strength above the minimum levels.
2. **Amend the 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. The Commission has decided not to amend the broader non-market ancillary services (NMAS) frameworks at this time due to the considerations set out above. Further, the NMAS framework does not have a detailed infrastructure for the enablement, information sharing, and approval of contracts by AEMO for those network support agreements outside of the NSCAS framework (i.e. for those procured by TNSPs to meet the standards under S5.1). Clause 5.20C.4 currently provides this more detailed infrastructure for system strength services under the existing framework and the draft rule. While possible to amend the NMAS framework to include the kind of requirements such as clause 5.20C.4, the Commission considered that this may have unintended consequences including more stringent requirements than necessary for all the other network support agreements – present and future – that TNSP's use to meet other S5.1 standards than the system strength standard. These would need to be worked through if this approach was adopted.

For completeness, the current system strength framework is excluded from the network support and control ancillary services (NSCAS) framework, with this exclusion continuing under the draft rule.¹⁴⁸ This was considered previously by the Commission when it concluded that the fact that NSCAS framework allows AEMO to act as a procurer of last resort could result in reactive procurement outcomes and has some perverse outcomes with a doubling up of procurers in the investment timeframe. This thinking is why the current system strength framework is excluded from the NSCAS framework. The Commission continues to hold this view. Therefore, the Commission considers that this framework is not suitable for the evolved system strength framework and why the draft rule continues excludes system strength services from the NSCAS framework.

The Commission is interested in stakeholder views on these issues.

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B.7 Integration of the standard into AEMO planning processes

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 when determining the efficient level of system strength to meet the standard at each system strength node over time.

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).¹⁴⁹
- Determine the minimum fault levels at these nodes that are required to be met in the timeframes specified in the standard,¹⁵⁰ and the forecasts for how they may change over the ten-year horizon.¹⁵¹

¹⁴⁸ See the definition of 'NSCAS need' in Chapter 10 of the Draft Rule.

¹⁴⁹ Clause 5.20C.1(a) of the Draft Rule.

¹⁵⁰ Clause 5.20C.1(b) and clause S5.1.14 of the Draft Rule.

- Projecting the efficient amount and types of generation due to connect in an area, as informed by relevant ISP projections and other planning processes such as the ESOO.¹⁵² 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 (what SSS Providers use to determine the efficient level of system strength to procure).
- Undertake appropriate joint planning with SSS Providers to enable efficient sharing of information and to collaborate on understanding the impact of different system strength solutions on general power system stability.¹⁵³

Under the draft rule, AEMO would no longer be required to declare shortfalls that a selected SSS Provider must meet.¹⁵⁴ SSS Providers would use the information and projections provided by AEMO to coordinate and plan to deliver all services that constitute efficient level of system strength. This would include ensuring minimum fault levels, which would still be determined by AEMO, are maintained and shortfalls do not occur. The SSS Provider would not be planning to fill gaps in any forecast coincidental provision of system strength but instead procure and pay for any system strength service that is required to meet the efficient level.

In this manner, AEMO would no longer be required to determine and how much system strength is projected to be provided by generators as a result of their expected dispatch patterns in the energy market, as AEMO no longer has to determine the 'gap' between what system strength is needed and how much may be provided in operational timeframes. This should avoid the need for AEMO to undertake complex market modelling to determine what the system strength requirements are that SSS Providers must address to meet the standard.

For example, under the current arrangements for determining a shortfall, AEMO would first run the appropriate studies to determine the minimum fault level required at a node to maintain system security. It would then try to forecast the expected dispatch of synchronous units in the area that could provide system strength over the following five years to establish whether they expect that the minimum fault level will be maintained as a coincidental by-product of the dispatch of synchronous generators in the energy markets. If AEMO finds that these expected dispatch patterns would not be sufficient, AEMO would then have to quantify the extent of the 'gap' or shortfall. Under the draft rule, AEMO would only be required to undertake the first step of this process to determine minimum fault levels that the SSS Provider would then procure to meet the minimum fault level component of the standard. This should simplify AEMO's process to forecast system strength requirements compared to the current arrangements for forecasting shortfalls.

AEMO would still have the ability to manage unforeseen eventualities that impact system strength and system security through interventions. The existing RIT-T exemption for urgent and unforeseen circumstances also provides a potential avenue for SSS Providers to quickly

151 Clause 5.20C.1(c)(2) of the Draft Rule.

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

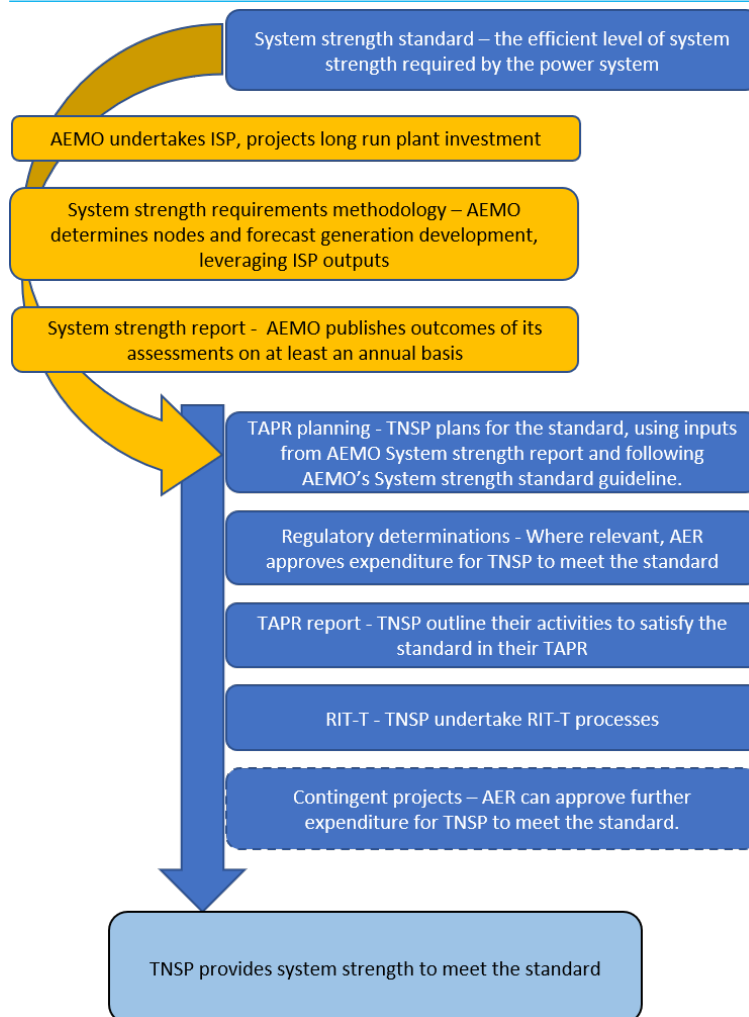
153 Clause 5.14.4(c) of the Draft Rule.

154 Clause 5.20C.2 of the NER is omitted.

address unforeseen network issues that would adversely affect the reliability and secure operating state (i.e. security) of the transmission network.¹⁵⁵ This is also discussed in appendix B.9.2.

AEMO's planning processes are the initial steps required to translate the SSS Provider obligations under the system strength standard into efficient SSS Provider investment in system strength solutions, as show in Figure B.4 below.

Figure B.4: 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.

These responsibilities are explored further in turn in the following sections.

¹⁵⁵ AER, *Regulatory investment test for transmission application guidelines*, 25 August 2020, pg. 12

B.7.1 Determining nodes where the standard should apply

Under the draft rule, 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. The system strength standard would apply at each of these nodes.¹⁵⁶

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.¹⁵⁷ This time period is considered to be sufficient for SSS Providers to account for this new area of the network that the standard will apply including the forecasts by AEMO, undertake their planning processes, and procure the most appropriate (network or non-network) solutions. However, we consider this may be possible to occur in a shorter time period and have provided the flexibility for this to be achieved through the agreement of an earlier date by AEMO and the SSS Provider. This is discussed further below in appendix B.7.3.

The draft rule requires AEMO to provide an overview of system strength nodes and the process to declare them in its system strength requirements methodology.¹⁵⁸ To determine these nodes, AEMO must take into account the matters in clause 5.20.6(e). The draft rule does not amend clause 5.20.6(e), other than to substitute 'fault level nodes' with 'system strength nodes'. Therefore, AEMO would take into account the same factors, which are important in terms of system strength such as:

- Which points in the power system minimum fault levels would best be monitored and maintained. As per the current minimum system strength framework, such areas include load centres, synchronous generation centres and areas with high densities of existing or committed IBR.
- Where AEMO projects efficient levels of IBR to connect; that is, IBR development of sufficient density projected as part of the least cost pathways under the ISP, given forecast non-IBR, as well as its projections of where plants that may supply system strength will connect.

The AEMC's expectation in making this draft rule is that AEMO would declare some representative nodes at practical locations in each region. This may look like retaining the existing nodes that have been declared as fault level nodes under the current arrangements, with the addition of a new nodes in areas of concentrated IBR development, such as in a renewable energy zone (REZ). The intent of the rule is that the system strength nodes provide reference points in the system against which SSS Providers plan and procure to meet the system strength standards for local system strength requirements. Therefore, the most practical number of nodes for AEMO to declare would likely be the minimum required to collectively reflect the total system strength requirements of the system without inefficient gaps or overlap.

¹⁵⁶ Clause 5.20C.1(a)(2) of the Draft Rule.

¹⁵⁷ Clause S5.1.14(c) of the Draft Rule.

¹⁵⁸ Clause 5.20.6(f)(1) of the Draft Rule.

There may be benefit in AEMO considering declaring a node at locations where there is current and projected latent system strength. That is, in locations where there is projected to be more than enough system strength to meet minimum levels and support any expected new connections without the need for SSS Provider investment in the foreseeable future. Such areas would, all else equal, be efficient for new plant to connect. This would allow new connections to pay a charge under the proposed SSMR framework instead of needing to fund their individual remediation of their whole system strength impact (see Appendix D). The system strength charge would be lower at locations with latent system strength as the SSS Provider would have to procure little or no additional system strength to meet the standard as a consequence of the connection. This should preserve incentives for new connections to connect in the most cost effective areas of the NEM.

B.7.2

Projecting the system strength requirements that inform the minimum fault level requirement and stable voltage waveform criteria

Under the draft rule, AEMO would be responsible for determining the efficient level of system strength a SSS Provider must provide to meet the standard by projecting how the system strength requirements (the supply and demand for system strength) at a node changes over time and then confirming those forecasts as actual requirements three-years out.¹⁵⁹

Projections of system strength requirements made by AEMO, including minimum fault levels and generation and load development to support, would leverage existing planning processes and outcomes in the ISP. AEMO has also suggested that planning process undertaken for projects like the ESOO may also be relevant. Therefore, the outputs of these other processes and reports would be required considerations that AEMO must take into account in determining the nodes.¹⁶⁰

SSS Providers are substantially involved and consulted in these existing processes, promoting an appropriate two-way flow of information between the parties when planning under the standard. Through practical processes, like joint planning, SSS Providers and AEMO would work together to determine how much system strength to procure to meet the standard, including efficient volumes to support at a node, expected dispatch traces of projected connections and system operational conditions being planned for.

AEMO would also detail the exact processes it uses to determine system needs to be captured under the standard in its system strength requirement methodology. AEMO would be in the best position to develop, with stakeholder consultation, how the efficient level of system strength is determined as it would involve similar considerations and collaboration with SSS Providers and other stakeholders to planning processes such as ISP scenario projections. The draft rule requires that AEMO must include in this methodology:

- A description of the technical detail of what constitutes stable voltage waveforms, what SSS Providers must account for when assessing projected connections, and how it should maintain voltage waveform stability under the stable voltage waveform criteria

¹⁵⁹ Clauses 5.20C.1(c)(2), (d) and (e) and clause S5.1.14 of the Draft Rule. The three-year period is discussed below in the next section.

¹⁶⁰ Clause 5.20.6(f)(3) of the Draft Rule.

component of the system strength standard, as discussed in appendix B.6.2. This is to include a description of any modelling and analysis methodologies AEMO deems appropriate for this purpose.¹⁶¹

- The assumptions used by AEMO, including how it leverages processes such as the ISP, to determine the system strength requirements including assumptions about the size, type and operational profile of facilities or classes of facilities to be connected and their contribution to the matters taken into account in determining the system strength requirements.¹⁶²

In developing this methodology, we expect that AEMO must consider both system strength requirements to maintain system security and reliability, and requirements that would result in least cost pathways for consumers over the long-term through processes such as the ISP.¹⁶³ While the draft rule does not require this, the Commission would expect that AEMO might take into account such factors as:

- the density of connections and the minimum fault level at the node to determine whether a centralised SSS Provider solution would more efficiently service connections than individual remediation works otherwise required
- local power transfer limits and expected levels of constraint on different amounts of projected generation
- likelihood of dispersed, individually operated system strength assets and their potential impact on system operability and planning
- risks of planned or unplanned outages, including consideration of contingency risks caused by generation or system reliance on system strength providing assets
- risks of existing generation retirement paired with delayed connection of new generation leading to reliability concerns
- total system costs and system operability risks

Based on the system strength requirements methodology described above, AEMO would then publish in the system strength report, the actual system strength requirements.¹⁶⁴ Each annual publication of this report, or any necessary inter-annual update, could be used as the trigger for SSS Providers to reassess their planning to meet the standard.

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, as discussed in appendix B.6.3.¹⁶⁵

B.7.3

Standard set in Schedule 5.1.14 with AEMO determining the standard's specifications

The draft rule provides guidance in terms of the timeframes in which the SSS Provider's obligations under the system strength standard are determined. This reflects the fact that

¹⁶¹ Clause 5.20.6(f)(4) of the Draft rule.

¹⁶² Clause 5.20.7(d) of the Draft rule.

¹⁶³ Clause 5.20.6(f)(3) of the Draft Rule.

¹⁶⁴ Clause 5.20.7 of the Draft Rule.

¹⁶⁵ Clause 4.6.6(a)(2) of the Draft Rule.

AEMO must undertake forecasting to determine several key variables, which the SSS Provider must then consider when it plans to meet the standard.

The draft rule seeks to strike a balance between the difficulty of accurately forecasting these variables years in advance, with TNSPs requirement for enough time for effective planning.

The draft rule requires AEMO to determine and forecast the system strength requirements over a 10 year horizon, which includes the location of where the system strength needs, as well as the amount of system strength needed at that location for the relevant year. These forecast requirements are determined by AEMO in its system strength report¹⁶⁶ using its system strength requirements methodology.¹⁶⁷

These system strength requirements include:¹⁶⁸

- the location of where the system strength standard must be met - being the system strength nodes
- the level of system strength service required at that location. This includes:
 - the minimum fault level required for the correct operation of protection systems of plant and network assets.
 - the level of system strength required to achieve stable voltage waveforms such that for the level and type of inverter based resources and market network service facilities, as projected by AEMO.

AEMO is required to set out these requirements over a ten-year planning horizon. However, as described further below, the SSS Provider only faces a firm regulatory obligation to meet the requirements three-years after AEMO has determined the requirement. This part of the requirement (i.e. when the forecast becomes an actual requirement) is the system strength standard specification.¹⁶⁹

The specification therefore effectively determines the standard that the SSS Provider must use reasonable endeavours to meet.¹⁷⁰ The forecast requirements beyond 3 years remain forecast system strength requirements that the SSS Provider can take into account in its planning, but does not yet have a regulatory obligation to meet.¹⁷¹

Therefore, to allow sufficient time for the SSS Provider to properly plan to meet its obligations, the draft rule requires AEMO to determine the system strength standard specification, as part of its forecast system strength requirements, *three-years in advance* of when the SSS Provider must actually meet the specification. 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 out by AEMO, three-years following the date at which this specification is set by AEMO.

¹⁶⁶ This report must be done in accordance with clause 5.20.7 of the Draft Rule.

¹⁶⁷ This methodology must be created and maintained in accordance with clause 5.20.6 of the Draft Rule.

¹⁶⁸ Clause 5.20C.1 of the Draft Rule.

¹⁶⁹ Clause S5.1.14(a) of the Draft Rule.

¹⁷⁰ Clause S5.1.14(b) and (c) of the Draft Rule.

¹⁷¹ Clause S5.1.14(a) of the Draft Rule.

The SSS Provider may take into account the forecast system strength requirements for the other years in AEMO's 10 year forecast, and any changes to these requirements in updated projections in subsequent years, to determine the most efficient investments to meet the standard. In doing so, the SSS Provider may consider whether more efficient solutions can be procured, given its considerations of likely future outcomes as forecast by AEMO. The draft rule therefore does not prohibit the SSS Provider from acting early to meet the forecast system strength requirements at a node where efficient and practical to do so.

SSS Providers would be able to plan and procure to meet short term forecast requirements where they deviate from the system strength standard specification set three-years out or plan and procure early to simultaneously meet both the current system strength standard specification and expected increases in the specification over the following years, where practical and efficient to do so. SSS Providers are therefore expected to make investments in line with investments expected of a prudent transmission business, given the information they have available. This includes AEMO's forecast system strength requirements beyond the 3-year deadline of the system strength standard specification, their own information, and the ability to provide more services than strictly required under the standard such that they may realise economies of scope and scale.

For example, SSS Providers may find it efficient to upsize or modify a system strength solution to meet both the current system strength standard specification and that will also meet increases in the specification determined or expected for future years. Similarly, the SSS Provider may also find it efficient and practical to procure system strength services to meet forecast system strength requirements within the three-year time frame, such as to meet updated forecast requirements for one or two years out that have increased from the system strength standard specification set three-years prior to it binding.

However, in any given year, the regulatory obligation on the SSS Provider is only to meet the system strength standard specification for that year (starting 1 September), as specifically determined from AEMO's forecast system strength requirements published in its system strength report, three years prior.

This three-year period between when AEMO identifies the system strength standard specification and when the SSS Provider is obligated to meet them, has been designed to provide SSS Providers with a sufficient time to undertake efficient planning. This is important so that SSS Providers can consider the full range of potential solutions, to help keep prices as low as possible for customers.

This has been balanced against the rate of change in the power system, and the extent to which this may affect AEMO's ability to accurately forecast system strength needs. As such, the Commission considers that a three-year period represents an appropriate balance between these two issues.

The Commission notes that AEMO retains the flexibility to update its projections of system strength requirements as it deems necessary, to inform its own operation of the power system and to better inform SSS Providers and market participants of the nature of the changes in system strength over time. SSS Providers would also be able to take account of any changes in AEMO's forecasts that may occur within the three-year period, and may elect

to adapt any planned solutions to meet their system strength obligations, where this is possible. However, to provide a degree of certainty and predictability, SSS Providers will not face a regulatory obligation to do so.¹⁷²

This approach embeds the system strength standard, and the determination of the system strength standard specification by AEMO, in the continuous and iterative planning processes of TNSPs.

The draft rule requires 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. This should allow sufficient time for TNSPs who are SSS Providers to include these forecast requirements and the specification in their annual planning reports of that year, which must be published by 31 October.

The draft rule allows AEMO to update the system strength report and to publish updates to the system strength requirements.¹⁷³ AEMO may elect to do this when a material change has occurred, in order to update the market of the new conditions and projections. However, if AEMO update the system strength requirements within the three-year period, these updates would not change the system strength standard specifications that the SSS Provider is obligated to meet, within the given three-year period. However, these updates would change the minimum fault levels required for security for AEMO's purposes of maintaining system security under Chapter 4 of the NER.¹⁷⁴

Figure B.5 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), 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). 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.

172 Clause S5.1.14(c) of the Draft Rule.

173 Clause 5.20C.1(e) of the Draft Rule.

174 Clause 5.20C.1(a) of the Draft rule.

Figure B.5: 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. Forecast system strength requirements are shown in generic units for illustrative purposes only. 2. 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.

B.7.4

System strength service provider joint planning obligations

The draft rule introduces new joint planning obligations, which would leverage those that already exist, to ensure that SSS Providers undertake thorough joint planning with AEMO, and other NSPs where necessary, to determine the most efficient way to maintain the system strength standard.

Joint planning is crucial throughout both AEMO and TNSP planning processes proposed under the draft rule. The new obligations proposed by the draft rule related to joint planning between:

- **The SSS Provider and AEMO** — Proposed new clause 5.14.4(d) specifies that AEMO and SSS Providers must take reasonable steps to cooperate and consult with each other where a possible credible option for a SSS Provider to provide the system strength requirements for a system strength node involves non-network options that affect dispatch. Therefore, the SSS Provider would collaborate and cooperate with AEMO when the SSS Provider is looking to procure a non-network solution to meet the standard that must be dispatched in real-time by AEMO, or otherwise affects 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 timeframe.
- **The SSS Provider and TNSPs** — Proposed new clause 5.14.3(b) requires joint planning between the SSS Provider and any relevant TNSP (who may also be an SSS Provider) where a possible credible option for a SSS Provider to provide system strength requirements for a system strength node involves an augmentation to the transmission network of another TNSP. That is, when the SSS Provider is considering potential solutions to system strength that involve augmentation to other transmission networks. 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.

Many of the key AEMO and SSS Provider planning processes proposed under this draft rule would 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** — Joint planning between SSS Providers and DNSPs is critical when exploring and procuring potential system strength solutions that would be installed or operated in distribution networks. 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. These joint planning arrangements provide DNSPs with opportunity for input and involvement in system strength planning under the standard without extending a full obligation to meet the standard to DNSPs.

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 Providers' own network needs contributes 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).

B.8 Integration of the standard into SSS Provider's TNSP planning processes

Like other standards, the system strength standard would place an obligation on SSS Providers that can be integrated into their existing annual planning process and TAPR publications.

By integrating SSS Providers' obligations into existing TAPR planning processes, TNSPs would be therefore be able to co-optimize all its system service obligations and resultant network investments with its 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-optimize system

strength solutions with other power system stability services, such as reactive power control or inertia.

The annual planning review process currently requires TNSPs to plan over a 10-year time horizon. This 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 under should allow SSS Providers to consider 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. The draft rule has made additions to the TAPR requirements such that all of the below information would be included in a SSS Provider's TAPR:¹⁷⁵

- 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.

The intent of including these clauses is that the TAPR:

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

B.9 Integration of the standard into existing TNSP economic regulation framework

This section discusses:

- how TNSPs revenue will be used to meet the new standard,
- the application of the regulatory investment test for transmission (RIT-T), including that used for ISP projects, to investments to meet the standard.

The revenue and pricing aspects of how the standard is integrated into the economic regulatory framework is discussed further in Appendix D.

¹⁷⁵ Clause 5.20C.3(f) of the Draft Rule.

B.9.1 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.¹⁷⁶

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 5.1.14 is defined as a new service — the system strength transmission service.¹⁷⁷ The draft rule defines this new service as part of 'prescribed TUOS services', which are already a category of prescribed transmission service.¹⁷⁸

The draft rule proposes 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, SSS Providers will forecast operating and capital expenditure needed to meet the standard as part of their revenue proposal.¹⁷⁹ This means that the standard would be treated the same by SSS Providers as other regulatory obligations placed on TNSPs that it forecasts operating expenditure and capital expenditure for.

The pricing requirements relating to SSS Providers are discussed in Appendix D.

B.9.2 Application of the RIT-T

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 is required for this 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.¹⁸⁰ 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.

¹⁷⁶ 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 commercial return on capital.

¹⁷⁷ See the definition in Chapter 10 of the Draft Rule.

¹⁷⁸ See the definitions in Chapter 10 of the Draft Rule and NER.

¹⁷⁹ Part E of Chapter 6A of the NER.

¹⁸⁰ Clause 5.15A.1(c) and 5.15A.2(b)(12) of the NER.

The draft rule introduces an obligation on SSS Providers to meet a system standard in Schedule 5.1 of the NER. This enables TNSPs to undertake a reliability corrective action RIT-T.¹⁸¹ 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 are proposed as part of this draft rule. However, the existing Rules provide for exemptions from 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. This test is unlikely to be met for system strength given the requirement that it is necessary that the assets or services to address the issue be operational within 6 months of the issue being identified and the ability for AEMO to manage short term risks through interventions; but does allow for any urgent and unforeseen issues to be dealt with through this existing process.¹⁸²
- **ISP actionable projects** — If AEMO includes a system strength project in the ISP as an actionable ISP project, a shortened RIT-T process applies.¹⁸³

Further details on the transitional arrangements of the draft rule are discussed further in Appendix E.

B.9.3 ISP actionable projects

The ISP provisions are 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 will give AEMO the ability to include system strength issues in the ISP, but will not preclude TNSPs from also progressing system strength investments outside of the ISP.

B.10 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. The AEMC considers the draft rule is compatible with the performance of AEMO's declared network functions because

¹⁸¹ 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.

¹⁸² Clause 5.16.3(a)(1) and (b) of the NER.

¹⁸³ Clause 5.15A.3 of the NER.

AEMO is the transmission network planner and is responsible for providing shared transmission services in Victoria.

There are some differences in how the Rules apply in Victoria in relation to Chapter 5 of the NER.¹⁸⁴ The AEMC 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 draft rule. The AEMC also does 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.¹⁸⁵ This is because, while the draft rule introduces 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 would also continue to apply to AEMO's investment decisions in the same way as other TNSPs, as it currently does.

¹⁸⁴ See, for example, clause 5.1A.1(d) and rule 5.3B of the NER.

¹⁸⁵ Appendices D and E discuss other aspects of the draft rule that necessitate amendments to the Rules and transitional arrangements.

C DEMAND SIDE: TWO NEW GENERATOR ACCESS STANDARDS

BOX 6: SUMMARY OF KEY POINTS

The 'demand side' reforms of the draft rule introduce two new access standards that relate specifically to system strength. These new standards would help manage the relevant IBR plant's demand for system strength, complementing the supply side reforms.

These new access standards are for:

- Minimum short circuit ratio (SCR), requiring new connecting inverter based resources (asynchronous generating units and inverter based loads) and MNSPs to be capable of meeting all of their agreed performance standards at a 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.
- Generating systems comprising partly or fully of asynchronous generating units to not include 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 would apply for 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 would 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 is discussed in Appendix E.

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 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. However, there is currently no similar provision in the NER for loads and MNSPs to alter plant and re-negotiate their registered performance standards. As such, the draft rule introduces a new clause 5.3.12 that would allow relevant inverter based loads and MNSPs to renegotiate technical performance in respect of the SCR requirements if they alter their plant in future.

This Appendix details the 'demand side' reforms of the draft rule, which include two new proposed access standards for system strength that would apply to inverter based resources that create a 'demand' system strength — including generator, load and market network service provider plant. The purpose of these new standards is to help manage the demand

for system strength by requiring and incentivising plants to focus on reducing their demand for system strength.

These demand side reforms complement the supply side mechanism, by introducing new mandatory technical limits on new connecting IBR plant (be it a generator, MNSP or load IBR plant) that underpin the way that the 'demand' for system strength services is managed.

These standards form 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. In addition, including minimum access standards in relation to system strength provides a backstop level of performance that places a cap on the amount of system strength services used by newly connecting IBR plant, by mandating that they can operate at a minimum capability. This would help to promote the effective use of system strength in the system, minimising costs for consumers and therefore promoting the NEO.

The new voltage phase shift standard, which is applied only to asynchronous generating systems, would 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.

In this appendix, 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, 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 explores:

- Appendix C.1 sets out the background of the existing arrangements, including the current 'do no harm' frameworks and existing access standards
- Appendix C.3 sets out the Commission's view on issues with the current arrangements
- Appendix C.3 sets out a short summary of TransGrid's views related to this issue, as set out in the rule change request
- Appendix C.4 sets out stakeholder views on this issue
- Appendix C.5 sets out a summary of the Commission's findings on this issue in the *Investigation*
- Appendix C.5 sets out the Commission's draft decision, considering:
 - who demands system strength and the benefits of the demand side reforms
 - the new short circuit ratio access standard
 - the new voltage phase shift access standard
 - application of 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.

C.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.

C.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 occurs by requiring 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.¹⁸⁶

C.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.¹⁸⁷

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 (transmission or distribution) network service provider, to determine generator performance standards (GPS) that are specific to each generating system.¹⁸⁸ These GPS must meet the requirements of the generator access standards.¹⁸⁹

These access standards include a wide range of requirements related to the secure operation and planning of the power system.¹⁹⁰ 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.

186 Clause 5.3.4B of the NER.

187 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.

188 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.

189 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.

190 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).

Those current standards that are relevant to the discussion in this chapter are set out below.

Short circuit ratio

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 meet 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.¹⁹¹

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.

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,¹⁹² voltage magnitude disturbances¹⁹³ and multiple network faults.¹⁹⁴ 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, clause S5.2.5.5 of the Rules does require a generating system, and each of its generating units, to remain in continuous uninterrupted operation¹⁹⁵ for any disturbance caused by a credible contingency event.¹⁹⁶ 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 the tripping or switching of a transmission line, which is a credible contingency.

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 to the plant may be required, including the upgrading and replacement of some sub-systems. These

191 Schedule 5.5.4 of the NER.

192 Schedule 5.2.5.3 of the NER.

193 Schedule 5.2.5.4 of the NER.

194 Schedule 5.2.5.5 of the NER.

195 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.

196 The automatic and minimum access standards are in S5.2.5.5(c)(1) and S5.2.5.5(k)(1) respectively.

upgrades and changes may affect the way the plant behaves, and its ability to continue to meet its GPS. In the case of generators, clause 5.3.9 provides a process to renegotiate the affected aspects of the GPS.

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:¹⁹⁷

- 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 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.¹⁹⁸

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

As an addition to TransGrid's proposal of 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 at an SCR of 2 at its connection point'.¹⁹⁹

C.3 Commission's views on issues with the current arrangements

This section covers the Commission's views on the issues with the current arrangements, namely the 'do no harm' arrangements and the current access standards.

C.3.1 Issues with the 'do no harm' arrangements

As discussed in section 3.3.2, 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 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 existing 'do no harm' arrangements incentivise generators and MNSPs to use inverters with a good performance at a low SCR to reduce the size of the system strength impact, and hence the cost of any remediation. However, these arrangements do not provide this

¹⁹⁷ Clause 5.3.9(b) of the NER.

¹⁹⁸ Clause 5.3.4A(b)(1A) of the NER.

¹⁹⁹ *TransGrid, 2020, Efficient management on system strength on the power system — Rule change proposal, p. 11, 27 April 2020.*

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.

In addition, the 'do no harm' arrangements do not 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. This could potentially lead to loads inefficiently consuming system strength, thus increasing the costs to customers in the future should available system strength in that part of the system reduce.

C.3.2 Issues with the current access standards

The Commission believes there is a need for the access standards to more directly speak to what is required of connecting plant to increase their ability to operate in environments with low levels of system strength, and therefore potentially reduce their demand for the service. As noted above, while some access standards speak implicitly to these matters, none do so explicitly.

Clarity around these requirements would subsequently reduce the amount of work required by connecting parties to remediate their impact, either individually or as reflected through a lower system strength charge.

New access standards are also required to clarify how asynchronous generators²⁰⁰ should maintain stability following a voltage phase shift. This is an emerging issues for asynchronous generators connected to low system strength networks, and would support the general stability and security of the power system.

In relation to the renegotiation of access standards, a generating system that was connected prior to the commencement of the draft rule would not have a performance standard related to the two new access standards that would be introduced under this draft rule. Therefore, if the generating system is altered then it is unclear how these new access standards would be treated under the process in clause 5.3.9.

In addition, clause 5.3.9 only applies to generators that alter their generating systems but there are currently no equivalent provisions for loads and MNSPs to alter their plant and re-negotiate their registered performance standards. It also does not include links to the new access standards S5.2.5.15 and S5.2.5.16 proposed under the draft rule.

C.4 Stakeholder's views

Stakeholder views relating to do harm arrangements were 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.

²⁰⁰ The term asynchronous is used in the NER to refer to those generating units and generating systems that do not consist of synchronous generating units. While this is not the most accurate description of this plant type, it has been used in this Draft rule to maintain consistency with the way the NER describes this type of plant.

C.5 Recommendation from the Investigation

In the Final Report of the *Investigation*, the AEMC proposed two changes to the generator access standards, to introduce two new standards for system strength for generators. These standards would require generators to be capable of the following:

1. Short circuit ratio — having a general capability to be able to operate stably to a given level of system strength, as measured by a short circuit ratio (SCR) capability.
2. Voltage phase shift — having minimum (achievable by type 3 wind turbines) and automatic (higher and achievable by other IBR plant) access standards for maintaining continuous uninterrupted operation following a large shift in the phase of the voltage at the generating system.

This new standard would not apply to synchronous generating systems and would rely on the generator and network service providers to negotiate an appropriate level for the connecting generating system. In each case, the Commission considered that the inclusion of these two additional access standards was expected to:

- enhance security of the power system, by delivering greater certainty that generation that demand system strength will remain stable and connected to the power system under lower system strength conditions
- lower demand for system strength services, therefore reducing the mitigation costs and increasing network hosting capability
- increase 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.

C.6 Commission's draft decision — introduction of new system strength access standards

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: 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. IBR plant that use this type of inverter can be described as "demanding" system strength given they require a stable voltage waveform to operate effectively. The amount of system strength demanded by these resources depends on several factors, particularly the capabilities of the inverter equipment used.
- Grid forming inverters: can create their own voltage reference and do not need a reference from the system. These inverters will not "demand" system strength in the same way as grid following inverters in order to remain stable. These types of IBR plant may in fact contribute to the strength of the power system, however it is also noted that there is significant further work to be done in terms of understanding this technology, and integrating it into the power system.

System strength services may not be efficiently utilised if demand is not adequately managed. This can be done through imposing limits on how much system strength these units can demand, through mandatory technical capabilities in the generator access standards that require them to use inverter equipment with a base level of capability. In addition, the connecting entities are further incentivised to manage demand for system strength through the system strength charge mechanism.

C.6.1 Benefits and role of the demand side reforms in the evolved framework

The draft rule would introduce new access standards in addition to the existing arrangements that relate specifically to system strength for 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 new access standards in the draft rule would place obligations on newly connecting IBR plant under the NER to have equipment with a base level of capability such that they can perform to at least the level defined in the standards. This would support management of demand for system strength, and also would provide a system security backstop, guaranteeing that the plant will remain stable down to a given level of system strength.

The new access standards would also underpin the effective function of the charging mechanism, being the main way in which the demand for system strength is managed efficiently. The inclusion of the SCR access standard provides a mechanism to negotiate and register the SCR requirements of connecting IBR plant, with this then informing the plant's specific 'demand' for system strength (the SSQ component) within the system strength charge, as set out in Appendix D. Thus, the proponents of connecting IBR plant would have an incentive to connect plant that has a low system strength requirement in order to minimise its system strength charge.

The use of new system strength access standards should be simple and effective to implement as they utilise the existing well-known and understood process for negotiating access standards.

As explained in Appendix E, the approach to applying these standards to loads and MNSPs that demand system strength mean that it is technology neutral, consistent with other reforms and sets up the framework to be flexible towards future changes to the power system and technology.

C.6.2 Short circuit access ratio

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 short circuit ratio (SCR) to operate.

The draft rule would introduce a new access standard for a minimum short circuit ratio for new asynchronous generators,²⁰¹ network users where the plant to be connected includes any inverter based resource,²⁰² and MNSP's plant that demands system strength.²⁰³ This new access standard is 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 would 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.

Given IBR plant uses inverters that demand system strength in order to operate stably may be either load or generation, the mechanisms to manage the consumption of system strength would also apply to relevant loads under the draft rule. The draft rule includes 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.²⁰⁴ This is an expansion of the existing 'do no harm' arrangements that only captured MNSPs and generators.

Additionally, as previously noted, the performance standard registered in accordance with the access standard agreed under the new clauses 5.2.5.15, 5.3.11 and 5.3a.7 in the draft rule also informs the system strength quantity used in the calculation of the system strength charge, enabling the charging mechanism to be implemented, discussed in Appendix B.

This 'quantity' is based on an estimate of the consumption of system strength. Because the charge reflects the quantity, it would provide a strong incentive on these connecting parties to reduce their consumption of system strength. This may include 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.

For generators, this is achieved through the new generator access standard in clause S5.2.5.15, requiring new connecting generating systems to be capable of meeting all of their agreed performance standards at a specified short circuit ratio (SCR) level of 3.0.²⁰⁵ This would require the new generating system to be capable of maintaining continuous uninterrupted operation during disturbances and to remain stable during steady state operation, down to a level of SCR. The access standards for new load and MNSPs are in clauses S5.3.11 and 5.3.a.7, respectively.

201 Clause S5.2.5.15(a) of the Draft Rule.

202 Clause S5.3.11(a) of the Draft Rule.

203 Clause S5.3a.7(a) of the Draft Rule.

204 See Chapter 10 of the Draft Rule.

205 The performance that is negotiated with the network service provider, recorded in the connection agreement between the generator and network service provider, and registered with AEMO in accordance with clause 5.3.7(g)(1), clause 5.3.9(h) or established in accordance with rule 4.14.

The requirement would not apply to synchronous generating systems, since the connection of these systems would add to the supply of system strength.²⁰⁶

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. 2) could increase the cost of connecting new IBR generation, by requiring higher capability, more expensive inverters, adding to the cost of new connections, which will eventually flow through to consumer costs. Conversely, a looser standard (i.e. one where the minimum SCR number is higher, e.g. 4) could increase present and future mitigation costs of managing inverter-driven instability.

The draft rule would include a level of the SCR minimum access standards such that IBR plant is able to operate when the SCR is as low as 3.0. This is different to the rule change request which suggested the use of SCR of 2.0. The Commission chose this level for the draft rule because it considers 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.

The SCR access standards in the draft rule are a single minimum access standard, rather than both an automatic and minimum access standard (which is common for many of the access standards). A minimum access standard only is simpler as it removes the need for negotiation and would mean that the:

- connecting equipment must be capable of meeting a given level of performance
- network service providers cannot require that the connecting party's equipment be capable of operating below the level specified in the SCR access standard
- an automatic access standard is not required as the system strength charge will act to incentivise the connection of IBR plant that requires a lower SCR by reducing the charge faced by the connecting party.

Compliance with the recommended SCR standard

The SCR access standard in the draft rule would be 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 prevailing conditions at the connection point. As such, this access standard forms an obligation on the physical capability of the equipment, rather than an actual requirement for the physical tuning and behaviour of the system at its connection in the network during real time operation.

²⁰⁶ Existing stability requirements in the access standards would apply to these generating systems, such as the ability to maintain continuous uninterrupted operation following a fault or following a disturbance to the voltage magnitude or system frequency.

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 and be based on, 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.

The draft rule also includes a requirement for AEMO to include in its system strength impact assessment guidelines:²⁰⁷

- a methodology for the purposes 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 is included to provide consistency of how these standards will be applied by NSPs across the NEM and in so doing providing transparency to connecting parties on what is expected from them to meet by 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.

It is important to note that the new SCR access standards would not:²⁰⁸

- 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.

C.6.3

Voltage phase shift access standard

The draft rule would introduce 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. 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.

Large phase shifts of the voltage that can occur in the power system have caused some generating system inverters to trip following the switching of a nearby transmission element. This occurs if the inverter's control system fails to maintain synchronism with its terminal voltage. This is more likely to occur in weak parts of the transmission network as the phase

²⁰⁷ Clause 4.6.6(a)(3) and (4) of the Draft Rule.

²⁰⁸ Clause S5.2.5.15(d) of the Draft rule.

angle shifts would be larger and the system strength being very low following the switching of the element.²⁰⁹

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.²¹⁰

Large voltage shifts are more likely to be a problem in weaker networks. This is because the voltage phase shifts are generally larger, due to:

- the larger line impedances, and
- because inverter controls find it harder to track the terminal voltage, due to the stronger interaction between the inverters and the network.

The size of a given phase shift of the voltage at the generating system's connection point will depend on the:

- topology and impedances of the relevant part of the network
- distribution of load and generation within this part of the network
- element in the network that has been switched.

National and international experience on voltage phase shift technical standards

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 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.

The Commission notes that there are a number of related national and international technical standards that impose minimum settings for vector shift protection systems.

These include:

- **Australian Standards:** AS4777 that requires three-phase DER inverters to remain in continuous operation for a voltage phase angle shift within a cycle (20ms), in the positive sequence, of at least 20 electrical degrees.²¹¹
- **Institute of Electrical and Electronics Engineers Standard:** IEEE Std 1547 that requires multi-phase DER to be capable of riding through a positive-sequence phase angle changes within a sub-cycle-to-cycle time-frame of less than or equal to 20 electrical degrees. In addition, multi-phase DER shall remain in operation for change in the phases

²⁰⁹ The Commission understands that these issues have been resolved in certain cases by the manufacturer retuning their control systems to better track the phase of the voltage at the inverter terminals.

²¹⁰ 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.

²¹¹ AS/NZS 4777.2:2020, Grid connection of energy systems via inverters, Part 2: Inverter requirements, section 4.5.5.

angle of individual phases less than 60 electrical degrees, provided that the positive sequence angle change does not exceed 20 electrical degrees.²¹²

- **South African grid code:** states that requires generation to be capable of withstanding a sudden phase jumps of up to 20 degrees at the connection point without disconnecting or reducing its output.²¹³

The Commission has drawn on these standards applied in other jurisdictions to inform the development of the new voltage phase shift standard in the evolved framework.

Draft decision

The Commission considers 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 considers 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:
 - international practice, including the IEEE standard
 - the Australian requirements in AS4777 for small distribution connected and customer inverters.

Therefore, the draft rule includes a minimum access standard for voltage phase shift as in clause S5.2.5.16 that applies for generating systems comprising partly or fully of asynchronous generating units. This minimum access standard would not allow the generating system to include 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. The associated negotiated performance standard would be recorded in the generator's performance standards.

The draft rule does 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.

212 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, IEEE 2018, section 6.5.2.6

213 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.

C.6.4 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 make changes to 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).²¹⁴ Therefore, the draft rule includes processes for how relevant load and MNSPs can renegotiate their access standard (new clause 5.3.12) for a minimum short circuit ratio as well as amend the existing process for generators (i.e. clause 5.3.9) to include this new standard.

The existing process set out in clause 5.3.9 of the NER is amended under the draft rule to allow for generators to alter their systems and renegotiate its SCR and voltage phase shift access standards.

The draft rule excludes existing generators from the application of clause 5.3.9, even if they alter their plant in the circumstances under clause 5.3.9.²¹⁵ 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 includes 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.²¹⁶

Similarly to that for generators, this is 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.

²¹⁴ 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.

²¹⁵ Clause 11.xxx.11(c) of the Draft Rule.

²¹⁶ A general ability to renegotiate other access standards is out of scope of the issues being considered for this rule change.

D EFFICIENT COORDINATION OF SUPPLY AND DEMAND SIDE: SYSTEM STRENGTH MITIGATION REQUIREMENT

BOX 7: SUMMARY OF KEY POINTS

The Commission considers the costs of providing system strength services should be paid for — as they currently are today — by both generators and consumers. This is on the basis that such a sharing would align the incentives of market participants to locate in the areas where system strength is provided, thus better utilising this service and better coordinating the supply and demand of system strength. This cost sharing would be facilitated by imposing a charge proportional to consumption of the service on those connecting parties, including generation and load, that require it.

In practice, connecting parties that consume system strength would pay for most of the service used, while consumers would only bear the residual costs of providing system strength on a forward looking basis. Connecting parties can then alter their plant to use less system strength throughout its lifespan using the 5.3.9 or 5.3.12 processes under the draft rule, resulting in a reduced system strength charge.

This would coordinate the supply and demand sides of the system strength framework in order to provide efficient and effective use of the service and mean that costs that flow through to consumers are minimised.

Under the draft rule, the system strength mitigation requirement (SSMR) would coordinate the supply and demand sides of system strength:

- 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 would assist in evolving the current 'do no harm' obligation to support more efficient connection of connecting parties.

At a high level, the choice faced by a connecting party would be to either utilise a system strength service provided by the system strength service provider (SSS Provider), or to provide its own. This means there would be two ways the system strength needed by a connecting party can be provided under the evolved system strength framework:

1. SSS Providers providing efficient levels of system strength (given forecasts of new resources connecting) to provide connecting party hosting capability, with connecting parties charged in proportion to their system strength requirements.
2. The connecting party undertaking remediation itself because of its general system strength impact, as determined by the relevant NSP using EMT type modelling as per 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 to meet their system strength need.

The charge is made up of three components, which, when multiplied together, equal the charge a connecting party would pay:

1. **The system strength unit price** component of the system strength charge reflects the change in **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.
2. **The system strength locational factor** component reflects the localised nature of system strength. This component changes the magnitude of the charge a particular connection would face depending on its approximate electrical distance (or impedance) from the closest system strength node.
3. **The system strength quantity** 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 that connecting parties would now have a choice. They can elect to pay a charge (and potentially reduce it overtime) for the use of centrally provided system strength, or model their own impacts and undertake their own remediation actions, to manage their own system strength impact. The Commission considers that this choice would help reduce the complexity, and associated cost, of the connection process. The benefits associated with the reduction in investment uncertainty in relation to system strength remediation required, a streamlined connection process, and accurate and timely system strength unit price signals to new connecting plant would all flow through to lower costs for consumers.

This Appendix provides detail on:

- Appendix D.1 and appendix D.3 sets out current arrangements and the Commission's view on the issues with the current arrangements
- Appendix D.2 and appendix D.4 sets out proponents and stakeholder's views
- Appendix D.5 sets out the Commission's recommendations from the *Investigation*
- Appendix D.6 through appendix D.11 sets out the Commission's draft rule and determination, including the specific design decisions:
 - the Commission's draft decision
 - what is the system strength charge
 - who is liable under the SSMR
 - integration of the SSMR into the connection process

- the process when a connecting party chooses to remediate
- integration of the system strength charge into transmission and distribution pricing processes
- Appendix D.12 sets out a brief summary of the differences of its applications in Victoria as an adoptive jurisdiction.

D.1 Current arrangements

Under the 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 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*,²¹⁷ and is undertaken in accordance with the system strength impact assessment guidelines (SSIAG) that are maintained by AEMO. It occurs in two stages:

- A preliminary assessment following the receipt of a connection enquiry, which is based on the available fault level at the connection point, to provide the proponent an indication whether an adverse impact is likely.²¹⁸
- A full assessment following the receipt of an application to connect, unless the preliminary assessment indicates that the full assessment is not needed.²¹⁹ It is required to determine if an adverse system strength impact would occur following the connection and the effectiveness of any system strength remediation scheme or connection works necessary to manage the adverse impact.

This means in practice, the new connecting generator is required to fund the costs associated with the provision of any required system strength services, to address the impact of its connection on the stability of the system or other generating units i.e. to 'do no harm' which is what these arrangements are colloquially known as. This is done either through 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).²²⁰

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.

²¹⁷ Adverse system strength impact is defined in relation to security of the power system and relates to the impact of the connection of the 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.

²¹⁸ Clauses 5.3.3(b5) and 5.3.4B(a)(1) of the NER.

²¹⁹ Clause 5.3.4B(a)(2) of the NER.

²²⁰ Clause 5.3.4B(e) and (f) of the NER.

D.2 Proponent's view on issues with the current arrangements

TransGrid proposed that the rule change removes the 'do no harm' framework.²²¹ It notes that generator connection processes would still require each plant to negotiate and meet generation performance standards (GPS) to connect. TransGrid states this means that generators will not have to undergo the full impact assessment associated with the 'do no harm' obligation. However, if a generator does not locate in optimal (strong) parts of the network then it may result in them being penalised when trying to meet their GPS. By extension, the proposal also expects the risk of constraints will provide an additional locational signal.

Notwithstanding, TransGrid noted that the Commission could consider, in addition to these proposed arrangements, further changes that could improve the effectiveness of the system strength framework. One change relevant is the suggestion that the rule change could require "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."²²²

D.3 Commission's view on issues with the current arrangements

The Commission considers there is strong evidence that the 'do no harm' framework described above requires amendment. Throughout the *Investigation*, engagement with stakeholders following the final report and through submissions to the consultation paper for this rule change request, there has been strong support to make changes to evolve the 'do no harm' obligations. Stakeholders have advised the Commission that the 'do no harm' process is introducing material uncertainty into the connection process and project development and may result in costly and inefficient remediation measures.

Stakeholders have suggested that the current 'do no harm' framework creates a barrier to entry to new connecting generators. It has been argued that the current framework, in practice, has become a key concern and potential deterrent for new entrants in the NEM.²²³

TransGrid noted in its rule change request that a significant contributor to this is the additional time and cost for connection of new generation to the power system. This is due to the system strength impact modelling and remediation requirements of the full impact assessment stage of the 'do no harm' obligation.²²⁴

Further, stakeholders have identified other issues with the 'do no harm' framework, including:

- It requires most new connections to undertake remediation work. This is resulting in numerous discrete, private synchronous condensers being built, maintained and operated in the system, which is actually increasing operational complexity — and which could potentially create system security risks, rather than mitigating them.

²²¹ TransGrid, *Efficient management of system strength on the power system* — rule change request, p. 10-18.

²²² *Ibid*, p. 11.

²²³ Submissions to the Investigation into system strength frameworks in the NEM Discussion paper, CEC, pg. 9, Origin, pg. 1, CEIG, pg. 2.

²²⁴ TransGrid, 2020, *Efficient management on system strength on the power system* — Rule change proposal, 27 April 2020.

- That while co-ordination of remediation work between individual generators is theoretically possible, such outcomes are unlikely in practice, due to project financing, timeframes challenges and the competitive nature of the connection process. This is resulting in piecemeal system strength investments that miss out of economies of scope and scale if they were more coordinated.

The Commission also notes that the current arrangements do not incentivise connecting parties to act in a manner which 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 system strength is provided by the TNSP consistent with it maintaining minimum system strength levels
- connecting parties that 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.

D.4 Stakeholder's views

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.

D.4.1 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.²²⁵ For example:

- Ausgrid stated that removing the requirement "will lead to more efficient system strength planning and management, remove uncertainty for generator investments through reduced connection times, and lead to more predictable and lower cost connection process and lower costs to consumers."
- The Clean Energy Council (CEC) supported replacing the 'do no harm' framework with a centrally coordinated mode that places the risks with AEMO and TNSP who they identify as the "parties best placed to manage this risk."

However, some stakeholders supported retaining the 'do no harm' requirements.²²⁶ This includes:

- Energy Queensland stating that the framework is useful in remote locations and that there is value in the full EMT analysis of connections the framework requires.

²²⁵ Submissions to the consultation paper: AEC, pp. 4-5; Ausgrid, p. 3; CEC, p. 2; Energy Australia, pp. 15-17, Maoneng, pg.5.

²²⁶ Submissions to the consultation paper: Brickworks, p. 8; Energy Queensland, p. 12; Monash University, pg. 25, OMPS Hydro, p. 13; CS Energy, pg. 17.

- OMPS Hydro supports a market solution for system strength and stated that "a market solution could include an optimised TNSP solution to the market. Removing the 'do no harm' requirements also removes the ability for efficient market solutions to solve the problem."

Tesla were supportive of amending the 'do no harm' framework retaining aspects for specific generational types or locations.²²⁷ It stated that by "updating" the framework, barriers to grid-scale renewable connections and associated investments could be removed.

D.4.2 Stakeholder views on cost recovery arrangements

Several stakeholders supported cost recovery arrangements that include a financial contribution for system strength services.²²⁸ These positions included:

- Energy Queensland in particular suggested that any funding mechanism developed "ensure costs do not automatically pass on to end-use consumers..."
- Brickworks' put forward that any existing or connecting generator "should incur a cost to fix a deficiency where it is needed to avoid degrading system strength."

In relation to causer pay arrangements, several stakeholders support some requirement for generators to contribute to the cost of connection, particularly where they are contributing to the need for the provision of system strength.²²⁹ However, ARENA believe it is 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".²³⁰

D.5 Commission recommendation from Investigation

The Commission made a series of recommendations to evolve the existing system strength framework in the *Investigation* final report, which would help facilitate the power system transition.

Key to this Appendix is the recommendation for a SSMR. This would share the costs of providing system strength between customers and generators, but do this in a more pragmatic, transparent manner.

Consumers would pay for system strength (as they do now), reflecting that they derive a benefit from its provision. Generators would also pay a contribution to these costs as they are causing some of the increased need for these services. These fees would then be used to reduce the total amount that customers pay through their TUOS charges. This would result in the effective utilisation of the system strength that is supplied, as well as making sure it is balanced with levels of system strength that are demanded.

These recommendations were designed to address the core concern from stakeholders described above that the existing 'do no harm' framework creates costly time delays and

²²⁷ Tesla, Submission to the consultation paper, p. 19.

²²⁸ Submissions to the consultation paper: Brickworks, p. 8; Energy Queensland, pp. 4, 12-13; Clean Co, p. 9 .

²²⁹ Submissions to the consultation paper: AEMO, pg. 17-18, ARENA, pg. 15, Brickworks, pg. 8, CitiPower, Powercor, and United Energy, pg. 7 CS Energy, pg. 18, GE Renewable Energy, pg. 9, and Walcha Energy, pg. 8.

²³⁰ ARENA, Submission to the consultation paper, p. 18.

unknown remediation requirements that are only confirmed at the end of the connection process, which are negatively impacting on the costs of new investment and project financing. The Commission expected that the ability for connection applicants to select a (forecastable and predictable) charge should alleviate these concerns and assist the connection process as well as project financability. This is because a connection application would be able to avoid the timely and complex modelling required for a full impact assessment and the requirement to remediate entirely when selecting to pay the charge.

Additionally, the Commission noted that charging participants an amount that is reflective of the marginal cost of the provision of system strength by the SSS Provider would incentivise those participants to efficiently utilise the service, trading off the charge against the other costs and benefits associated with their location and plant equipment.

The Commission recommended that the generator charge would consist of three components each reflecting a certain cost to the system and so incentivising efficient decisions by the connection applicant, the:

1. Cost of supplying system strength by the TNSP.
2. Amount of system strength required by an inverter to operate securely and stably.
3. Locational nature of the service, as an inverter require more of the service the further it is from the source of the service.

D.6 Commission's draft decision — Overview of the system strength mitigation requirement

The Commission has continued to develop the SSMR concept through this rule change request, building on the work above through extensive engagement with stakeholders and market bodies resulting in the proposal set out below and contained in the draft rule.

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.

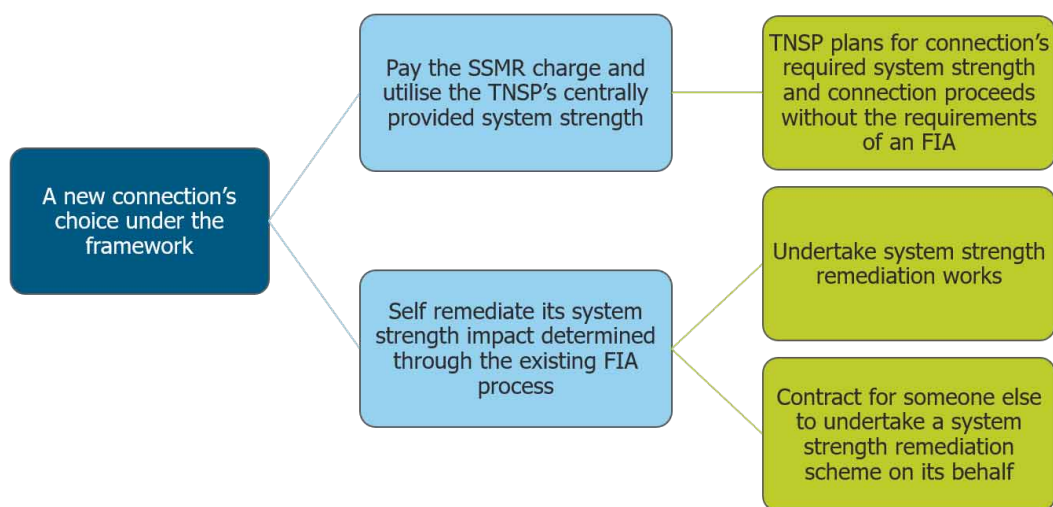
The SSMR process would evolve the current 'do no harm' provisions and would work alongside the supply and demand side reforms to support more efficient connection of connecting parties.

At a high level, the choice faced by a connecting party would be to utilise a system strength service provided by the system strength service provider (SSS Provider), or to provide its own. As shown in the figure below, there would 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:

1. SSS Providers providing efficient levels of system strength to provide connecting party hosting capability, with connecting parties charged in proportion to their system strength requirements.
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 full impact

assessment (FIA) process. Remediation actions include connecting a synchronous condenser behind their connection point, or contracting with a third party to meet their system strength need.

Figure D.1: Choice for a new connection under the SSMR – pay the charge or remediate



Source: AEMC

The rest of this section discusses the benefits of the SSMR while the rest of the Appendix discusses the details of the SSMR.

D.6.1 Benefits of the SSMR

The key benefit of the SSMR is that connecting parties would now have a choice as to how they assist with contributing towards the costs of system strength. They can elect to pay a charge for the use of centrally provided system strength, or model their own impacts and undertake their own remediation actions, to manage their own system strength impact. This choice would provide benefits to connecting parties, by allowing them to select the lowest cost system strength solution to meet their requirements. It would also provide them with increased certainty as to the costs they would face when connecting, reducing any potential investment risks that may current result from estimates of a system strength remediation requirement changing over time as new generators connect.

From a broader perspective, the system strength charge would allow generators to effectively share some of the benefits of the scale economies associated with centralised provision of system strength. The SSMR would also provide benefits the broader system, in that it would provide price signals to connecting parties that more accurately reflect the cost of providing the system strength needed to support their stable operation.

This choice would help reduce the complexity, and associated cost, of the connection process. The connection process for connecting parties would be greatly improved by providing the option of avoiding the extensive modelling process, and uncertainties around

the potential for costly self remediation, by electing to pay the system strength charge and utilising the centrally provided system strength. From this, it is expected that future connections could be streamlined compared to the existing processes.

A key element of the charge will be that it would be transparent. The charge would be calculated using a known formula, and would be based on public information provided through AER, AEMO and TNSP guidelines and methodologies. This would assist in promoting certainty for investors, by giving them something transparent and that is capable of being understood upfront to factor into preliminary considerations about whether to connect to the NEM, and if so, where.

The benefits described above would all ultimately flow through to lower costs for consumers. Therefore, the Commission considers evolving the 'do no harm' obligation into the SSMR best contributes to the achievement of the NEO than the alternatives proposed by the proponent or stakeholders.

D.7 What is the SSMR charge?

The draft rule allows for new connecting parties to choose between paying a charge for centrally provided system strength or to remediate their impact. Before understanding who faces the SSMR obligation and where it is applied, it is important to understand what this new charge option is and how it is designed to efficiently coordinate the supply and demand sides.

This section sets out what is the charge and its three components that reflect the applicant's system strength impact, quantity and location.

D.7.1 Overview of the charge's three components

The underpinning economics of the SSMR framework is to incentivise new connections to make efficient investment decisions relating to location and plant design, as this would influence the magnitude of any charge they face. On the margin, providing the price reasonably reflects 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 will be incentivised to:

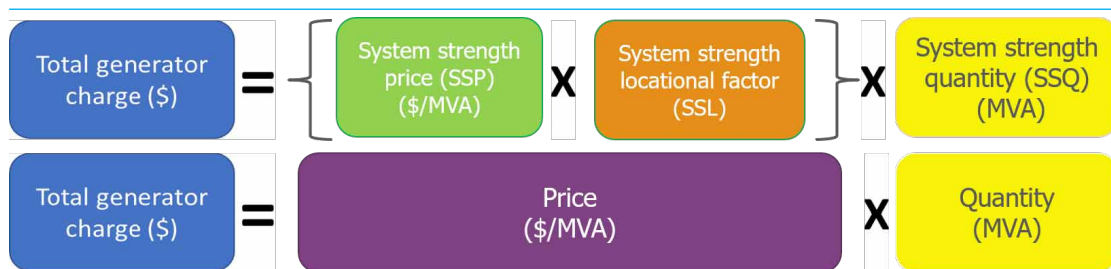
- consume the TNSP provided service where the cost of avoiding it is higher, or
- not consume the TNSP provided service where the cost of self-provision is cheaper.

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 and therefore better contributing to the achievement of the NEO.

The system strength charge would consist of three components combined to send price signals to newly connecting generators, MNSPs and loads.²³¹

²³¹ See clause 6A.23.5(e) and the definition of 'System Strength Transmission Service User' in the Draft Rule.

Figure D.2: Components of the system strength charge



Source: AEMC

It is useful to consider the equation in Figure D.2 above, as follows:

- 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.

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.²³²

²³² Also see clause 6A.23.5 of the Draft Rule.

Table D.1: Summary of system strength charge components

SYSTEM STRENGTH CHARGE COMPONENT	WHAT IT IS REFLECTING	WHO SETS THE METHODOLOGY FOR HOW THIS COMPONENT IS CALCULATED	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. In practice, this should be five years based on current regulatory control periods.	The SSS Provider in its pricing methodology, which must comply with the requirements of the AER’s pricing methodology guidelines. The AER’s pricing methodology guidelines would specify permitted methodologies for determining the SSUP component of the charge.	This would be recalculated by SSS Providers each system strength charging period, which is roughly in line with the regulatory control periods.
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: <ul style="list-style-type: none"> the additional fault level that would need to be added at the nearest system strength node to restore the available fault level (AFL) at the connection point to the pre-connection level, and the system strength quantity requirement of the connecting party plant. This would be fixed for each connection point for which the	AEMO provides guidance through the System strength impact assessment guidelines. 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.

SYSTEM STRENGTH CHARGE COMPONENT	WHAT IT IS REFLECTING	WHO SETS THE METHODOLOGY FOR HOW THIS COMPONENT IS CALCULATED	WHEN/HOW DOES IT CHANGE
	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.		
System strength quantity (SSQ) — yellow	The expected consumption of the service (MVA/MW x MW) by the connecting party connecting to the grid, which would 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 S5.2.5.15, S5.3.11 or S5.3a.7 (as applicable) and AEMO's system strength impact assessment guidelines. Where a party chooses to self-remediate, or has no impact on system strength, the SSQ would be zero and so the system strength charge at that connection point would be zero.	AEMO provides guidance through the System strength impact assessment guidelines. 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 and new clause 5.3.12.

The following sections set out what each component of the charge and the rationale for their selection in more detail.

D.7.2

Component 1: system strength unit price (SSUP) (\$/MVA) — green box

The system strength unit price component of the system strength charge would reflect the change in **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. That is, the change in the investments that would need to be made by the SSS Provider in order to facilitate the connection of an additional user of system strength above that otherwise expected, as determined by AEMO and set out in its system strength report each year.²³³

This forward-looking cost would be determined by the AER.

The Commission's draft decision is that the rules should be relatively high level and principles-based and provide the AER flexibility to determine, and adjust over time, the most suitable methodology — be it long-run marginal costs (LRMC) or long-run average cost (LRAC).²³⁴

LRMC is an economic concept not tied to a firm's historical or "embedded" costs. It is the cost of an additional unit of output on a forward-looking basis over the long-run. LRMC based pricing should be considered as a potential pricing signal to support efficient generation investment and incentivise efficient usage.

This contrasts with LRAC, which simply takes the total cost of the provision of system strength and divides by the units of system strength provided. To provide a simple example, if a synchronous condenser costs \$25 million for a 250MVA unit, then the average cost would be \$25 million/250MVA = \$100 thousand/MVA.

There are a variety of different considerations as to what the relationship between LRMC and LRAC. Key to this is the amount of spare capacity. The LRMC tends towards the average cost as the anticipated change in demand relative to the lumps of capacity expansion gets higher. The presence of material economies of scale and hence lumpy investments relative to the underlying growth in demand will tend to drive differences between long run marginal and long run average costs.

The use of each method has consequences for the incentives created by the charge:

- If the LRAC is similar to the LRMC then the underlying principle of using a marginal cost approach to provide more accurate signals and so preserve the efficiency benefits is retained.
- The LRAC is likely similar to compute and so more predictable for participants.

²³³ See Appendix B for the full explanation of the supply side reforms including more information on the forecasts of expected generation by AEMO and the System strength report.

²³⁴ The Commission considers that of the two options, LRMC will send the most accurate signals to support efficient investment. However, we also understand that LRMC may be approximated by the administratively simpler LRAC in some circumstances. Therefore, providing the AER flexibility in how the "long-run" forward-looking costs of the SSS Provider are calculated was deemed to be the most appropriate and future proof approach to the SSUP methodology.

- There are also implications for residuals — that is, the difference between actually incurred costs and the revenue recovered via the charge. In this case an LRAC method is likely to reduce the amount of residuals, because in the presence of economies of scale, marginal costs are lower than average costs.

From the above it is clear that there is trade-offs between the two approaches, and the extent these arise depend on how close two methods are to each other at a particular point in time. Therefore, the Commission has built flexibility into the framework on this point.

The Commission's desire for flexibility is due to the speed on change in technologies that relate to system strength. This includes both the nature of how system strength can be supplied, as well as the drivers of demand for system strength. Given the rapid pace of transition in the energy sector, the Commission considers that this could change substantially and therefore wishes to set the framework up to be as flexible as possible.

Therefore, the draft rule does not specify a specific pricing structure but instead, provides for the AER to amend its pricing methodologies guidelines in relation to the *system strength unit price* component of the system strength charge, in order to leave the AER a degree of flexibility in this respect.²³⁵

Pricing principles for the system strength unit price component

From this, the SSUP for each of the system strength nodes would be determined by the relevant SSS Provider according to its pricing methodology. This methodology would be approved by the AER to ensure that it follows the requirements provided in the AER's pricing methodology guidelines.

Pricing principles for prescribed transmission services are set out in rule 6A.23. Clause 6A.25.2 sets out the required contents of the AER's pricing methodology guidelines, which includes specifying permitted pricing structures for each type of prescribed transmission service. This clause includes matters the AER must have regard to in relation to prices and price structures for the locational and non-locational component of prescribed TUOS services.

The draft rule adds a new clause 6A.25.2(h) that requires the AER's guidelines to specify permitted methodologies for determining the system strength unit price component of the system strength charge having regard to the following:

- the various components of the system strength charge structure discussed above;
- the desirability of providing efficient investment and system strength transmission service utilisation signals to actual and potential System Strength Transmission Service Users based on the long run cost of providing system strength transmission services at the relevant location;
- the desirability of consistent pricing structures across the NEM; and
- the costs and benefits associated with calculating, implementing and applying the methodology.

²³⁵ Clause 6A.25.2(h) of the Draft Rule.

These factors are based on existing factors for prescribed TUOS services in clauses 6A.25.2(b) and (c) and relevant aspects of the distribution pricing principles in clause 6.18.5(f).

The second factor reflects the intention that the system strength unit price should be based on forecast long run costs of providing system strength transmission services. This contrasts with current prescribed transmission services, where prices are based more directly on the TNSP's maximum allowed revenue for the regulatory control period as determined by the AER, which is then allocated to individual prescribed transmission services based on attributable cost shares in accordance with rule 6A.22.

This factor only refers to 'long run costs',²³⁶ leaving the AER discretion to specify in the guidelines what type of measure of long run costs should be used by SSS Providers, for example long run marginal cost or long run average cost, for the reasons stated above.

Residual costs associated with any cost recovery approach

The Commission is cognisant that there remains the chance of some residual costs (and risks) being borne by consumers. This may be a positive or negative residual – i.e. it is possible to both over-recover and under-recover actually incurred costs during a regulatory year. These may arise in theory due to:

- Carrying costs from the recovery of charges lagging investments: because market participants consuming the services provided by an asset are not expected to connect simultaneously to one another at the time of the asset's completion.
- Changes to the forward-looking estimates of costs in the provision of the service: if the cost of providing the service declines/increases over time due to technological change, then this may result in the systematic under/over recovery of historic costs, all else equal.
- Differences between actually incurred historic costs and marginal, future-looking costs.

To be clear, these residual costs are an inherent feature of any charging regime, regardless of whether it is based on marginal or average costs, which by definition has no regard to historically incurred actual costs. Recovery of (some or all) actually incurred historic costs would be a change to the underlying philosophy of marginal cost pricing, which incentivises efficient use of a service. This fact has been accounted for in the draft rule through the revenue adjustment for a SSS Provider for over and under recovery to be achieved.²³⁷

D.7.3

Component 2: System strength locational factor (SSL) – orange box

The system strength locational factor component reflects the localised nature of system strength. That is, it changes the magnitude of the charge a particular connection would face depending on its approximate electrical distance (or impedance) from the closest system strength node. That is, the locational factor would reflect how much available fault level (AFL) would be required at the system strength node, to return the AFL at the connecting

²³⁶ Clause 6A.25.2(h)(2) of the Draft Rule.

²³⁷ Clause 6A.23.3A of the Draft Rule.

party plant's connection point back to the pre-connection level. This would be based on the change in the AFL at the connecting party's connection point.

As such, the draft rule requires AEMO to specify the following in its SSIAG:

- Guidance on the calculation of AFL for the purpose of calculating the SSL.²³⁸
- A methodology for calculation of the SSL, which must be representative of the impedance between the connection point and the applicable system strength node and must use available fault level as the basis for the methodology.²³⁹

Publication of each SSMR connection point's locational factor – A system strength specific locational signal for the market

Under the draft rule, the relevant NSP must calculate the locational factor for each of its connection points that is a system strength connection point — being one that is paying the charge — every system strength charging period,²⁴⁰ and publish them in their annual planning report each year.²⁴¹

This is because we consider there is value in the locational factors for each SSMR connection point being publicly available information to inform future generator and load connections such that they can assess the likely charges that would apply. This is unlikely to be a significant burden on the NSPs as they generally already publish fault levels at their transmission and distribution connection points.

Circumstances of manifestly excessive locational factor or NSP being unable to reasonably calculate the locational factor – connection must remediate

Under the draft rule, a network service provider is not required to calculate the system strength locational factor where it determines in accordance with the system strength impact assessment guidelines that a system strength locational factor cannot reasonably be calculated or would be manifestly excessive.²⁴² The result of this is that the connection would have to undergo a full impact assessment and undertake remediation. That remediation involves is explored in appendix D.10.

It should be noted that a manifestly excessive or incalculable SSL is a natural outworking of the SSMR framework. In certain parts of the network, it is likely to be more efficient for connecting parties to remediate their own requirements, as opposed to the TNSP providing the service centrally, at very great cost. High (or infinite) SSLs reflect this.

AEMO would provide guidance to NSPs about the circumstances in which the SSL is not reasonably able to be determined or would be manifestly excessive.²⁴³ This should provide transparency as to when a connection is located so far away from a system strength node that the SSL is too large for proper use in the SSMR framework.

238 Clause 4.6.6(a)(2) of the Draft Rule.

239 Clause 4.6.6(a)(1) and (b)(9) of the Draft Rule.

240 Clause 5.3.4C(c) for a NSP who is not a SSS Provider and clause 6A.23.5(h)(1) for the SSS Provider in the Draft Rule.

241 Schedule 5.8(o) for a DNSP and clause 5.12.2(c)(12) for a SSS Provider of the Draft Rule.

242 Clause 5.3.4B(a3) of the Draft Rule.

243 Clause 4.6.6(b)(10) of the Draft Rule.

D.7.4 **Component 3: System strength quantity (SSQ) — yellow box**

Those parties that demand system strength currently use grid following inverters to interface with the network and these inverters require sufficient system strength to operate correctly. The issues that can occur when there several IBR connect in a weak part of the power system (with insufficient system strength) include steady state instability and an inability of most inverter control systems to meet their performance standards (such as riding through disturbances).

The system strength quantity component of the charge is important for determining the efficient allocation of the cost of the system strength services provided by the TNSP 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 in megawatts (MW)
- its short circuit ratio (SCR) (MVA/MW) requirements.

Under our proposed framework, this amount would be determined at the:

1. **Connection enquiry stage** with a preliminary assessment which uses the methodology prescribed by AEMO in its system strength impact assessment guidelines. This would determine the indicative SSQ of the applicant using a model of the plant operating in isolation, such as a single machine infinite bus (SMIB) model.²⁴⁴ As such, the connection applicant would receive an indicative SSQ in response to a connection enquiry from the preliminary assessment. This would allow the connection applicant to understand its exposure to the charge for its use of system strength and any trade offs it can make to reduce it before making a connection application.
2. **Connection application stage** through the negotiated connection process and would be recorded as part of the applicant's registered performance standards. Relevant here is that the new SCR access standard — S5.2.5.15 for generators, S5.3.11 for relevant customers/loads, S5.3a.7 for MNSPs — which requires that the electrical plant must have the capability sufficient to meet its performance standard at SCR of 3.0 and for the value of the actual SCR capability to be noted in the performance standards.²⁴⁵ AEMO would prescribe the methodology for assessing the SCR in relation to these clauses — and therefore the SSQ — in its SSIAG, similar to the indicative amount above.²⁴⁶ These new access standards are all AEMO advisory matters (see more detail Appendix C). This means the final SSQ used for billing the charges would be noted in the connecting party's registered performance standard/connection agreement.

The SSQ could be calculated at any time by a prospective connection applicant as these SMIB models are all of their own prospective equipment, unlike the existing FIA process that requires a wide area system model to assess the impact. This is because the complex modelling required for very accurate measurements are timely and expensive. The relatively simple and cheap SMIB modelling would provide a sufficiently accurate representation of a

²⁴⁴ Clause 4.6.6(b)(1A) of the Draft Rule.

²⁴⁵ Note — those connections that choose to pay the charge will not undergo a full impact assessment as set out in the NER.

²⁴⁶ Clause 4.6.6(a)(3) of the Draft Rule.

connecting party plant's system strength quantity, while not resulting in unnecessary costs or delays for connecting parties.

This is a balancing of the objectives of the price signal — being accuracy of the price signal and investment certainty — that the SSMR is sending to potential connections. It seeks to increase the transparency of system strength related costs associated with connection and the timeliness of generator connections whilst maintaining a financial contribution from those that consume the service to its provision such that they have a price signal to make efficient locational and investment decisions.

Connections exempt from the SSMR – AEMO sets thresholds for connections that do not need to undertake the SSMR, in the SSIAG

The SSMR is applied to all parties that seek to connect to the network but would only capture those connections that consume or demand system strength. This distinction is set out in AEMO's SSIAG, which would describe thresholds under which a connection's use of system strength is considered to be negligible, and that are therefore exempted from the SSMR framework.²⁴⁷

Noting that the SSIAG will be updated, AEMO's existing interpretations under the current SSIAG, suggest that:

- Synchronous generating systems would **not** face the system strength charge, as they do not increase the need for system strength. Rather, these generating systems increase the system strength in the vicinity of their connection points while they are operating.²⁴⁸ The way this is done would be through AEMO including a threshold below which the impact of a system may be disregarded in relation to the SSMR.²⁴⁹ These parties may be remunerated through network support agreements with the TNSP as part its portfolio to meet the new system strength standard being implemented through the supply side, as set out in Appendix B.
- Generating systems that consist of grid following inverters **would** be subject to the charge as they require a minimum level of system strength to operate stably, and therefore contribute to the need for system strength.²⁵⁰ This includes current wind and solar technologies as well as most of the existing and planned battery storage systems.
- Loads, specifically large inverter based resource defined in Chapter 10 of the draft rule would also require system strength to facilitate their connection and will be captured

247 Clause 4.6.6(a)(5) and (6) of the Draft Rule and clause 4.6.6(b)(7) of the NER.

248 Increasing the overall strength of the system can support the operation of the network if it improves the stability of the nearby connecting party generation. This will depend on how often it operates, the electrical distance to other units, and whether a shortage of system strength exists in the first place. However, increasing system strength can also potentially have a negative impact, if this increases the fault level above the rating of the power system equipment at that location. For this reason – i.e., that the provision of additional system strength (in this case, additional fault current) is not automatically beneficial in every part of the power system – we do not consider that all synchronous generators should receive a 'negative charge' (an automatic payment), rather they should only be remunerated for their fault current where it is actually needed to enhance overall levels of system strength.

249 Clause 4.6.6(b)(7) of the NER.

250 This can either be directly by necessitating the immediate need for additional system strength, or indirectly by bringing forward in time the need.

under the SSMR.²⁵¹ AEMO will set out the criteria for classification of a large inverter based resource which must take into account plant type and size and other matters it considers relevant to identifying these loads that may have a general system strength impact above the threshold for inclusion in the SSMR.²⁵² Some planned loads, like hydrogen production facilities, may also be connected to networks using grid following inverters.

- MNSPs, as classified under Chapter 2 of the NER, would also be subject to the charge as they also require a minimum level of system strength to operate stably, and in so doing, contribute to the need for system strength.²⁵³

Flexibility around emerging technologies — grid forming inverters not expected to pay the charge

There are numerous emerging technologies that aim to make inverter control system act, and provide output like, synchronous generators. These technologies are generally known as grid forming inverters.

It is also anticipated that grid-forming inverters would not require system strength from the network to operate stably and hence are not expected to contribute to the need for system strength. In fact, grid forming inverters may be able to supply system strength to nearby grid following inverters (in the form of a stable reference voltage service, rather than purely as fault current).

However, as grid forming inverters are emerging technologies that are not yet fully specified and understood, it is not yet possible to know the extent to which they will contribute to the demand or supply of system strength. AEMO would refine its SSIAG as understanding develops around this new technology.

D.7.5 Changing the charge's components

This section sets why and how each component of the total charge should vary over a plant's lifetime, such that investors are able to plan for and react to the price signal the charge is sending. It firstly sets out these drivers which would change the underlying economics of each of the components, and then explores some options for how we might vary different components of the charge.

The Commission considers it is useful to consider the lower equation in Figure D.2 above, as follows:

- Everything inside the brackets – the system strength unit price component multiplied by the locational factor – is the fee per unit 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.

251 Clause 4.6.6(a)(6) and Clause 5.3.4B(a)(1) of the Draft Rule.

252 This threshold is already determined by AEMO as part of its obligations under Clause 4.6.6(b)(7).

253 Clause 5.3.4B(a)(1) of the Draft rule.

Generally, as a connecting party plant is likely to have some control of the *quantity* of system strength it uses, this factor (the SSQ) can be changed by the connecting party plant over time, as technology changes. This would provide incentives to parties to install equipment that makes the most efficient use of available system strength. This is then fixed at connection as part of the performance standards of that plant. However, this component of the charge can be changed by the owner of the connecting party if it decides to do so, through a change to its performance standards. This is done through clause 5.3.9 or new clause 5.3.12.

In contrast, owners of connecting plant have little or no control over the *price* paid for system strength – being the product of the two remaining factors of SSUP and SSL. Furthermore, these two components are potentially subject to material changes in underlying cost drivers, suggesting that the efficient price could change materially over time.

As such, the Commission considers that a balance should be struck between:

- More frequent changes to the fee— being the product of the price and locational factor, which sends efficient price signals and incentivises efficient behaviour, but which also creates significant uncertainty and risk for connecting parties, and
- Not changing the fee at all, which reduces the risk for the connecting party, but may send inefficient price signals, to the extent that the underlying marginal costs of the provision of the service change significantly over time.

Total system strength fee – SSUP and SSL components

These two components are critical in reflecting the costs of supplying system strength by SSS Providers, and therefore important in terms of influencing the investment decisions each party will make when considering the service. To facilitate timely and efficient innovation in supplying system strength, such as the uptake of grid forming inverters, both components would be recalculated every system strength charging period by the:

- system strength service provider in relation to the SSUP
- relevant NSP in relation to the SSL.

This would allow for the price to reflect an updated marginal costs of providing each market participant with system strength.²⁵⁴

The Commission considers changing the SSUP and SSL every five years balances the competing investment certainty and accurate price signal objectives. Additionally, the rationale for the draft rule is that a changing SSUP and SSL component:

- Better aligns with past and proposed pricing policy, which aims to reflect changes in marginal costs e.g. marginal loss factors (MLFs), rather than charges determined once at connection.
- Would allow for an easier transition to future market design arrangements such as spot markets for system strength.

²⁵⁴ Stakeholders in technical working group sessions did not hold strong views on whether this should change or not over time for a particular market participant. Renewable energy developers again noted that it is simplest for them to make investment cases when costs of the project are set at financial close.

- Integrates more effectively with the TNSP revenue determination process, where expenditure proposals on system strength will be assessed.
- Provides market participants with a degree of predictability in costs faced over the lifetime of the project – generators can assess observed trends over time.

Further, the SSUP is set for the charging period for each node but not for a specific connection point. If a connection occurs midway through the charging period, then that price would apply until the price is recalculated. That is, for example, if a generator connects two years into a price applying then that price applies for the remaining years of that period until the price is recalculated, with the new price applying from the start of the next period. Similarly, the SSL is calculated at the time of connection and is then recalculated when the next round of SSL recalculations are due to occur with all other system strength connection points.

The recalculated components would be published in the:

- SSL: annual planning report by the relevant NSP for each system strength connection point.
- SSUP: transmission prices for that pricing year (noting that it will remain the same for a system strength charging period, subject to any indexation).

System strength quantity component

This component is based on the equipment and design decisions made by the connecting party at the time of connection, or when these elements are changed over the life of the plant by the connecting party. This component is the agreed settings for the agreed performance standards and would therefore require a change to the connecting party's plant to warrant revising this component.

This component should remain fixed, unless the participant elects to change it, through commencing a change in the agreed performance standards, which is already an established process that both the NSP and connecting party can initiate through NER:

- existing clause 5.3.9 of the NER for generators
- new clause 5.3.12 of the draft rule for loads and MNSPs.

These clauses detail the procedure that must be followed by NSPs, AEMO and a party when that party is proposing an alteration to its system, such as retuning or replacing its inverters, that will affect its performance standards.

Clause 5.3.12 is introduced by the draft rule to establish a process (like that which already exists in clause 5.3.9) by which loads and MNSPs can change their agreed performance standards such that they may reduce their SSQ, and hence their charge.

D.8 Who is liable under the SSMR — Generators, MNSPs and loads connecting under Chapter 5 of the NER

This section discusses the connections that would be liable under the SSMR – that is, which parties the charge would apply to under the draft rule.²⁵⁵

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 will be set out in AEMO's system strength impact assessment guidelines.

This generally means those liable under the SSMR would 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) that are connected under Chapter 5
- market network service providers (MNSPs).

The table below shows the different types of connection points in the NEM and whether they would face the SSMR framework.

²⁵⁵ Note, this is not the distinction of which generators or loads consume system strength, as this is determined by NSPs through the preliminary impact assessment stage by NSPs in accordance with the methodology set by AEMO (as set out in appendix D.7.4). Rather, this section sets out the thresholds which determine if a connection under Chapter 5 is required to undergo the SSMR process.

Table D.2: Type of connections who face the SSMR

CONNECTION TYPE	TRANSMISSION CONNECTED GENERATION	MARKET NETWORK SERVICE PROVIDERS (MNSPS)	REGISTERED EMBEDDED GENERATION	LARGE INVERTER-BASED RESOURCE ⁽¹⁾	NON-REGISTERED EMBEDDED GENERATION⁽²⁾ ELECTING TO CONNECT UNDER CH 5	NON-REGISTERED EMBEDDED GENERATION⁽²⁾	MICRO EMBEDDED GENERATOR GENERATION⁽³⁾	LOAD⁽³⁾	
Connection point	Transmission	Transmission or Distribution	Distribution	Distribution	Distribution	Distribution	Distribution	Transmission	Distribution
Size	≥5 MW	-	≥5 MW	Meets the criteria set by AEMO in the SSIAG	<5 MW ⁽⁵⁾	<5 MW ⁽⁵⁾	AS4777 about 30kW	Any	Any
Registered Participant	Yes	Yes	Yes	No	No	No	No	Can be either	No
Conditions for Connection	Chapter 5 — Rule 5.3	Chapter 5 — Rule 5.3	Chapter 5 — Rule 5.3A	Chapter 5	Chapter 5 — Rule 5.3A	Chapter 5A	Chapter 5A	Chapter 5	Chapter 5A
DNH – SSIAG in Cl. 5.3.4B	Applies	Applies	Applies	Applies	Applies, but likely to be below threshold	Does not apply	Does not apply	Applies if plant includes an inverter	Does not apply

CONNECTION TYPE	TRANSMISSION CONNECTED GENERATION	MARKET NETWORK SERVICE PROVIDERS (MNSPS)	REGISTERED EMBEDDED GENERATION	LARGE INVERTER BASED RESOURCE ⁽¹⁾	NON-REGISTERED EMBEDDED GENERATION ⁽²⁾ ELECTING TO CONNECT UNDER CH 5	NON-REGISTERED EMBEDDED GENERATION ⁽²⁾	MICRO EMBEDDED GENERATOR GENERATION ⁽³⁾	LOAD ⁽³⁾	
								based resource	
Proposed to face system strength charge	Yes	Yes	Yes	Yes	Yes, but likely to be below threshold	No	No	Yes	No

Note: (1) Large inverter based resources include generation, load and energy storage systems (ESS). (2) Non-registered embedded generation, includes ESS. If the non-registered embedded generation is a large inverter based resource, that column applies. (3) Micro-embedded generation includes ESS. (4) Load is taken to exclude embedded generation (ESS) and large inverter based resources. (5) Non-registered embedded generation excludes micro embedded generator generation. It can be greater than 5 MW if granted an exemption by AEMO.

In the case of a distribution connected generating system the charge would be for the use of system strength provided by the TNSP that supplies the associated distribution network. The collection of the charge and the offsetting of the consumer's TUOS charges, as discussed later in appendix D.11, would be paid by the connecting generator to the DNSP and then to the relevant TNSP. Consequently, the draft rule requires that all registered generators will be liable for the SSMR, regardless of whether they are transmission or distribution connected.

This means that all generator types connecting under Chapter 5 would be eligible to pay the charge if they elect to do so (as opposed to remediating their impact). However, the magnitude of the charge is commensurate with the demand for / consumption of the service by the relevant party.

Additionally, AEMO would identify through its SSIAG those parties that are exempted from the framework — that is, those parties who do not have to pay the charge or remediate. In practice, this means that parties who connect as grid following, inverter based plant will generally face a charge or a requirement to remediate, as they would have a demand for the service, while plant such as synchronous generators (and potentially grid forming inverters) would not be required to pay the charge, or undertake remediation actions.

For the avoidance of doubt, the charge would not apply to non-registered embedded generators connecting under Chapter 5A. The Commission considers that that generators smaller than 5MW should not face the SSMR because, while such generators may well contribute to a need for system strength, the complexity of assessing this need, and undertaking potential remediation actions, is not appropriate for much smaller, low impact projects.

Any new connecting MNSPs would be required to remediate or pay the charge, for the same reason that they are subject to the current 'do no harm' arrangements — that they, like generators, create a demand for system strength and so should face incentives to efficiently use those services.

D.8.1

Inclusion of loads in the SSMR

The draft rule proposes to extend the existing arrangements to include grid-connected loads who require system strength to facilitate their connection, in the same way connecting generators do. That is, a proposed new connection for a network user that includes an inverter based resource to whom Schedule 5.3 of the NER applies will be liable under the SSMR.²⁵⁶ Such loads could include electrolytic hydrogen production facilities, and are currently not subject to the 'do no harm' obligation.

The Commission is of the view that these loads should be included under the SSMR when connecting under Chapter 5 of the NER and face the same incentives under the mechanism, as they create demand for system strength services in the same way that inverter-based generators do. As such, these loads would face similar decisions regarding their use of

²⁵⁶ Clause 5.3.4B(a)(2) of the Draft rule.

system strength as generators would 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.

This is also consistent with the direction of the ESB's DER integration and demand side participation workstream of the Post 2025 market design project for a two-sided market and a *trader services* model, which would provide for greater regulatory flexibility and supporting innovation by attaching obligations to services at connection points as opposed to attaching them to registration categories and assets.

For the avoidance of doubt, the draft rule does not apply to loads connecting under Chapter 5A, for reasons similar to non-registered embedded generators. However, due to the set up of the current rules, some loads that require system strength to connect may do so under a Chapter 5A process and will be obliged to connect using the Chapter 5 process,²⁵⁷ which is fit for purpose for these 'large inverter based resource' that will be liable under the SSMR.²⁵⁸ The definition of such a resource will be determined by AEMO in its SSIAG.²⁵⁹

As such, the draft rule establishes that loads that are at or above the threshold for loads that impact on system strength such that they should face the SSMR set by AEMO in the SSIAG cannot undergo a connection through Chapter 5A. Rather, these connections must occur through the Chapter 5 process which remains fit for purpose for these types of connections and allows for them to be appropriately captured under the SSMR. The Commission considered this to be the simplest way to achieve the principle that any connection that requires system strength to support it joining the grid must undergo the SSMR.

D.8.2

SSMR will not apply to existing MNSPs or generators or loads — only to those that apply after its commencement

The SSMR would only apply to those parties who connect following the commencement of the applicable parts of the final rule. That is, not to the parties who connected or signed connection agreements prior to the rule commencing. The Commission considered that applying the SSMR (and the new access standards) to existing parties would require renegotiation of performance standards and therefore, re-opening an existing connection agreements. Negotiating a new set of performance standards and the required physical changes to equipment may involve significant costs for a connecting party. Additionally, the rule is not intended to alter the terms or contractual rights or obligations of the parties to such an agreement.²⁶⁰

Further, the Commission considers that on the date that the SSMR and new access standards commence, applicants who:

²⁵⁷ Clause 5A.A.2(a1) of the Draft Rule.

²⁵⁸ See definition of 'large inverter based resource' introduced in Chapter 10 and clause 4.6.6(a)(6) of the Draft Rule.

²⁵⁹ Clause 4.6.6(a)(6) of the Draft Rule.

²⁶⁰ Clause 11.xxx.11 of the Draft Rule.

- are yet to submit a connection application will come under the new SSMR and access standard arrangements.²⁶¹
- have submitted a connection application will come under the old/existing ('do no harm') arrangements by default, but will be able to elect to use the new arrangements if they want to.²⁶²

The rationale for this and the full set of transitional arrangements for the draft rule are described further in Appendix E.

D.8.3 **Where is the SSMR applied?**

The SSMR coordinates the supply and the demand sides of system strength by placing a levy on a party relative to its consumption of the service, which is centrally provided by the TNSP who is a SSS Provider at certain nodes in the network called system strength nodes.

The SSMR is proposed to apply universally across the NEM, rather than only in administratively determined system strength zones (as originally proposed in the Investigation final report).²⁶³ This means that all connecting parties can be said to face the SSMR, regardless of their location, or proximity to a system strength node.

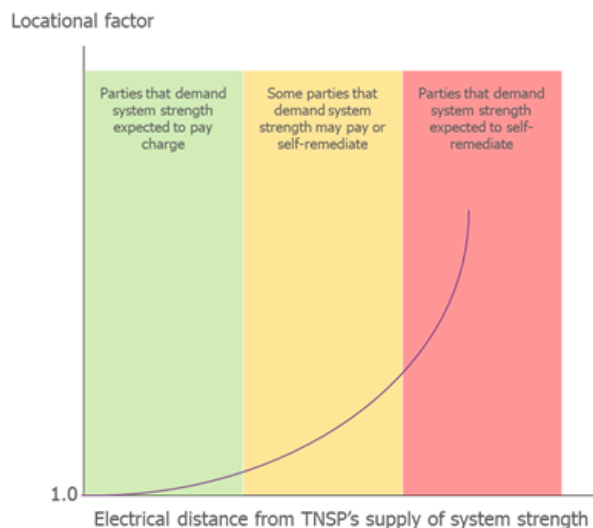
However, the specific components of the charge — discussed in appendix D.7 — would mean that the further a generator locates from the relevant system strength node, the higher this charge would be. All else being equal, this means that at a certain electrical distance from the node, it would become more cost effective for a generator for it to elect to self-remediate, rather than to face the charge. In effect, each generator has a *choice*, in terms of whether it elects to consume the service provided by SSS Provider and if it does, how much it elects to consume. This is shown in the figure below.

²⁶¹ Clause 11.xxx.8 of the Draft Rule.

²⁶² Clause 11.xxx.9 of the Draft Rule

²⁶³ 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 D.3: Expected outcomes of the SSMR depending on a connection's electrical distance from a system strength node



Source: AEMC

In summary, if the party that demands system strength chooses to locate electrically:

- Close to the node, its consumption would be relatively low, and so the charge would be low. It may, therefore, choose to consume the service rather than making investments to avoid these charges.
- Remote from the node, the charge may be very high. Parties may be incentivised to avoid these charges completely by self-remediating their system strength requirements.
- Between these two situations, generators may take some low-cost actions to partially reduce their consumption and therefore reduce their system strength charge, rather than undertaking higher cost actions such as full self-remediation.

While the remediation portion of the SSMR can apply universally, the Commission understands that there are practical limitations to the system strength charge option being available to all potential connections. This is because there could be some connections that are so distant from the nearest system strength node that the locational factor, set out in appendix D.7.3, cannot be reasonably calculated by the NSP. In these situations the connecting party would have to undergo a full impact assessment (FIA) and remediate its impact, as set out in appendix D.10. The Commission is interested in stakeholder views on other ways to resolve this.

Network areas of 'latent' system strength

An outworking of this model is that, at least in theory, there may be some areas of the network where there is an apparent conflict between the calculated charge, and the actual system strength that is available. This could occur in locations in the network:

- that are electrically distant from a 'system strength node', and would therefore have a high locational factor, which would result in an apparently high charge
- but where there is some latent system strength available due to network impedances. The availability of system strength at these locations means that there should be a low to zero cost LRMC/LRAC associated with the provision of system strength available for a newly connecting generator at that node – which should ideally be reflected in a low system strength charge. However, due to the distance from the nearest declared node, and subsequent locational factor, the charge would be inaccurately high.

If this situation was to occur, in such areas there is a risk that the design of the system strength charge could create a disincentive for the efficient use of this system strength, due to the fact that while the actual cost of providing the service in the area is low, the electrical distance from a defined node would mean that the system strength charge would be disproportionately (and inaccurately) high. This is an outworking of basing the charge on the locational factor from nodes.

The Commission considers that this situation is likely to be a fringe case and not likely to occur widely across the power system. Therefore, the Commission has not addressed this in a draft rule given it does not consider this to be material. If it was material, then the Commission would need to consider options to address this e.g. an exemption framework to manage the situation.

Instead, we consider that to the extent this issue arises, it can be most easily resolved by having a robust 'system strength node' declaration process in the first place. Appendix B: Supply side sets out more detail on how system strength node declaration will occur, including consideration of this issue.

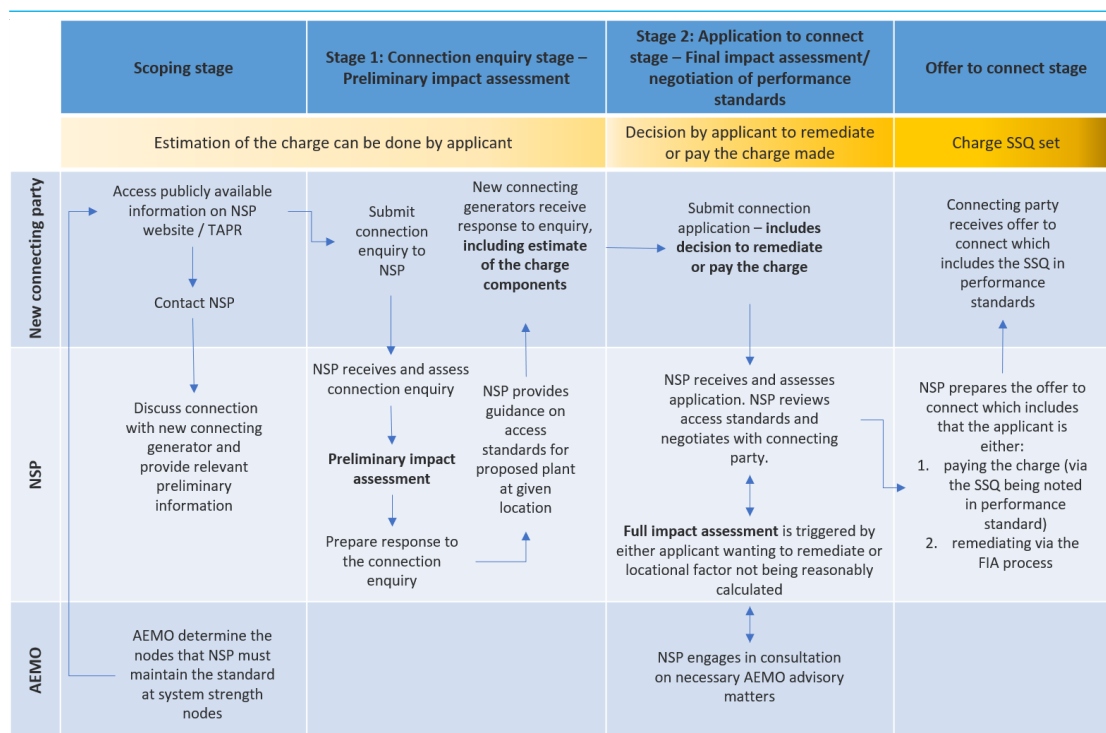
D.9 Integration of the SSMR into the connection process

This section covers how the SSMR integrates into the existing connection process. This includes the how and when of an applicant gets the information required to make an informed decision on whether to:

- undertake remediation which involves a full impact assessment and the complex and timely modelling necessary for that process, or
- pay the charge.

The figure below sets out the SSMR out against the stages of the connection process, and each following subsection discusses the SSMR process steps involved in each connection process step.

Figure D.4: Integration of the SSMR into the connection process



Source: AEMC

D.9.1

Pre-connection enquiry – early stages of development – prospective developers should be able to estimate costs easily

A connecting party would be able to estimate the size of their likely charge in the initial stages of developing the project, prior to submitting a connection enquiry.

This can be done using the published system strength unit price (the TNSP’s forward-looking costs for the provision of system strength in \$/MVA) and calculating its own system strength quantity (SSQ) and locational factor (SSL) using single machine infinite bus (SMIB) modelling and AEMO’s SSIAG. A SMIB model is a simple model of the connecting party’s plant isolated from the rest of the grid such that its performance can be determined. This is separate to a ‘power system’ model that determines the connection’s performance in relation to its connection point, including its interaction with the network elements and other plant near its connection point.

This would allow potential connection applicants to better understand the costs of connecting to the grid due to its likely system strength impact, hence increasing investor confidence in this area. The use of simpler modelling (for the charge and PIA) also allows for developers to be able to better predict its potential costs ahead of the connection process.

D.9.2 Stage 1: Preliminary impact assessment – NSP provides an estimate of remediation and charge in response to the connection enquiry

Stage 1 — the preliminary impact assessment (PIA) — occurs at the receipt of a connection enquiry and provides an indication of potential remediation but also informs the SSQ and SSL components.

Under the proposed draft rule, the analysis in the PIA stage must be undertaken using a SMIB model²⁶⁴ and the NSP in response to a connection enquiry must provide an estimate of the:²⁶⁵

- 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 of whether to remediate or pay the charge, a decision required for the connection application.

D.9.3 Stage 2: Full impact assessment at the Connection application – applicant decides to remediate or pay the charge

Under stage 2, the FIA is undertaken at the receipt of a connection application and is only required if the:²⁶⁶

- applicant chooses to remediate instead of paying the charge
- in the very unlikely event that the system strength locational factor cannot be reasonably calculated (set out in AEMO's SSIAG as described above in appendix D.7.3).

This process is set out further in appendix D.10, but in summary, this process means a connection must elect in its connection application its decision to either to pay the charge, or to undergo a full impact assessment (including the associated remediation processes).²⁶⁷ This choice, once made, cannot be revoked. However, a party that elects to pay the charge can later undertake actions (such as by installing additional equipment) that would have the same effect as if it had remediated its impact — this would mean that the SSQ component of the charge would effectively become zero.

Allowing a participant to choose between the charge and remediating prior to this point, means that applicants can choose to avoid the potentially costly and timely complex modelling exercises and design of remediation schemes/connection works, if they consider that paying the charge is likely to be a better outcome for them financially. The payment of the charge should then be incorporated into the connection agreement, including recording the value of the SSQ component.

If the connecting party elects to remediate instead of paying the charge, the party then essentially follows the existing 'do no harm' remediation process, retaining all concepts from

264 Clause 4.6.6(b)(1A) of the Draft Rule.

265 Clause 5.3.3(b5)(3) of the Draft Rule.

266 Clause 5.3.4B(a2)(3) of the Draft Rule.

267 Clause 5.3.4B(b1) of the Draft Rule.

the existing framework – such as undertaking power system modelling (typically extensive EMT-type modelling), plus the potential need for undertaking system strength remediation schemes/connection works, or procuring system strength services from a third party.

However, a difference from the existing arrangements is that the draft rule introduces a new definition of '*general system strength impact*' to reflect that the remediation required by the connecting party is that which returns the power system *back to the level of system strength that the local system had prior to its connection*. This change is necessary as any other interpretation, such as using '*adverse system strength impact*' as used in the existing framework that relates only to security and remediation to the minimum levels, would undermine the SSMR. This is given that the charge is based off the amount of the service that the connecting party uses and therefore if it is less than this amount it would distort the incentives and price signals being sent by the SSMR. However, the existing definition of adverse system strength impact has been retained for use of information provision to AEMO such that it can maintain power system security.²⁶⁸ This is expanded on in appendix D.10.3.

D.9.4

Post-connection – system strength need can be changed by plant on request

As stated in appendix D.7.5, a connecting party could elect to change their system strength need (SSQ) through going through a clause 5.3.9 or clause 5.3.12 process under the draft rule. This would allow a connecting party to lower its charge amount by lowering its demand for the system strength. Beyond this, the connecting party could go so far as to undertake remediation in order to reduce its charge to zero – be that because technology costs have reduced or because it wants reduce the uncertainty of the charge.

These incentives to reduce its consumption of system strength would result in parties making efficient investment decisions over the life of the asset, which can involve replacement of all its inverters, or to expand or retire the asset. All of these would impact on the use of system strength services in the NEM and by having the system strength charge ongoing, it would coordinate effective and efficient use of the service through the maintenance of accurate price signals to these parties.

As discussed in appendix D.7.2, the price of the charge (ie, \$ per MVA, made up of the SSUP multiplied by a location factor, the SSL) would change over time, reflecting changes in the forward-looking costs associated with the provision by the SSS Provider of the system strength service. This would allow those connected parties that have connected after the SSMR takes effect and are subject to the charge to trade off the charge (reflecting future costs incurred by the SSS Provider) against the cost of actions they could take to reduce the quantity of system strength they consume (for example, by tuning inverters). As such, this approach intends to incentivise continued efficient behaviour by connecting parties over the life of assets to regularly think about how they can minimise their demand for system strength.

²⁶⁸ Clauses 5.2.3A(a)(3), 5.2.3(j)(3), 5.2.4(c)(3) and clause 5.2.5(d)(3) of the NER.

D.10 The process when choosing to remediate its general system strength impact — Full impact assessments and remediation works/schemes

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 full impact assessment is equivalent to reducing the SSQ to zero.²⁶⁹ This would be a particularly attractive option when the connecting plant is located further from the system strength node and the locational factor could be significantly greater.

The proponent of a connecting party generator, MNSP or connecting party 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 assess that the connection of the plant would not produce a general system strength impact.

This sections details what is involved when a proponent selects to remediate rather than pay the charge. That is, what is involved in a full impact assessment and the options from there that a proponent has to remediate.

D.10.1 Full impact assessment — using power system modelling to calculate 'general system strength impact' of the connection

The connection of inverter based resources can increase the risk of inverter driven instability. This occurs when the quantity of inverter based resources 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 understands that to date, the majority of PIAs have indicated that a full assessment is 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

²⁶⁹ 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.

- 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
 - other connecting party is committed in the same part of its network.

Under the draft rule, where a proponent chooses not to pay the connection charge it would be necessary to ensure that they remediate their general system strength impact, being 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 full mitigated.

The Commission considers that a system strength impact assessment is still 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, the Commission expects 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 to be in more remote parts of the network with limited interactions with other connecting parties.

Thus, the output from the full impact assessment would be actions required by the proponent of the connecting party 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 at its own expense.

D.10.2 System strength remediation schemes and connection works — going from amount of impact to offer to connect

Once the connection applicant has been provided the amount of general system strength impact it has on the system, it must remediate to gain an offer to connect to the power system. In doing so it would have to negotiate with the NSP and has two options: either implement a remediation scheme or have the NSP undertake connection works.²⁷⁰

System strength remediation scheme

The proponent of the connecting party plant could address the general impact through a system strength remediation scheme. The draft rule does not limit the nature of system strength remediation schemes, but the Commission expects that they could consist of one or more of the following:

²⁷⁰ Clause 5.3.4B of the Draft Rule.

- 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 plant control systems to reduce the system strength need
- the use of grid forming inverters to eliminate the system strength need
- contracting with existing plant not otherwise contracted.

System strength connection works

An alternative for the proponent is, to have the local NSP undertake system strength connection works to increase the fault level at the connection point. The draft rule does not limit the nature of system strength connection works, but the Commission expects 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.

D.10.3

Difference between 'adverse system strength impact' and 'general system strength impact'

BOX 8: DEFINITIONS OF 'ADVERSE SYSTEM STRENGTH IMPACT' AND 'GENERAL SYSTEM STRENGTH IMPACT'

Adverse system strength impact: An adverse impact, assessed in accordance with the system strength impact assessment guidelines, 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: The amount equal to a *plant's adverse system strength impact* as well as any additional amount the connecting party's *plant* reduces the *available fault level at its connection point*.

Source: Definition of both are contained in Chapter 10 of the Draft rule.

Under the current arrangements 'adverse system strength impact' relates to the ability of the power system to maintain stability, and for generating system or MNSP to remain 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.²⁷¹
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.²⁷²

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.²⁷³

However, 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', which is a term introduced by the draft rule.²⁷⁴

This is the amount equal to the connecting party plant's adverse system strength impact as well as the amount it reduces the available fault current at its connection point as a result of its connection. The latter is equivalent to the system strength quantity, which is determined from the SCR performance standard and the rating of the IBR plant. However, the connecting plan 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.

When the connecting party chooses to pay the system strength charge

When the proponent of connecting IBR plant chooses to pay the system strength charge the NSP determines the charge based on the general system strength impact, in conjunction with the associated system strength price and system strength locational factor.²⁷⁵ In this case, it is not 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

When the proponent of connecting IBR plant chooses to remediate then it would need to implement a system strength remediation scheme or fund the NSP to undertake system strength connections 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. 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

271 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.

272 As specified in clause 5.3.4B of the NER.

273 Clause 5.2.3(j)(3) of the NER.

274 See the definition in Chapter 10 of the Draft Rule.

275 Clause 5.3.4B(a2) of the Draft Rule.

adverse system strength impact, means that its connection would not bring forward costs of 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 exist system strength in the network.

D.11 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 TUOS 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 the non-locational component of prescribed TUOS 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.

D.11.1 The new SSMR transmission service, which is classified as a prescribed TUOS service

The draft rule creates a new service called a *system strength transmission service*.²⁷⁶ 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
- each 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 divide regulated transmission services into prescribed transmission services and negotiated transmission services. For the reasons discussed in Appendix A, the SSMR transmission service is classified as a prescribed transmission service. This means that

²⁷⁶ See the definition in Chapter 10 of the Draft Rule.

a regulated price will be determined for the service that is 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 system strength transmission service is 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 makes relatively minor changes to the definitions of prescribed transmission service, prescribed TUOS services, and negotiated transmission service to clarify this classification of the service.

D.11.2 How system strength charges are determined by the SSS Provider

System strength charges are calculated as explained in appendix D.7 above.

The draft rule gives effect to the policy explained above by amending the relevant provisions of Part J of Chapter 6A of the NER. The key aspects of the process for how the system strength charge is set under the draft rule and integrated into the current pricing framework are as follows.

Pricing methodology guidelines

Rule 25.2 of the NER sets out the requirements for these guidelines, including certain required contents. Under the draft rule, the AER updates 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 introduces new requirements for TNSPs to include in their pricing methodologies.²⁷⁷ For those TNSPs who are also SSS Providers, there are additional requirements.²⁷⁸

Components of the system strength charge

The three components of the system strength charge are as explained in appendix D.7 above:

1. system strength unit price
2. system strength locational factor
3. system strength quantity.

²⁷⁷ Clause 6A.23.6 of the Draft Rule.

²⁷⁸ Clause 6A.23.5 of the Draft Rule.

Clause 6A.23.5 of the draft rule sets out the various components of the charge and requirements for how each component is calculated.

The system strength unit price component is fixed for the SSMR charging period

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 means 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.²⁷⁹ 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.

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.

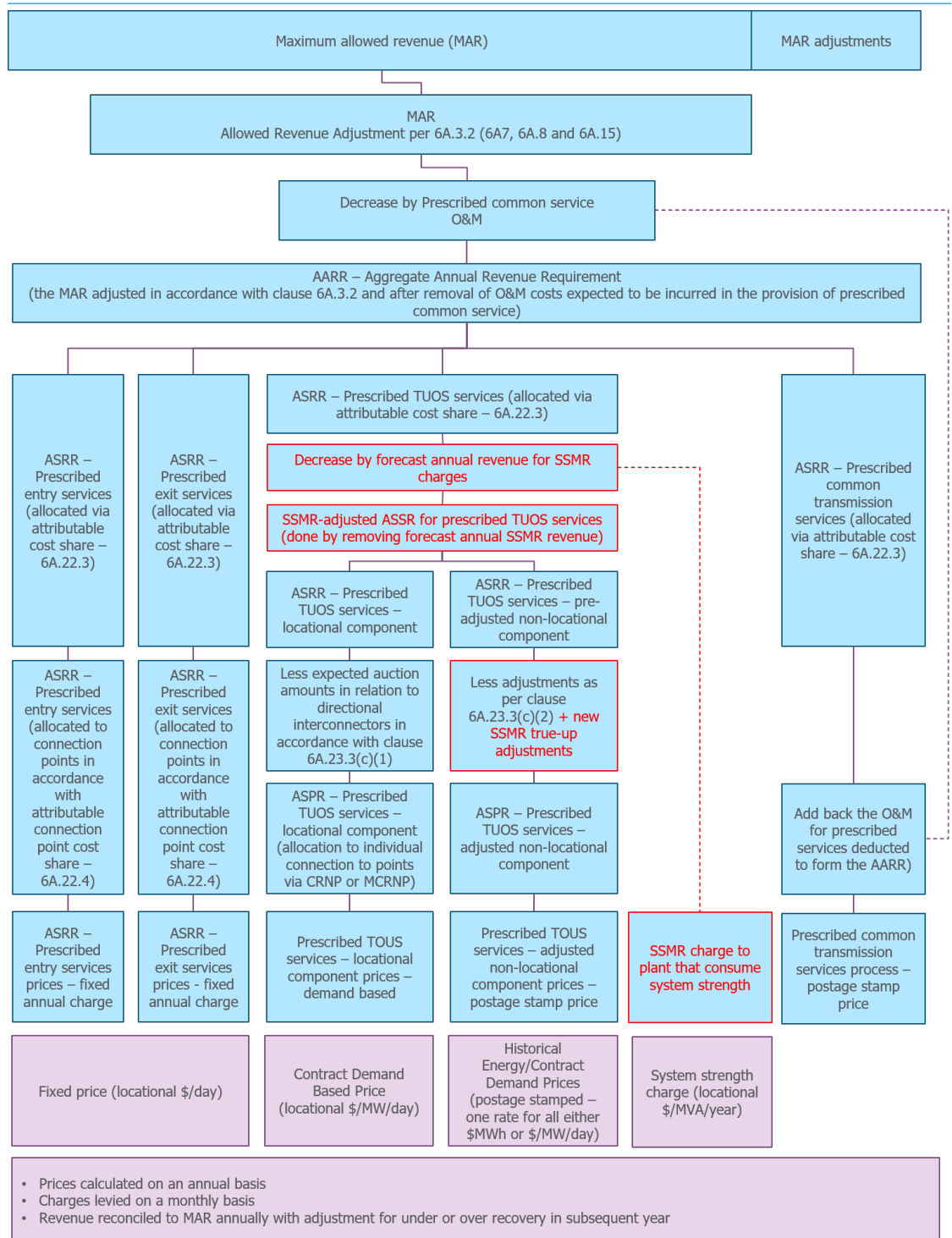
D.11.3 Incorporation of SSMR revenue into the pricing principles for prescribed transmission services

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 is integrated into these provisions by the draft rule is illustrated in diagram below and explained in this section.

²⁷⁹ 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.

Figure D.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.

The intention of this process is that:

- The SSS Provider calculates 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' discussed in appendix D.7.2 above). This difference is 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 as follows:

- The maximum allowed revenue (MAR) is adjusted as set out in rule 6A.22 to determine the aggregate annual revenue requirement (AARR) for all prescribed transmission services. There are no changes to this step.²⁸⁰
- The AARR is then allocated to each category of prescribed transmission service to determine the annual service revenue requirement (ASRR) for each service in accordance with rule 6A.22. There are no material changes to this step.
- The ASRR for prescribed TUOS services is adjusted by subtracting forecast annual system strength revenue, i.e. an estimate of the amount of revenue the SSS Provider expects to earn from system strength transmission services for that regulatory year based on connection forecasts. This is a new step in clause 6A.23.2(e).
- The adjusted ASRR for prescribed TUOS services is split into a locational component and a non-locational component and allocated to connection points in accordance with clause 6A.23.3. There are no changes to this step. These components continue to be paid by customers. Deducting forecast system strength revenue in the step above means that customers do not pay for the costs of providing the system strength transmission service through prescribed TUOS service charges to the extent that those costs are included in forecast system strength revenue. However, where there is a difference between forecast revenue and the costs of providing the service, that difference will be recovered through the non-locational component of prescribed TUOS service changes. This difference could be a positive amount (i.e. it could increase prescribed TUOS service charges) or a negative amount (i.e. it could reduce prescribed TUOS service charges).
- An annual true-up mechanism is added to clause 6A.23.3A to make adjustments to account for differences between forecast and actual system strength revenue. Any adjustments under this mechanism are added to or deducted from the non-locational component of prescribed TUOS service changes. This true-up mechanism is based on the current true-up mechanism for modified load export charges in clauses 6A.23.3(f) and (g).

²⁸⁰ Clause 6A.22.2 of the Draft Rule.

D.11.4 Invoicing and payment of system strength charges

Appendix D.8 above describes who is liable to pay system strength charges.

These charges would be integrated into the current billing process for transmission services in rule 6A.27. The draft rule also makes 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.²⁸¹

The SSS Provider would charge:

- 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. 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.²⁸² The users have an obligation to pay system strength charges under clause 6A.27.3 of the draft 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).²⁸³ The DNSP's system strength charges must match the SSS Provider's charges to the maximum extent possible.²⁸⁴ 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.²⁸⁵

281 Clause 6A.27.1(a) of the Draft Rule.

282 Clause 6A.27.1 and 6A.27.2 of the Draft Rule.

283 Clause 6.18.7(e) of the Draft Rule.

284 Clause 6.20.3A of the Draft Rule.

285 Clause 6A.27.2(d) of the Draft Rule.

The prudent discount arrangements in rule 6A.26 do not apply to system strength charges.²⁸⁶ That is, a prudent discount is not available to a participant who is required to pay the charge.

D.12 Application of the system strength charge in adoptive jurisdictions

As noted in Appendix A and B, the Commission may only make a rule that is compatible with AEMO's declared network functions. In relation to the SSMR, the Commission considers it 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.²⁸⁷ However, like other TNSPs, AEMO has a pricing methodology approved by the AER.²⁸⁸ 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.²⁸⁹

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,²⁹⁰ so that it remains consistent with the performance of AEMO's declared network functions. The draft rule is consistent with AEMO's declared network functions because AEMO is responsible for allocating the ASRR for prescribed TUOS services,²⁹¹ and the new system strength transmission service forms part of prescribed TUOS services.²⁹²

The specifics of the amendments made by the draft rule to clarify the application of the draft rule to AEMO are set out in Appendix A.2.3.

286 Clause 6A.26.1 of the Draft Rule.

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

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

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

290 See clause S6A.4.2(k) item 2 of the Draft Rule.

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

292 See the amended definition of 'prescribed TUOS service' in the Draft Rule.

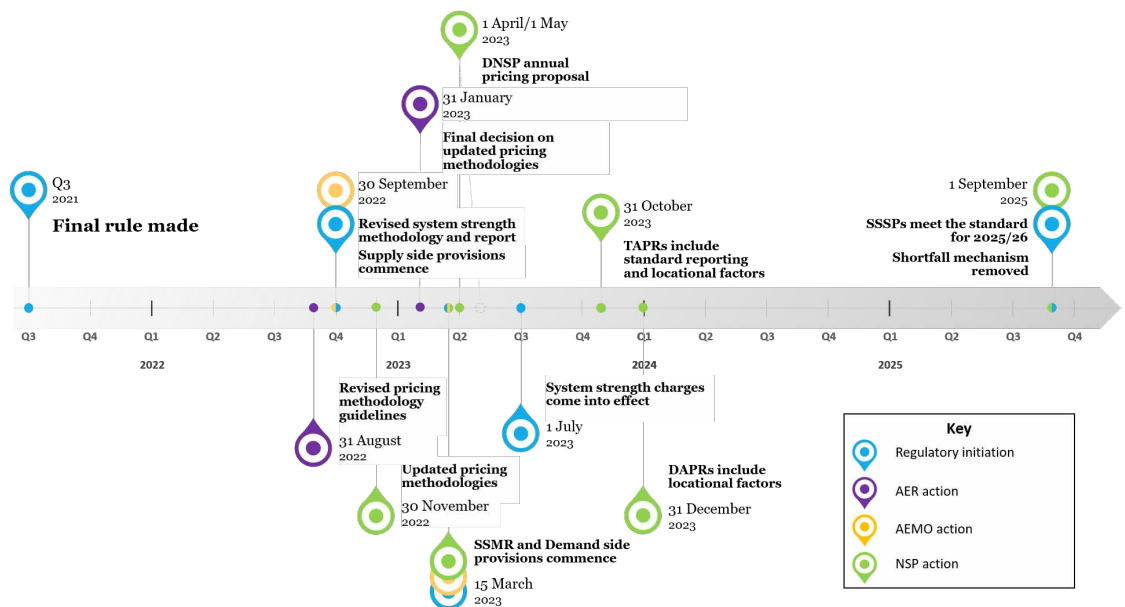
E TRANSITIONAL ARRANGEMENTS: A SEQUENCED IMPLEMENTATION OF THE EVOLVED FRAMEWORK

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 as described in Appendix B, C and D. Evolving the framework as quickly as possible would promote the long term interest of consumers. However, the proposed draft rule requires an inter-related sequence of events to occur for proper implementation.

As such, this Appendix describes the proposed transitional arrangements set out in the draft rule that the Commission considers strike a balance between the time needed for parties to prepare to meet their obligations under the evolved framework with the need to enable the new system strength framework to be implemented as soon as possible to realise the benefits.

Figure E.1 and Table E.1 below summarises the sequence of transitional arrangements described in this appendix that lead to the evolved framework being fully implemented.

Figure E.1: Timeline of implementation



Source: AEMC

Table E.1: Sequence of events to implement the evolved framework

DUE DATE	MILESTONE
Q3 2021	<ul style="list-style-type: none"> Final rule made by the AEMC

DUE DATE	MILESTONE
31 August 2022	<ul style="list-style-type: none"> AER makes the revised pricing methodology guidelines.
30 September 2022	<ul style="list-style-type: none"> AEMO makes the revised system strength requirements methodology. AEMO publishes its first <i>system strength report</i> 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: <ul style="list-style-type: none"> SSS Providers in relation to planning for the new standard. AEMO on determining the system strength requirements, including the declaration of system strength node. Transitional provisions to: <ul style="list-style-type: none"> Deem existing fault level nodes to be system strength nodes. Preserve the fault level shortfall framework for a period of three years.
30 November 2022	<ul style="list-style-type: none"> 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 draft rule and submit it to the AER for approval.
31 January 2023	<ul style="list-style-type: none"> AER must publish its final decision on the proposed amended pricing methodology for each TNSP and AEMO.
15 March 2023	<ul style="list-style-type: none"> Provisions relating to the SSMR and demand side commence - these include new obligations on: <ul style="list-style-type: none"> AEMO to make system strength impact assessment guidelines (SSIAG). 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 April 2023 (unless it is the first year of a regulatory determination, where it is 1 May)	<ul style="list-style-type: none"> If required, DNSPs submit annual pricing proposal (or initial pricing proposal where applicable) that includes amounts to pass through relevant system strength charges.

DUE DATE	MILESTONE
1 July 2023	<ul style="list-style-type: none"> System strength charges are in effect.
31 October 2023	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> DNSPs publish the locational factors of all system strength connections points in its network as part of its distribution annual planning report (DAPR).
30 September 2025	<ul style="list-style-type: none"> 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. The system strength shortfall mechanism is removed as it is now completely replaced by the new system strength standard.

E.1 Supply side implementation — new system strength planning commence on 30 September 2022

The materials AEMO would either update or create underpin the standard and therefore, need to be in place before the other obligations commence. These materials underpin the nature of the obligation that SSS Providers — being the jurisdictional planners of TasNetworks, TransGrid, Powerlink, AusNet, 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 could commence on 20 September 2022.

E.1.1 Materials required for the standard to begin — to be completed by 30 September 2022

The new system strength standard is underpinned by AEMO's declaration of system strength nodes at the locations at which the standard is required to be met by system strength service providers. It is also partially driven by AEMO's projections of the minimum fault level needed for power system security and of the expected connections at these nodes under the optimal development path set out in the integrated system plan.²⁹³

As such, for the supply side to be implemented, AEMO must, by no later than 30 September 2022:

- amend and publish its system strength requirements methodology under clause 5.20.6 of the draft rule to account for the changes proposed under the new rules.

²⁹³ The optimal development path is the development path — a set of projects that together address power system needs — identified by AEMO in the ISP in accordance with rule 5.22 of the NER.

- using this amended methodology, publish its first system strength report under clause 5.20.7 of the draft 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 draft rule for both:
 - the requirements which would be binding on the SSS Providers to meet the S5.1.14 standard three years after those requirements are declared.
 - projections of what it expects to occur, providing the SSS Providers with an indication of what the requirement may be in the future, for years four to ten of the forecast period.

This means that SSS Providers can begin planning for how they will meet the standard in respect of the requirements set out by AEMO in its system strength report published in September 2022 for the years following September 2025. This three year period is to allow sufficient time for the TNSP to properly plan to meet its obligations as an SSS Provider, including consideration of different solutions, whether network or non-network. However, the SSS Providers should aim to meet the requirements as soon as possible, although compliance with the standard would not be assessed until three years after the requirements are declared by AEMO. The result should be for the benefits of this framework to be realised, especially those of economies of scope and scale in the provision of the service.

Additionally, the Commission considers the simultaneous development of AEMO's methodology with the publication of the system strength requirements in the first report is an efficient use of time and allows for faster implementation of the evolved framework. It means that AEMO would be consulting on *how* the requirements should be calculated and modelled at the same time as actually determining *what* they are for that first year. The Commission acknowledges that some time separation between these publications (i.e. publication of the methodology ahead of the report for some time) may have been preferable. However, the criticality of the system strength issues in the NEM, both to security and the connection process, means that the benefit gained from such separation is something that the Commission considers is not as significant as the benefits gained from the framework being in place earlier.

E.1.2

New provisions required to implement the standard — SSS Providers start planning to meet the standard from 30 September 2022

From the above, each system strength service provider would have the requisite information to begin planning, designing, maintaining and operating its transmission network in order to meet the new standard from 30 September 2022. As such, Schedule 2 of the Draft rule would also commence on 30 September 2022 to allow for this to happen. Schedule 2 of the Draft rule includes:

- System strength requirements methodology – clause 5.20.6 of the draft rule
- System strength report – clause 5.20.7 of the draft rule
- Node declaration and system strength requirements – clause 5.20C.1 of the draft rule

- System strength service providers to make available system strength services – clause 5.20C.3
- System strength services – clause 5.20C.4 of the draft rule
- The new system strength planning standard – clauses S5.1.1, S5.1.14 and S5.1a.9 of the draft rule
- Joint planning obligations specific to system strength service providers – rule 5.14 of the draft rule
- RIT-T changes – clauses 5.15A and 5.16 of the draft 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 draft rule

From this, the SSS Provider can begin planning on how it will meet the standard although it will not be required to be meeting the standard until three years later.²⁹⁴

In order to plan, design, maintain and operate its transmission network to meet the requirements for 2025 as determined by AEMO in its 2022 system strength report, the Commission expects that prudent SSS Providers will begin to make investments well ahead of 2025.

Transitional revenue arrangements relating to the recovery of costs incurred by the TNSP, including ahead of 2025 to meet its obligations starting from 2022, are outlined in section E.2.1.

E.1.3

Maintenance of the shortfall mechanism until 1 September 2025

The existing system strength shortfall mechanism would be removed from the NER on 30 September 2022 but would be preserved in the savings and transitional provisions for a further three year period.²⁹⁵ 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 will take time to contract and / or build these assets, this preservation of the shortfall mechanism is required 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). As a result, significantly more system strength will be being provided in a coordinated manner by this stage, and 'shortfalls' in the provision of the service should no longer be expected to occur. The infrastructure in the existing rules surrounding the shortfalls mechanism, including system strength specific cost pass through events and RIT-T exemptions, would also cease on this date as the new planning standard is being met by SSS Providers.

²⁹⁴ Clause S5.1.14(c) of the Draft Rule.

²⁹⁵ See clauses 11.xxx.13, 11.xxx.14 and 11.xxx.15 of the Draft Rule.

Following this, any sudden system requirements that would have triggered a system strength shortfall declaration by AEMO under this now removed framework may instead be covered by the 'urgent and unforeseen network issue' RIT-T exemption.²⁹⁶ However, the Commission expects that such sudden and unforeseen system strength issues should not arise under the new framework. This is because of the way that the standard has been embedded into the planning process, which are iterative constant checks on whether sufficient investments have been made, and if not action is taken to remedy this such that the service is continually provided at the required level. Additionally, the way that the standard has been designed means that the total amount of system strength being provided in the NEM will be coordinated by a single party in each region — being the SSS Provider. This should remove the reactivity of the existing framework as there is no longer a reliance on the typical dispatch patterns of synchronous generation through the energy spot market for the majority of the service's provision.

The Commission expects that the ways in which a SSS Provider is providing system strength to meet any of its existing shortfall obligations should be able to be used to also meet the new system strength planning standard from 1 September 2025 when the shortfall framework no longer applies. Therefore, there should not be any duplication in the provision of system strength, but rather, a transition from one framework to the other where the underlying service is the same.

E.1.4

2023 TAPR and DAPR to be first with new requirements

2023 TAPRs first to include supply side reporting requirements for SSS Providers and TNSPs reporting on locational factors

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 30 September 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 adequate time to sufficiently plan prior to its publication.²⁹⁷

This allows these parties 13 months to be able to fully plan how they intend to meet the new standard over the 10-year planning horizon, noting that the planning process is a continuous and iterative process with commitment to required projects occurring on an as needed basis, rather than through the planning report process.

These clauses also obligate TNSPs 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 30 September 2022 but would not have to be included until each TNSP's 2023 TAPR published. This is because the rest of the SSMR framework would not have been implemented yet prior to the 2022 TAPR meaning that the TNSP could not reasonably comply with the standard as there is not information to present in the report.

²⁹⁶ Clause 5.16.3(a)(1) of the NER. This could apply to system strength under clause 5.16.3(b) of the NER if those requirements are met.

²⁹⁷ Clause 11.xxx.12 of the Draft Rule.

2023 DAPRs first to include reporting on locational factors

The Rules would reflect the new requirements for DNSPs to include information on the system strength locations factors for each of the system strength connections in its network in their DAPRs from 30 September 2022.²⁹⁸ However, similar to TNSPs, DNSPs would not have to comply with this additional requirement until their 2023 DAPR, usually published on 31 December 2023.²⁹⁹ This is because the rest of the SSMR framework would not have been implemented yet prior to the 2022 DAPR meaning that the DNSP could not reasonably comply with the standard as there is not information to present in the report.

E.2 Pricing and revenue arrangements for NSPs prior to next regulatory determination

The draft rule includes proposed transitional arrangements for NSPs' pricing arrangements in relation to the evolved framework due to the staggered nature of NSP regulatory control periods³⁰⁰ as well as the desire to not wait until the next regulatory control period to implement the rule. It does not include transitional arrangements in relation to the revenue aspects of NSPs' regulatory determinations.

As such, there are proposed transitional arrangements for:

- TNSPs who are SSS Providers in relation to their pricing methodology updates to include how the system strength unit price component of the system strength charge is calculated, as well as how the revenue received from system strength charges is forecast, deducted from and true up in order to make adjustments to the pre-adjusted non-locational component of prescribed TUOS services each year.
- 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.

The TNSPs that are SSS Providers are TasNetworks, TransGrid, Powerlink, AusNet, AEMO and ElectraNet. TNSPs who are **not** SSS providers include Ausgrid, Directlink and Murraylink.

E.2.1 TNSPs who are SSS Providers — Revenue arrangements

The Commission has not included any transitional rules relating to the revenue arrangements for TNSPs who are SSS Providers. This is because we consider there to be three possible ways under the existing rules/processes for SSS Providers to incur expenditure to meet the new system strength standard — subsume some costs within an existing revenue allowance, submit a contingent project application where provided for in a revenue determination, or through the regulatory change event cost pass through rules.

²⁹⁸ Schedule 5.8(o) of the Draft rule.

²⁹⁹ Clause 5.13.2(a) of the NER.

³⁰⁰ 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>.

Some SSS Providers may be able to subsume some costs to meet the new system strength standard within an existing revenue allowance where, for example, other expenditure may no longer need to be spent or could be deferred. However, this may not be possible and would likely only be for a relatively small amount of costs, such as some operating expenditure for initial planning activities.

The ability of SSS Providers to successfully submit a contingent project application relating to expenditure to meet the new system strength planning standard proposed in this draft rule would depend on whether the relevant contingent project information was included in its latest regulatory determination.³⁰¹

Therefore, it is more likely that a cost pass through for a regulatory change event would be most applicable.³⁰² This is a well-established process that allows for TNSPs to apply to the AER for a positive pass through amount as the result of a change in a regulatory obligation or requirement that:³⁰³

- falls within no other category of pass through event; and
- occurs during the course of a regulatory control period; and
- substantially affects the manner in which the Transmission Network Service Provider provides prescribed transmission services or the Distribution Network Service Provider provides direct control services (as the case requires); and
- materially increases or materially decreases the costs of providing those services.

All of these could be true for the new system strength standard. Therefore, we consider it fit-for-purpose for those TNSPs who are SSS Providers who are within a regulatory control period and incur expenditure necessary to meet the system strength standard.

However, the Commission considers the requirement for a sequence of transitional rules to occur prior to the standard being met by SSS Providers will likely have a long planning and RIT-T process as well as procurement process before expenditure to meet the standard occurs. As such, we expect that there may be very limited expenditure in the transitional period before the next regulatory periods commences. For the circumstances that this does occur, as stated above, the regulatory change event process — in line with good regulatory practice — should be triggered and used for the approval of any expenditure.

E.2.2

TNSPs who are SSS Providers — Pricing methodology updates

AER updates pricing methodology guidelines by 31 August 2022

The AER is required 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. This includes consulting on and specifying permitted methodologies for how the system strength unit price — being the forward-looking price of system strength investments that the charge is partly based on — is to be calculated by SSS Providers.

³⁰¹ Rule 6A.8 of the NER.

³⁰² Clause 6A.7.3(a1)(1) of the NER.

³⁰³ 'Regulatory change event' definition in Chapter 10 of the NER.

SSS Providers update their pricing methodology by 30 November 2022

Following publication of the new AER guideline, the SSS Providers (i.e. TransGrid, ElectraNet, AusNet, AEMO and Powerlink) would all have to amend their pricing methodologies and submit them to the AER for approval by 30 November 2022.

The NER sets out the process for how the AER's approval pricing methodologies occurs during the revenue determination process. This is a lengthy process and the Commission considers that it double ups in some areas of consultation in relation to similar issues that the AER would have already covered as part of its guideline consultation. As such, the savings and transitional provisions in the draft rule would use an amended process to enable revised pricing methodologies to be in place in time for prices to take effect in the 2023 pricing year:

- All references to the 'proposed pricing methodology' in Clauses 6A.11.1, 6A.11.2, 6A.14.3(g) and 6A.14.3(h) of the NER would continue to apply to the proposed amended pricing methodologies.³⁰⁴ In short, these clauses allow for the AER to find the pricing methodology is not compliant resulting in the TNSP having one month to resubmit it.
- However, clause 6A.11.3 would not apply to the proposed amended pricing methodology.³⁰⁵ This clause allows the AER to consult on the proposed amended pricing methodology for 40 business days. The Commission considers this round of consultation is not required as the amended pricing methodologies should reflect the AER's guidelines that would have just been consulted on and are not expected to provide scope such that another round of consultation would be required for the AER to make an informed decision regarding the methodology's suitability and compliance. Additionally, this pricing methodology will only be in place until the next regulatory determination for each TNSP (and AEMO) and therefore, in the desire for a fast implementation of the process in the long term interest of consumers, we consider that this to be a pragmatic modification to the process.
- Despite anything else in the Rules, each TNSP and the AER are required to cooperate such that the AER can approve a pricing methodology for each TNSP by 31 January 2023.³⁰⁶ This is important because in order to implement the system strength charge in the 2023 pricing year, TNSPs need to publish transmission prices by 15 March 2023.³⁰⁷ Therefore, sufficient time needs to be allowed for TNSPs to use the approved pricing methodology to develop prices and publish them. The TNSPs, including AEMO, and the AER should work together to enable this to occur so that the evolved framework can be implemented as soon as possible.

The amended pricing methodology would be deemed to be pricing methodology for each TNSP (and AEMO) from the date of its approval by the AER.³⁰⁸ This means that the amended methodology would be in force until the next regulatory determination for each TNSP (and

304 Clause 11.xxx.5(d) of the Draft Rule.

305 Clause 11.xxx.5(e) of the Draft Rule.

306 Clause 11.xxx.5(f) of the Draft Rule.

307 Clause 6A.24.2(c) of the NER.

308 Clause 11.xxx.5(g) of the Draft Rule.

AEMO) where new pricing methodologies would be consulted on that would include the system strength charge.

Further, some TNSPs have specific transitions in relation to their pricing methodology updates as they will be undergoing a regulatory determination process at the time the rule is made. The Commission is interested in stakeholder views on the suitability of these arrangements. The arrangements are that TransGrid and ElectraNet will still be required to submit a pricing methodology in January 2022, as usual under clause 6A.10.1(a) of the NER. They will then be required to submit another pricing methodology by 30 November 2022 but only to amend it to the extent required by the changes in the draft rule to allow for the system strength charge.

In regards to TasNetworks, who has its next regulatory control period commencing on 1 July 2024, it is required to submit a pricing methodology by 31 January 2023 in accordance with the clause 6A.10.1(a), and in so doing can follow the normal process of updating its guidelines for the next regulatory period. The AER's updated guidelines will be in place and so they can update and have their guidelines approved whilst complying with the new requirements.

Publication of the system strength unit price for the first time on 15 March 2023

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.³⁰⁹ This would be done using the updated pricing methodology that would have now been updated and approved in accordance with the process described above, as well as the planning that the TNSP will have been able to undertaken up until this point, as set out in appendix E.1.4.

It is understandable that SSS Providers would not have completed their planning for how they intend to meet the new system strength standard by this time. However, the Commission considers that an accurate price signal should be provided by the system strength unit price published on 15 March 2023 given that the system strength unit price is a forward-looking estimate of the long run costs imposed on the TNSP for the provision of system strength at each node. This would inform connecting parties decisions about where to connect.

E.2.3

TNSPs who are not SSS Providers — Pricing methodology updates

TNSPs who are not SSS Providers that would have system strength connection points (that is, plant that connects to its network that will pay the charge) would need to update their pricing methodology. However, this update will not be as significantly as those that are SSS Providers.

Further, the Commission does not expect that Murraylink or Directlink would have any connections to its network that will pay the system strength charge and therefore, can be exempted from having to update their respective pricing methodology.

³⁰⁹ Clause 6A.24.2(c) of the NER.

However, Ausgrid may have some connections that will do so and as such, would need to update its methodology. It is worth noting that Ausgrid's transmission regulatory determination is approved at the same time and alongside its distribution business' regulatory determination.

The update to its methodology would need to reflect the new obligations under clause 6A.23.6(b) of the draft rule. This clause requires that the pricing methodology must provide for a charge applicable to each system strength connection point on its network to recover from the relevant Transmission Network User, on a pass through basis, the annual system strength charge for the system strength connection point determined by the relevant System Strength Service Provider.

Ausgrid is due to submit its pricing methodology to the AER for its next regulatory control period (commencing 1 July 2024) by 31 January 2023. Therefore, like TasNetworks, the new AER pricing methodology guidelines would already be in place and so Ausgrid would be able to submit a pricing methodology that complies with the requirements of the new rules.³¹⁰ A transitional provision is still required, however, as those provisions (Schedules 3 to 7 of the Draft Rule) would not be consolidated into the NER until 15 March 2023.

E.2.4

DNSPs — Pricing process to account for system strength charge

No explicit transitional arrangements are required for DNSPs to include the system strength charge into their pricing processes. DNSPs would be required to include the charge, as published by TNSPs on 15 March 2023, in their 2023 prices through the usual TUOS pass through processes.³¹¹ As noted above, those provisions will be in the NER by 15 March 2023, which is before the date DNSPs would be required to comply with them, and therefore, no transitional provision is needed.

However, for the avoidance of doubt, the transitional arrangements include 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.³¹² The key new requirement under the draft rule for DNSPs to comply with is clause 6.20.3A of the draft rule, which sets 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.³¹³

The Commission acknowledges that this would be a relatively short time for DNSPs to include this new system strength charge in its pricing processes however the Commission does 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.

310 Clause 11.xxx.5(j) of the Draft Rule.

311 Under the process set out in clause 6.18.2 of the NER.

312 Clause 11.xxx.7 of the Draft Rule.

313 Clause 6.20.3A(b) of the Draft Rule.

E.3 Demand side and system strength mitigation requirement implementation

The new access standards in the draft rule impose additional requirements on newly connecting plant,³¹⁴ 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.³¹⁵ 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. While the access standards are an important reform, they act primarily as the "floor" to which the plant of a connecting party can perform in concert with the SSMR to incentivise the connecting party to install plant that performs at a higher level than might otherwise occur. This is why the access standard does not have an automatic access standard, rather just a minimum — that is, because the SSMR is acting as that incentive for better performance, rather than negotiation with the relevant NSP.³¹⁶ As such, this interaction means it simpler and easier if these parts of the evolved framework begin at the same time.

E.3.1 Commencement of access standards and SSMR on 15 March 2023

The Commission considers that the new access standards should begin on 15 March 2023. By this date, the following would have occurred to allow a connection to negotiate its new access standards and make a fully informed decision regard how it would undergo the SSMR:

- AEMO would have declared system strength nodes by 30 September 2022.³¹⁷
- AEMO would have updated its SSIAG by 15 March 2023, such that there is:³¹⁸
 - 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).

³¹⁴ Clauses S5.2.5.15, S5.2.5.16, S5.3.11 and S5.3a.7 of the Draft Rule.

³¹⁵ Clause 5.3.4B of the Draft rule.

³¹⁶ Although parties can still negotiate for a negotiated performance standard.

³¹⁷ Clause 11.xxx.3 of the Draft Rule.

³¹⁸ Clause 4.6.6 of the Draft Rule.

- The AER would have made the new pricing methodology guidelines, and subsequently, the SSS Providers will 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 would have also updated their pricing methodology to allow for the system strength charges to be passed through.
- TNSPs who are SSS Providers would have published the system strength unit price at system strength nodes as part of their prices for the first time on 15 March 2023.

Which connections who fall under the new obligation proposed under the draft rule?

The Commission proposes 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.³¹⁹ 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.³²⁰
- 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),³²¹ 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.³²² 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.³²³

The rationale for this is that the rule would be made approximately 12-18 months prior to the new access standards and SSMR process commencing. We consider this provides sufficient time for prospective connections to understand the new arrangements and be able to react to the differing obligations under the evolved framework. For those parties that are a substantial way through a connection process, this should give them sufficient time to conclude that process under the existing arrangements.

Additionally, we also expect 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 is similar to the existing framework with the addition of an option to pay a charge instead of remediate if the local system strength is at or below the minimum amount required such that adverse system strength impact and general system strength impact are equivalent. For those parties wanting to use the new framework, they may still be able to progress other aspects of their connection in anticipation of the changes.

319 Clause 11.xxx.8(a) of the Draft Rule.

320 Clause 11.xxx.8(b) of the Draft Rule.

321 Clause 11.xxx.9(b) of the Draft Rule.

322 Clause 11.xxx.9(c) of the Draft Rule.

323 Clause 11.xxx.9(e) of the Draft Rule.