System Strength Framework Frequently Asked Questions

June 2024

Fact Sheet

This fact sheet addresses frequently asked questions related to the Strength Framework. It is intended to be read in conjunction with the National Electricity Rules (NER), System Strength Impact Assessment Guidelines (SSIAG), System Strength Requirements Methodology (SSRM) and relevant consultation documents[1,2].

This document is based on the System Strength Framework at time of publication. As the framework becomes increasingly tested through practice, additional questions or issues may arise. A market bodies working group (comprising the Australian Energy Market Commission (AEMC), Australian Energy Regulator (AER), and AEMO) has been established to monitor, prioritise, and respond to these issues. AEMO will update this FAQ document as necessary.

General questions

1. Do the SSIAG apply to generating systems comprised of only synchronous machines?

Under NER 5.3.4B, the system strength impact assessment requirements apply to connections or alterations of generating systems and integrated resource systems, that is, synchronous generation is not explicitly excluded from system strength assessment, contrasting with load connections which are only covered if they include an inverter-based resource (IBR). However, the efficient system strength framework is built on accommodating IBR in the power system, and only asynchronous machines have the potential to contribute to voltage waveform instability. For that reason, a generating system comprising only synchronous machines will not have a general system strength impact in any preliminary assessment, and the access standards in NER S5.2.5.15 and S5.2.5.16 only apply to generating systems or integrated resource systems that include asynchronous units. It should be noted that the Connecting Network Service Provider (NSP) or AEMO may need to undertake wide area PSCAD™/EMTDC™ studies for other purposes associated with the assessment of a synchronous generation connection.

2. How should proposed alterations under NER 5.3.9 be treated where new production units are being added behind the same connection point of an existing connection?

As described in the SSIAG final report published in March 2023[3], the preliminary assessment and full assessment will only assess the system strength impact of the proposed alteration; that is, the assessed general system strength impact should be relative to the network (including the existing plant) prior to the alteration.

For example, if a 50 megawatts (MW) battery energy storage system (BESS) is proposed to be added to an existing 100 MW solar farm, the system strength quantity (SSQ) (if electing to pay the system strength charge) or the reduction in

[1] Consultation following 2021 Efficient Management of System Strength rule change: https://aemo.com.au/consultations/current-and-closed-consultations/ssrmiag

[2] Consultation following 2024 Calculation of System Strength Quantity rule change: https://aemo.com.au/en/consultations/current-and-closed-consultations/system-strength-impact-assessment-guidelines-amendment-consultation

[3] https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/ssrmiag/final-report/ssiag-final-report-and-determination.pdf

available fault level (if electing self-remediation) is estimated based on the impact of adding the proposed 50 MW BESS component rather than the total 150 MW plant (SF+BESS). When evaluating the adverse system strength impact (full assessment or stability assessment) the total hybrid plant is to be included in the wide area PSCAD™/EMTDC™ model (SF+BESS in this example).

If a 50 MW BESS is added to an existing 100 MW solar farm but rated active power (P_{rated}) remains unchanged at 100 MW, the impact of the alteration on the withstand short circuit ratio (SCR) of the integrated resource system as a whole would need to be considered; that is, if it can be demonstrated that the same withstand SCR can be achieved by the altered plant, then it is reasonable to conclude that the alteration does not have a general system strength impact.

3. What types of loads are required to undergo assessment?

AEMO has clarified that an inverter-based load (IBL) is a load that is supplied by power electronics, including inverters, and potentially susceptible to inverter control instability.

In future, further consideration may be given to including specific criteria around what is, or is not, 'potentially susceptible' as informed by AEMO's ongoing reviews of the Power System Model Guidelines[4] and the technical requirements for connection (access standards)[5].

4. What information is needed for determining whether a load is classified as IBL and when should the information be submitted?

Generally, NER S5.3.1 and NER S5.4 set out the information that must be submitted to the NSP.

Where possible, the following key information (some of which is required to be submitted under NER S5.3.1) is encouraged to be submitted at the connection enquiry stage (see Figure 3 in SSIAG) to facilitate the classification of a load:

1. single line diagram with protection details, all major equipment, e.g., the load and associated auxiliaries that impact the stable operation of the load,
2. general arrangement locating all the equipment on the site,
3. operational arrangements, and strategies in controlling active power, reactive power and voltage under normal and contingency operation conditions,
4. technical documents that show details of the technologies adopted by the major equipment (load and auxiliaries).

In addition, if PSS®E and/or PSCAD™/EMTDC™ models[6] that reflect behaviour of the connection (e.g., fault ride through capability and protection schemes) are available, they are encouraged to be provided as part of the connection enquiry to support the classification.

[4] https://aemo.com.au/consultations/current-and-closed-consultations/psmg-review-consultation

[5] https://aemo.com.au/consultations/current-and-closed-consultations/aemo-review-of-technical-requirements-for-connection

[6] Refer to section 3.2 in AEMO Power System Model Guideline for load model requirements.

Available fault levels

5. How is the stability co-efficient (α)factor calculated to be 1.2?

The choice of a value of 1.2 for the stability coefficient is consistent with the current general consensus of the SCR value at which voltage collapse could reasonably be expected to occur. However, it is also noted that voltage collapse could occur due to excess MW transfer which would not be present if the generating system or integrated resource system under consideration was not connected, or was generating at a lower MW level. In such circumstances, devices such as synchronous condensers or grid-forming inverters will provide the dual benefits of added system strength support and reactive power support in one device.

While a slightly higher stability coefficient might be more accurate on a case-by-case basis depending on network limitations and connection point characteristics, a precise calculation accounting for wider power system characteristics requires the development of new tools and techniques and cannot be directly obtained from PSS®E studies. Noting that the stability co-efficient is intended as an approximation only, a constant value of 1.2 allows for ease of use and provides clarity and transparency to both 4.6.6 Connection Applicants and NSPs, without significant impact on the calculated reduction in available fault level (∆AFL).

6. Which PSS®E method (automatic sequence calculation (ASCC) or International Electrotechnical Commission (IEC)) and parameters should be used for AFL short circuit calculations?

Using the methodology described in SSIAG Section 7.3, the user can choose either IEC or ASCC calculation methods. To avoid diverging results, the suggested approach is to use the following settings in PSS®E 34.8 or above:

1. Click “Short Circuit” and then click “Automatic Sequencing fault calculation (ASCC)“.
2. Select FLAT Classical and click “Apply”.
3. Select “Three phase fault”.
4. Specify the desired bus in “The following buses”.
5. Click “Go”.

This selection should prevent pre-condition load flow from impacting the results.

7. What is the *rated active power* or P_{RATED} to be used for the short circuit ratio and AFL calculations?

AEMO understands that, for access standards based on the defined term *rated active power*, this has historically been understood to be synonymous with the maximum active power a generating system can deliver at its connection point (referred to in the generator performance standards as “Maximum Capacity”). For completeness, AEMO notes that this application is not clearly aligned with the NER definition of *rated active power*, and AEMO is considering this issue in its current review of the technical access standards.

In the context of the SSIAG, rated active power should be interpreted as the maximum amount of active power that is permitted to be transferred to a connection point from a production unit, generating system or integrated resource system (as the case may be) as demonstrated in the examples below. This is represented by the “Maximum Capacity” in the Generator or Integrated Resource Provider Performance Standards (GPS).

Example 1: SCR calculation 100 MW Solar Farm

- Number of inverters = 40
- Nameplate rating of PV inverter = 3 MW
- Nameplate rating of solar farm = 3 x 40 = 120 MW
- Maximum Capacity at connection point = 100 MW = P_{RATED}
- 3ph synchronous fault level at connection point = 360 megavolt-amperes (MVA)

In this example SCR = 360/100 = 3.6

Example 2: Fault level calculation example for Hybrid plant (120 MW BESS, 80 MW Solar)

For this hybrid plant, studies to demonstrate a given Withstand SCR at the connection point should apply a fault level which is based on the larger of the maximum demand (load) and the maximum capacity (generation).

- Maximum Demand at connection point = -100 MW
- Maximum Capacity at connection point = 100 MW
- BESS nameplate rating = 120 MW
- PV nameplate rating = 80 MW

SMIB connection point fault level (MVA) = abs(max(demand, capacity)) x Withstand SCR

In this example, testing for a Withstand SCR of 3 (MAS) for the combined plant, the connection point fault level would be 300 MVA.

8. For calculation of AFL for the purpose of forecasts as system strength node (SSNs) (Section 3.4.4 of the SSIAG), how should both existing IBR and new IBR covered under the new framework be treated?

All generation connections should be represented by a Thevenin voltage source behind their proxy impedance. If the minimum Withstand SCR is not known and is unable to be determined, then an NSP should make a reasonable assumption about the value of Withstand SCR to apply (historically an SCR of 3.0 has been assumed). See example A.1 (IBR1) in the SSIAG for an example of the proxy impedance calculation.

For existing grid-forming plant, this same method is followed unless that plant has demonstrated a positive system strength contribution through wide area PSCAD™/EMTDC™ studies. The contribution of that plant can then be included in the calculation of the Synchronous Three Phase Fault Level, as defined in the SSIAG.

System strength locational factor

9. Which Operations and Planning Data Management System (OPDMS) case should be used for conducting system strength locational factor (SSLF) calculation?

Any ‘system normal’ case which includes an accurate reflection of the network at the time of completing the SSLF calculation is considered reasonable. It is critical to consider representation of any network augmentations that would materially affect the impedance of the network in the case that is used.

10.With reference to Section 6.1.4 of the SSIAG, is the SSLF of distribution-connected generation to be shared with the system strength service provider (SSSP)?

NER 5.3.4C details the requirement for the relevant NSP to provide the SSLF and other information to the SSSP after specific milestones as defined in that section.

11.Which PSS®E method (automatic sequence calculation (ASCC) or International Electrotechnical Commission (IEC)) and parameters should be used for SSLF short circuit calculations?

Using the methodology described in SSIAG Section 6.1.4, the user can choose either IEC or ASCC calculation methods. To avoid diverging results, the suggested approach is to use the following settings in PSS®E 34.8 or above:

1. Click "Short Circuit" and then click "Automatic Sequencing fault calculation (ASCC)".
2. Select FLAT Classical and click "Apply".
3. Select "Three phase fault".
4. Specify the desired bus in "The following buses".
5. Click "Go"

This selection should prevent pre-condition load flow from impacting the results.

Preliminary assessment

12.In relation to Section 4.1.6 of the SSIAG, what is defined as preliminary assessment results?

It is expected that the Connecting NSP will provide the Applicant with the following preliminary assessment results:

- Provisional Withstand SCR capability (assumed to be 3.0 if there is no model available).
- ΔAFL calculated as per Section 3.4.2.
- SSLF calculated as per Section 6.1.4.
- Determination of whether the proposed plant or alteration will cause a general system strength impact (noting it may not be possible to determine the adverse system strength impact with confidence in the preliminary assessment).

13.Do NSPs need to provide AFLs for system buses other than the 4.6.6 point of connection where the connection is impacting them (that is, negative AFL)?

The NSP is only required to provide the reduction in AFL for the 4.6.6 Connection Point using the methodology described in Section 4.1.5 of the SSIAG.

Stability assessment and full assessment

14.If a connection satisfies either of the materiality threshold criteria of Section 3.5 of the SSIAG, then its effect on the general system strength can be ignored. This implies that the SSQ value for this connection would be zero, resulting in no payable system strength charge. In this scenario, would conducting a stability assessment alone be sufficient?

Where a general system strength impact is below the materiality threshold and can be disregarded, there is no requirement to complete a full assessment. It is important to note that a general system strength impact may only be disregarded if the preliminary assessment (if possible to determine with confidence at that stage) or the full assessment demonstrates that the 4.6.6 Connection has no adverse system strength impact.

Where a full assessment is not required, the Connecting NSP may still need to perform wide area PSCAD™ studies as part of its due diligence on the connection application to ensure conformance with the proposed access standards and to confirm no other adverse system stability impacts. This requirement would be separate from the stability assessment under the SSIAG, which is undertaken only if the applicant has elected to pay the system strength charge.

15.When completing a full assessment, should the 4.6.6 Connection be assessed against considered (network) projects which are completed or likely to be completed after the project's commissioning? In this scenario, are assessments of the 4.6.6 Connection required for conditions both pre and post-completion of those considered projects?

The NER outline a number of milestones to be met for a transmission or distribution network augmentation to be a *considered project*. NSPs should aim to include all relevant network augmentations which meet this definition. Where an augmentation meeting the considered project criteria is not expected to be completed and operational prior to a 4.6.6 Connection's commissioning, it is considered reasonable to base the assessment studies on the more onerous network condition. This does not preclude studies both with and without the relevant considered project modelled to confirm that the augmentation does not affect the operation of any proposed remediation.

16.Is there a requirement to complete a stability assessment or full assessment if the withstand SCR is 1.2 or less and the ∆AFL is zero or positive?

Where the preliminary assessment indicates sufficient confidence of a zero or positive reduction in available fault level (ΔAFL) and no adverse system strength impact, the connection will not need to remediate for a reduction in AFL or pay a system strength charge (SSC). However, wide area PSCAD™ studies may still be required to confirm that the connection does not have adverse system stability impacts. This requirement would be separate from the full assessment or stability assessment under the SSIAG.

Remediation schemes and connection works

17.Can Inter-trip be considered as a system strength mitigation strategy?

As described in the SSIAG final report published in March 2023, AEMO considers a special protection scheme, designed in accordance with the Remedial Action Scheme Guidelines and defined under a NER S5.2.5.8 performance standard, could be an acceptable system strength remediation scheme (SSRS) in appropriate circumstances. Examples include instability prevention in response to planned outages or non-credible contingencies, or in occasional circumstances where it is commercially prohibitive or technically infeasible to install a synchronous condenser or grid-forming inverters. The NSP should make this assessment in consultation with AEMO. It is, however, noted that an inter-trip scheme can only remediate for adverse system strength impact and not the ∆AFL component of the general system strength impact.

18.Can SSRS be located at a different place than the 4.6.6 connection?

As per SSIAG Section 5.1.2, SSRSs must be implemented behind the 4.6.6 connection point and address both reduction in AFL and adverse system strength impact. An SSRS, as opposed to system strength connection works (SSCW), is to be implemented, operated and maintained by the Connection Applicant.

AEMO is prepared to consider any further industry feedback on this issue for future revisions of the SSIAG.

19. Can the applicant opt to self-remediate if the SSC or SSCW are considered not optimal?

Under NER 5.3.4B (b1), the Connection Applicant must elect whether to pay the SSC in its connection application. The election cannot be revoked. However, the Connection Applicant may choose to withdraw the application and resubmit without the SSC election if it decides to self-remediate instead.

If opting for self-remediation, any SSRS proposal must be included in the connection application. If the Connection Applicant does not propose an SSRS, SSCW is the default option. AEMO encourages early engagement with the NSP to identify feasible remediation solutions (either SSRS or SSCW) collaboratively prior to submission of the application.

20. How will SSRS with a synchronous condenser be managed for high fault level connection points (that is, where fault level contribution from the synchronous condenser causes the system fault level limits to be exceeded)?

The NSP should evaluate whether any proposed SSRS or SSCW is likely to breach the system fault level limits. In such cases, it will be necessary to revise or redesign the SSRS or SSCW in a way that limits fault level contribution from the plant or otherwise addresses the risk of breaching system limits.

Grid forming technologies

21. How should plant which includes both grid forming and grid following inverters be assessed?

For plant that includes both grid forming inverters and grid following inverters, the combined plant should be considered. If sufficiently detailed models are not available at the preliminary assessment stage, it is likely that the same assumptions which are made for a purely grid-following plant would need to be applied to this combined plant; that is, an assumption of a Withstand SCR of 3.0.

The grid forming contribution to the ΔAFL will be considered through the detailed studies which demonstrate Withstand SCR capability for the overall generating system or integrated resource system (including both grid following and grid forming plant). If at the stage of detailed assessment (after the preliminary assessment is completed) it is demonstrated that the Withstand SCR for the combined plant is less than or equal to 1.2, the ΔAFL portion of the general system strength impact is taken to be zero or, where opting to pay the SSC, the revised Withstand SCR will be fed into the updated SSQ calculation. Within a full assessment, the adverse system strength impact is then considered, and any positive contributions of the grid forming component of the plant are likely to reduce that observed impact.

Example for Hybrid plant (100 MW grid forming BESS, 150 MW Wind):

In this example, the plant applied the assumed Withstand SCR of 3.0 at the time of the preliminary assessment. The Withstand SCR is subsequently revised to 1.2 based on more detailed information from the applicant.

- BESS MVA nameplate rating = 100 MVA
- Wind MVA nameplate rating = 150 MVA
- Maximum capacity (P_{RATED}) = 120 MW
- Withstand SCR = 1.2
- SMIB connection point fault level (MVA) = 120 x 1.2 = 144 MVA

Provided that the plant can satisfy the requirements detailed in the SSIAG Section 7.4 at the proposed Withstand SCR of 1.2, the plant's corresponding proxy impedance (1 / ΔAFL) is infinite, or effectively an open-circuit. This assessment can be done using different tuning (if required), where the extent of the changes must be advised to the NSP and AEMO.

22.How are NER 5.3.9 alterations to change from grid following to grid forming technology handled?

This question was covered in detail in Section 4.12 of the SSIAG final report published in March 2023[7].

The alteration is to be assessed as per the guidelines and the contribution of the grid forming technology will be assessed in terms of AFL. In these instances, it is expected that once Withstand SCR assessments are conducted, it is highly unlikely that the plant alteration will have a general system strength impact, resulting in no charges and no self-remediation requirement.

Withstand SCR

23.Does a 4.6.6 Connection need to be able to meet its proposed GPS using the alternative settings applied for demonstration of its Withstand SCR?

There is no explicit requirement for a 4.6.6 Connection to demonstrate compliance with its other proposed performance standards using the settings applied for demonstration of the SCR for NER S5.2.5.15 (the Withstand SCR). The minimum set of studies required for demonstration of this short circuit ratio are those outlined in the SSIAG. The acceptance criteria outlined in Section 7.4.4 do include requirements relevant to other NER clauses, for example aspects of the S5.2.5.5 minimum performance must be met. Additionally, as described in the SSIAG, an NSP may require tests additional to those outlined in the SSIAG to be carried out.

However, all proponents should be aware of the need to continue to meet all performance standards as network conditions change. It should also be noted that a NER 5.3.9 or S5.2.2 assessment process will be undertaken as applicable, if and when it becomes necessary to adjust settings or tuning for lower SCR levels.

24.Can the harmonic filter(s), if installed for a 4.6.6 Connection, be disconnected for Withstand SCR assessment?

AEMO understands that disconnection of harmonic filters may help achieve a lower Withstand SCR to mitigate the reduction in Available Fault Level (AFL). This is in effect proposing it as part of a System Strength Remediation Scheme (SSRS) to address an adverse system strength impact. Section 5.1.2 of the SSIAG describes acceptable SSRSs “must address each element of the identified general system strength impact, namely, the adverse system strength impact and the reduction in AFL, as applicable”. AEMO notes that disconnection of harmonic filters is expected to result in greater harmonic emissions by the 4.6.6 Connection, thereby contributing to an adverse system strength impact due to adverse power quality interactions as per Section 3.3.2(a)(iii) of the SSIAG. Therefore, proposing a Withstand SCR that is achieved by disabling harmonic filters is not an acceptable SSRS.

Considering the above, harmonic filters should not be disconnected for Withstand SCR assessment of a 4.6.6 Connection.

25.Is Withstand SCR assessment listed in SSIAG Appendix B required for RMS-type simulation tool, such as PSS®E?

The tests listed in Table 2 to Table 4 in Appendix B of the SSIAG are required to be carried out using PSCAD™/EMTDC™ models. In addition, tests listed in Table 2 in Appendix B of the SSIAG are optional to be performed with PSS®E models. It is acknowledged that the dynamic simulation results produced from an RMS simulation tool may not fully represent the assessed plant’s performance under low SCR conditions. Hence, the performance of a 4.6.6 Connection should be assessed based on the more granular PSCAD™/EMTDC™ simulation results. For the same reason, benchmarking

[7] https://www.aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/ssrmiag/final-report/ssiag-final-report-and-determination.pdf

between two different simulation tools (e.g., PSS®E and PSCAD™/EMTDC™) is not required to be considered under the Withstand SCR assessment.

System strength planning requirements

26. How is system strength defined in the planning requirements?

System strength describes the ability of the power system to maintain its voltage waveform at a given location, both during steady state operation and following a disturbance. System strength is often approximated by the amount of electrical current available during a network fault (fault current), however the concept is used as an umbrella term which also captures a range of other electrical characteristics and complex power system interactions.

To better capture that complexity, the new framework in the NER represents system strength in two different ways for the purpose of setting and meeting requirements at each network location:

- A minimum three phase fault level for protection and voltage control systems to operate correctly and for the power system to remain stable following a credible contingency or protected event (**minimum level**).
- A stable voltage waveform requirement at connection points that is sufficient to address the risk of connected plant causing or contributing to instability, and to facilitate plant remaining in operation after credible contingency and protected events (such that resolving voltage waveform instability is not dependent on plant disconnection or power transfer variation) (**efficient level**).

This dual approach is an important feature of the new framework, moving away from sole reliance on an MVA measurement, and instead focusing on underlying system characteristics and behaviours. This shift is also expected to provide broader options for how the system strength standard might be met, including new technologies that may stabilise the voltage waveform in ways that do not necessarily provide fault current.

The minimum level is generally set lower than the current typical levels available in the system – effectively the minimum level represents the point at which instability was observed in studies while progressively reducing available fault current levels; or below which protection requirements would have been violated. As such, this requirement should not incentivise investment to increase fault levels above current values; but rather reflect a need to prevent existing fault levels from falling towards zero as levels of synchronous generation progressively decline.

The efficient level is not specified in terms of fault current at all – it instead asks that SSSPs ensure a stable voltage waveform can be maintained for a forecast volume of IBR investment. Delivering this standard could be achieved through a range of non-synchronous or non-network options, including emerging technologies or a portfolio of complementary services.

27. How is a 'stable voltage waveform' defined and measured?

AEMO consulted on the characteristics of a stable voltage waveform through its review of the SSRM[8] in 2022. This resulted in the following four criteria:

- The positive-sequence root mean square (RMS) voltage magnitude at a connection point should not violate agreed limits.

[8] https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/system-strength-requirements-methodology.pdf?la=en

- The change in steady-state RMS voltage phase angle at a connection point should not be excessive following the injection or absorption of active power at a connection point.
- The three-phase instantaneous voltage waveform distortion at a connection point should not exceed acceptable planning levels of voltage waveform distortion for pre- and post-contingent conditions.
- Any undamped steady-state RMS voltage oscillations anywhere in the power system should not exceed agreed planning thresholds.

The SSRM contains more information on each of these characteristics, and suggested methodologies for assessing them over different forecast timeframes.

28. How are system strength requirements calculated and expressed?

Under the new framework, AEMO must publish a set of system strength requirements by 1 December each year. These requirements define the location of system strength nodes, and for each node, include a 10-year forecast of minimum levels and the projected level and type of IBR that must be accommodated for the purpose of achieving the efficient level.

AEMO calculates the minimum levels based on a combination of power system analysis, and equipment advice from the relevant NSP. The projected IBR levels are derived from forecast IBR build under the most likely scenario from AEMO's most recently published *Integrated System Plan*[9]. Where appropriate, the projected IBR levels can be supplemented with more recent modelling results from planning publications like the NEM *Electricity Statement of Opportunities*[10]. The detailed methodology used to forecast each quantity is presented in the SSRM.

29. How are the SSN locations selected and updated?

An SSN is a physical location on a transmission network at which AEMO must determine an explicit system strength requirement. These node locations are also used in determining the SSLF and SSC.

AEMO applies engineering, market, and policy judgement when selecting an appropriate set of nodes for each region; and considers the consulted principles and criteria in the SSRM. In particular:

- The selection of nodes should have regard for projected IBR connections, projected change in synchronous machine operation, existing and future high voltage direct current (HVDC) equipment, and general power system stability issues.
- The total number of SSNs declared per region must be practicable, having regard to the effort required to derive system strength requirements, and undertake investment planning for each node.
- Collectively the nodes should allow a reasonable representation of the overall system strength requirements of the power system.
- SSNs must be declared within the transmission network of a SSSP, although an SSSP can seek system strength services from sources in other transmission or distribution networks.
- SSN selection should have regard to locations where centralised and coordinated SSSP investment or service provision is expected to be most efficient.

[9] https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp

[10] https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo

- As part of the annual system strength requirements process, AEMO undertakes joint planning with the SSSPs to consider whether new or different SSNs are required to best accommodate the changing needs of the power system. AEMO welcomes any stakeholder feedback on the current or future set of node locations.

30. How have grid forming inverters been considered when setting the system strength requirements?

- The current efficient level forecast does not make any assumptions or distinguish between grid forming and grid following IBR, requiring only that SSSPs invest in sufficient assets and services to accommodate the full volume of projected IBR. AEMO is currently exploring options to better account for a mixture of grid forming and grid following technologies in the efficient levels.
- Given that grid forming IBR is unlikely to rely on central remediation services, capturing this technology more explicitly would likely reduce the level of total investment needed from each SSSP, but may equivalently reduce the cost base over which the unit prices are recovered.
- In cases where grid forming technology can provide surplus system strength to neighbouring plant (in addition to remediating its own needs), it may be possible for this excess to be offered as a service to the SSSPs.

31. How will system strength shortfalls be addressed until 1 December 2025?

From 2 December 2025, SSSPs are responsible for meeting the system strength standard published by AEMO three years earlier. Until that time (defined in NER 11.143 as the 'system strength transition period'), AEMO must continue to apply the previous framework to assess and declare system strength shortfalls, The SSSP is required to make services available to address any new shortfall declared in the transition period in the same way as the previous framework (see NER 11.143.15).

System strength investment

32. How are centralised system strength investments assessed, and how are these approved?

Powerlink, Transgrid, ElectraNet, TasNetworks, and AEMO Victorian Planning (AVP) are the SSSPs for their respective regions. Each SSSP has sole responsibility for procuring services that meet the system strength requirements from 2 December 2025.

System strength transmission services provided by an SSSP are prescribed transmission services, and related investments are subject to the regulatory investment test for transmission (RIT-T) process in the NER and the AER's RIT-T application guidelines.

33. What if the system strength requirements change over time due to new technologies or system conditions?

AEMO reassesses both the minimum fault level requirements and the efficient IBR forecasts annually, based on the latest information and modelling results available at the time. Through that process, the system strength requirements are expected to evolve over time to reflect changing power system conditions and new technologies. These changes may result in obligations on the SSSPs to accommodate additional IBR in certain locations, to deliver system strength at new locations. Technology improvements may also allow more IBR to be accommodated for the same levels of system strength investment.

The efficient level of system strength is expressed in terms of an underlying behaviour (stable voltage waveform), for a forecast quantity of IBR to be supported. This means that technological improvements can be considered explicitly when modelling investment needs against the standard – for example, based on the expected performance (or mix) of future IBR technology, a different level of investment may be required to deliver the same level of stability, while the standard itself remains unchanged.

34. What if fewer projects than expected elect to use the centralised services?

Consistent with the response to Q33, AEMO updates the system strength requirements annually based on the latest available information and modelling. As part of this annual review, AEMO also undertakes joint planning with the SSSPs to identify the impact of project commitment decisions and trends on the projected need for centralised services.

If IBR connections are lower than the forecast applied for the efficient level, the three-year delayed obligation on SSSPs may result in a slight over-investment initially, while the framework adapts to real uptake rates. However, the pipeline of new renewable projects means that any initial over-investment will likely still be required later in the horizon.

Over time, the planning, connections, and pricing components of the framework are expected to evolve in tandem via the feedback mechanisms between them.

35. How will system strength be managed if more IBR wants to connect than the efficient level forecast? Will the SSSP have to procure additional SS Services, or will the connection applicant have to self-remediate?

Under NER S5.1.14, SSSPs must use reasonable endeavours to meet the system strength specification published by AEMO through the annual System Strength Report. There is no obligation on SSSPs to procure additional system strength beyond these levels.

SSSPs must deliver enough system strength to accommodate a forecast fleet of IBR (based on AEMO's optimal development plan projections in the *Integrated System Plan*). New connections that elect to pay the SSC can then consider the strength afforded by these centralised investments when meeting their own remediation requirements. However, there is no guarantee that the centralised services will be sufficient to support stable operation for every project electing to pay the SSC.

Remote connections, or those in locations where the centralised service has already been exhausted, may see no benefits from electing to pay the SSC. Such connections may need to self-remediate to achieve a stable connection, or to consider alternative locations where centrally provided strength is likely to be available. As the power system evolves, updates to the efficient level forecasts may lead to shifts in the location of system strength requirements to support expected IBR connections.

36. How are system strength investment costs recovered by the SSSPs?

Investments made by the SSSPs to meet their system strength obligations are treated as prescribed transmission services, with costs recovered from network customers via Transmission Use of Service (TUoS) charges. This cost is offset (reduced) by any system strength charges collected from connecting parties who elect to use centralised services rather than self-remediating.

System strength unit prices

37. Who is responsible for calculating system strength unit prices, and how often are these updated?

Each SSSP is required to forecast the long-run costs associated with meeting their system strength obligations, and to convert these into a set of System Strength Unit Prices (SSUPs) that apply at each system strength node.

The methodology used must follow the AER's Pricing Methodology Guidelines[11], and is subject to review by the AER[12].

Once published, unit prices are fixed for a period of up to five years (with annual indexation), and are only recalculated alongside each SSSP's regulatory control period. Those periods are each five years in length, but the cycles are staggered between different regions. Initial SSUPs were published to each SSSPs website on 15 March 2023.

38. How are system strength unit prices calculated?

The unit prices published by each SSSP may contain commercial factors that are unique to specific regions, network locations, or SSSP businesses. AEMO does not have visibility of these factors for regions outside of Victoria.

However, outside these commercial considerations, the fundamental methodology used by each SSSP must be consistent with that described in Section 2.7 and Section 2.8 of the AER's Pricing Methodology Guidelines[11].

The SSUP (and resulting system strength charges), are intended to reflect the real long-run costs experienced by a SSSP in supporting connection of an un-remediated project at a particular location.

To calculate this, each SSSP uses the system strength requirements published by AEMO to model the optimal quantity and location of investment needed to meet those requirements. For each node, the cost of the required investment is then divided by the level of IBR that can be supported as a result. Depending on the network location, this can include 'sharing', where investment at one node allows additional IBR to be built in multiple other locations, reducing the per-unit cost (by increasing the per-unit effectiveness) of system strength built in that location.

39. Why are some unit prices higher than others?

There are many drivers that may impact the unit prices calculated for a given system strength node, including the sharing of support between neighbouring nodes, the ability of certain locations to accommodate new system strength assets, the electrical losses or other costs of operating the solutions (which may be impacted by regional spot prices), and the quantity of IBR that the investment will support at that location.

Together, these factors mean that per-unit prices can appear lower at nodes where the network allows greater sharing, where substantial headroom already exists above minimum requirements, or where projected volumes of IBR allow for higher economies of scale. As noted above, unit price calculations can also factor in commercial inputs and assumptions specific to particular locations, regions or SSSP businesses, but AEMO does not have visibility of these factors outside Victoria.

The spread of unit prices provides a locational signal, but also means that the relative benefits of paying the system strength charge will be highly dependent on the IBR needs and self-remediation alternatives at each site. AEMO encourages participants to engage directly with their regional SSSP to better understand the inputs and drivers behind specific prices.

40. What if the centralised services are not in the right location, or are not sufficient to support a project?

The framework is designed to incentivise generation around 'stronger' locations, where the scale efficiencies of centralised investment are likely highest. However, in other locations, self-remediation may still be the most cost-effective

[11] https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/pricing-methodology-guidelines-2022-system-strength-pricing

[12] https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/pricing-methodologies-system-strength-pricing

approach to achieve a stable connection. Proponents are encouraged to consider their specific circumstances and liaise with their connecting NSP when making this choice. See also the response to Question 35.

41. Can proponents get paid for providing a positive system strength impact?

SSSPs must consider both network and non-network options when meeting their system strength obligations.

This means that proponents may be able to offer any excess system strength services to the SSSP on commercial terms as a non-network service. The SSSPs must still test these service offerings economically alongside other options capable of contributing to their requirements.

Fact Sheet

Version control

Version	Release date	Changes
2.0	28/06/2024	Addition of items 4, 11, 24, and 25 and other minor revisions
1.0	09/08/2023	Initial publication

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Where can I find more information?

- National Electricity Rules
- System Strength Impact Assessment Guidelines
- System Strength Report and System Strength Requirements Methodology
- Amendments to the System Strength Impact Assessment Guidelines following 2021 Efficient Management of System Strength rule change
- Amendments to the System Strength Impact Assessment Guidelines following 2024 Calculation of System Strength Quantity rule change

For any further enquiries please email contact.connections@aemo.com.au.

Applicants are responsible for ensuring they understand the relevant provisions of the NER and other applicable instruments, which prevail in the case of any inconsistency.