

Power System Security Planning

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The increased contribution of generation from inverter-based resources (IBR) is changing the way system security services such as system strength and inertia are planned for, delivered and managed. Powerlink is actively planning for and procuring system security services to support the stable operation of the power system in Queensland.

Key highlights

- System security services have traditionally been provided as an inherent characteristic of synchronous generation.
- The need for new approaches to system security services arises because most IBR do not inherently provide all these services.
- Powerlink is the System Strength Service Provider and Inertia Service Provider for Queensland, with specific obligations defined in the National Electricity Rules (NER).
- Powerlink is seeking to deliver system security services that support a safe, reliable and cost-effective power system for Queensland customers.

3.1 System security services

Queensland's power system has historically comprised synchronous generation such as coal-fired power stations, gas turbines and hydro-electric plants. These large generators provide various system security services, such as voltage regulation, inertia and system strength, as an inherent characteristic of their energy dispatch, supporting stable and reliable power system operation.

Table 3.1 outlines the range of system security services that are needed to operate the power system.

Table 3.1 System security services

Service	Description
System strength	The ability of the power system to maintain a stable and reliable voltage waveform when something disturbs it, such as a fault or sudden change in generation or load. There are two distinct forms of system strength (minimum and efficient) which support different system functions and are currently provided by different sources.
Minimum system strength	Sufficient three phase fault levels to maintain correct protection operation, power quality and stability of the power system. Presently, minimum system strength can only be provided by synchronous sources.
Efficient system strength	Required to support a stable voltage waveform for forecast IBR connections. In addition to synchronous sources, this form of system strength can also be provided by grid-forming Battery Energy Storage Systems (BESS) technology.
Voltage regulation	Sufficient dynamic voltage support to arrest any changes following contingencies.
Frequency control	Maintaining system frequency within acceptable range with ongoing natural variations in load and generation, and sudden step changes following contingencies.
Inertia	Limiting the potential rate of change of system frequency following contingencies.
Damping	Damping of power system oscillations so that any disturbance impacts decay at an acceptable rate.
Power quality	Control of phase unbalance, voltage harmonics, and flicker.
Reserves	Availability of generation reserves or demand side resources to restore system security within 30 minutes following contingencies.

The increased contribution of IBR generation sources, particularly solar and wind, can reduce the availability of system security services in the National Electricity Market (NEM), prompting the need for new approaches to the planning and delivery of these services.

Under the NER, Powerlink is the System Strength Service Provider and Inertia Service Provider for Queensland. Our strategy to discharge our responsibilities to plan for and make system security services available includes:

- pursuing a complementary mix of different technologies to address requirements, as outlined in Powerlink's System Strength Regulatory Investment Test for Transmission (RIT-T)
- timely and efficient investment in solutions to anticipate withdrawal of synchronous generation, while preserving flexibility to invest in or procure further solutions (including non-network solutions) over time
- working with the Australian Energy Market Operator (AEMO) and Energy Queensland (as owner of the Energex and Ergon Energy distribution networks) to explore ways to enhance Queensland's operational tools and investigate new technologies to maintain system security during periods of low operational demand.

3.2 System security framework

The regulatory framework under the NER for the planning, procurement and enablement of system security services has evolved significantly in recent years. Under the current framework:

- AEMO has responsibility for the forecasting of power system security services
- AEMO's annual system security reports assess the need for services across all regions of the NEM, and evaluate requirements for system strength, inertia and Network Support and Control Ancillary Services (NSCAS)
- Powerlink must use reasonable endeavours to make system strength and inertia services available to AEMO.

In November 2025, AEMO submitted a proposal to the Australian Energy Market Commission (AEMC) to further amend arrangements. AEMO proposed changes to the NER to:

- allow it to declare forecast system strength and inertia deficits across the NEM to be NSCAS gaps that would require remediation action from System Strength and Inertia Service Providers
- extend the notice of closure period for existing generation plant from three and a half to five years
- extend timeframes for System Strength and Inertia Service Providers to comply with system security requirements from three to five years
- assess options for system security services under a new process, or a streamlined version of the RIT-T.

AEMO considers these changes would support the efficient and timely deployment of system security resources.

In January 2026, the Australian Energy Council and the Clean Energy Council submitted a related proposal to:

- provide greater clarity on annual planning obligations
- enhance accountability and transparency of system security services planning and procurement
- develop defined and consistent procurement processes across NEM jurisdictions with flexibility to progress and adapt with the market.

The AEMC has consolidated the two proposals, noting they are complementary and address different aspects of the system security planning and procurement framework. More information is available on the AEMC's [website](#).

Powerlink will continue to engage with the AEMC, AEMO and industry stakeholders to enhance the framework for system security services through the rule change process.

3.3 Activities to meet system strength and inertia requirements

Powerlink has progressed several activities to meet system strength and inertia requirements since publishing the 2025 TAPR:

- In addition to the existing agreement with Ratch Australia for the provision of system strength services at the Townsville Power Station, in December 2025, Powerlink finalised an agreement for system strength services from Pacific Hydro's synchronous condenser located at their Haughton Solar Farm Stage 1 site in Northern Queensland.
- In March 2026, Powerlink signed an agreement with Hitachi Energy to supply and install four synchronous condensers to deliver system strength in Central Queensland and maintain voltage stability and inertia. Two of the units will be installed at the Calliope River Substation, with one each at the Nebo and Stanwell substations.
- Powerlink will continue to assess the need for and monitor potential network and non-network solutions for future system strength requirements in Southern, Central and Northern Queensland.
- Powerlink is progressing studies to examine the technical feasibility and capability of grid-forming BESS to deliver minimum system strength.

The four synchronous condensers are part of the preferred option in Powerlink's System Strength RIT-T, concluded in June 2025. The target dates for the first two synchronous condensers to become operational is early 2029 with the final two operational by the end of 2029. The total cost of the four units is being finalised. Indicative costs for non-network solutions were included in the RIT-T cost-benefit assessment. However, these costs did not influence the identification of the preferred option as they are treated as a revenue transfer between energy market participants under the RIT-T framework. Actual costs proposed by non-network proponents during or following the RIT-T process are commercially sensitive and therefore not disclosed by Powerlink.

Powerlink will work with AEMO and other relevant stakeholders to manage the operational risks associated with insufficient system strength, such as through outage scheduling.

3.4 Modelling to plan activities to meet system strength standard

Most proponents of grid-following IBR in Queensland are choosing to remediate their efficient system strength requirements through project-specific solutions, including grid-forming BESS. Accordingly, the following discussion focuses on Powerlink's planning and assessment of minimum system strength requirements.

Minimum system strength is provided by synchronous generators when they are operating. Historically this has been provided by coal-fired generation, but it can also be provided by pumped hydro, dedicated synchronous condensers, and generators operating in synchronous condensing mode (enabling them to continue providing system strength even when not operating as a generator, such as when spot prices are insufficient to warrant normal operation).

The number of coal-fired generating units in-service at any point in time in Queensland is a primary consideration for Powerlink's ability to meet system strength requirements. There are currently 22 coal-fired generating units in Queensland, of which eight are in Southern Queensland and 14 are in Central Queensland. The number of units operating in Central Queensland may reduce to eight from March 2029 given the formal notification of potential retirement of Gladstone Power Station (see AEMO Generation Information [website](#)). The number of units which are online at any point in time may also vary in response to changing demand profiles and market conditions.

The system strength contribution of each coal unit is effectively equivalent, and considered as one system strength service. Some other sources of system strength provide a fraction of a service, depending on their size, location and technical characteristics (e.g. Kareeya hydro generating units).

To provide sufficient system strength a minimum number of synchronous strength services must be online at all times. This includes four synchronous strength services in Southern Queensland, six services in Central Queensland and two services in Northern Queensland¹.

For the System Strength RIT-T, Powerlink adopted a probabilistic approach to assess the likelihood of maintaining adequate system strength across the grid. This analysis incorporated coal retirement projections and their impact on fault levels and stability, based on AEMO's 2024 Integrated System Plan (ISP) forecasts. The 2024 ISP forecast installed levels of coal-fired generation in Queensland decreasing from 8.13 gigawatts in 2025/26 to zero in 2034/35.

The Queensland Government's Energy Roadmap, released in October 2025, established a new plan for the Queensland energy system. In terms of coal-fired generation, the Queensland Energy Roadmap:

- outlined that coal-fired generation will continue to play an important role in balancing supply and demand and stabilising Queensland's energy system
- reset operating timeframes for state-owned coal assets to technical lives, with options to further extend if needed
- indicated that long-term coal operating decisions will be informed by whole-of-system decision-making criteria for state-owned coal assets, considering system need, asset integrity and economic viability.

These developments are a key input to Powerlink's Material Change in Circumstances (MCC) assessment for the System Strength RIT-T. Powerlink is reassessing system strength requirements using the updated 2026 ISP inputs and assumptions. This includes updated planning analysis that recognises how system strength requirements are expected to shift over time as coal-fired generation unit retirement dates change, together with updated market benefit analysis reflecting the consequential changes in generation dispatch, network limitations and the timing of system strength needs. At the time of TAPR publication, Powerlink's draft MCC assessment is undergoing a 30 business day public consultation period. More information is on our [website](#).

While the Queensland Energy Roadmap may influence the timing and composition of longer-term system strength requirements, Powerlink's current assessment is that the near-term requirement for four new synchronous condensers in Central Queensland in 2029 remains unchanged. The draft MCC assessment further identifies the requirement for a fifth synchronous condenser or equivalent service in Central Queensland by January 2031.

The ordering of the four synchronous condensers does not pre-empt the outcome of our Contingent Project Application (CPA) to the Australian Energy Regulator (AER). The CPA remains the regulatory mechanism through which the AER will assess whether the investment is prudent and efficient and for cost recovery purposes. Rather, early ordering is for delivery risk management, reflecting the long lead times for synchronous condensers and to maintain a credible delivery pathway for the system strength requirements by 2029.

Powerlink's approach also preserves flexibility for non-network solutions to contribute where they become technically viable, commercially firm and deliverable within the required timeframe. This includes the potential future role of grid-forming BESS technology, synchronous service arrangements with existing or new generation plant, and other options such as gas-powered generators equipped with a synchronous condensing mode.

¹ Note there are no coal-fired generating units in northern Queensland, and northern Queensland has historically relied to an extent on system strength from central Queensland.

Powerlink considers that grid-forming BESS technology is continuing to mature and will likely play an important role in future system strength portfolios. It can already be used to provide efficient level system strength, and studies are ongoing to evaluate the extent to which grid-forming BESS can offset the requirement for minimum system strength.

Accordingly, Powerlink will seek to stage decisions to preserve optionality, while still allowing for the long lead times associated with any network solution that may ultimately be required. This approach gives market participants the maximum reasonable opportunity to develop and commit non-network alternatives, while ensuring Powerlink can continue to meet its system strength obligations safely, reliably and cost-effectively.

3.5 Response to AEMO's 2025 Transition Plan for System Security

AEMO's 2025 Transition Plan for System Security (the Transition Plan) noted:

- Queensland's energy system is progressing towards an increasing mix of renewables and storage backed by gas-powered generation.
- Queensland has the youngest coal fleet in the NEM with many Queensland coal stations not close to their end of life.
- Economic factors including inter-regional impacts determining the operational behaviour, availability, and long-term viability of Queensland's coal-fired generation means that it remains prudent to plan for system security ahead of publicly announced retirement dates.
- Minimum System Load (MSL) conditions are expected to become more prevalent, with MSL2 conditions forecast to occur in system normal conditions from Spring 2026². New BESS will help reduce the likelihood of these conditions from Winter 2026. Powerlink acknowledges the uncertainty associated with forecasting near-term MSL conditions and supports AEMO's recommendation of continued development of operational measures to manage these risks.

The Transition Plan also set out AEMO's assessment of Queensland's system strength, inertia and NSCAS requirements, which are explained in the following sections.

3.5.1 Minimum level system strength requirements

AEMO retained the same fault level requirements at Queensland's (five) system strength nodes and identified system strength deficits at three nodes between 2027/28 and 2029/30.

Table 3.2 Queensland Fault Level Requirements and AEMO Identified Deficits

System strength node	Fault level requirement (MVA)	2025/26 Deficit (MVA)	2026/27 Deficit (MVA)	2027/28 Deficit (MVA)	2028/29 Deficit (MVA)	2029/30 Deficit (MVA)
Gin Gin 275kV	2,800	0	0	0	0	0
Greenbank 275kV	4,350	0	0	0	190	30
Lilyvale 132kV	1,400	0	0	24	35	0
Ross 275kV	1,350	0	0	0	0	0
Western Downs 275kV	4,000	0	0	82	287	0

Source: AEMO, *2025 Transition Plan for System Security, Appendix A2: Network Requirements*, December 2025, page 53.

Note:

- (1) AEMO included nine synchronous condensers from Powerlink's System Strength RIT-T for the above fault level projections. Non-network contracts with synchronous generating units and grid-forming BESS were not included in the projections. AEMO also indicated that Powerlink was tendering for synchronous unit contracts for system strength, which were not included in this modelling, and which may address the deficits above the 99.87th percentile (used to forecast deficits) at the Greenbank, Lilyvale and Western Downs nodes.

These assessments are sensitive to assumptions regarding the future operation of the coal-fired generation fleet. Given the modest and temporary nature of the identified deficits, Powerlink has reviewed AEMO's results and is satisfied that no additional investment is required in the 2027/28 to 2029/30 period, beyond the network support contracts and synchronous condenser developments that Powerlink is already progressing. In reaching this position, Powerlink has applied the best available information but will continue to monitor developments to maintain demand reliability and system security.

² MSL2 is a low-demand operating state where the power system has limited ability to absorb further reductions in demand or increases in generation and is one credible contingency away from requiring operational intervention to maintain secure system operation.

A forecast fault level below AEMO's minimum requirement at a system strength node does not, by itself, require operational intervention. These fault level requirements are used for planning and assessment purposes. Operational measures would only be required where available system strength is insufficient to meet Powerlink's system normal or outage advice, as operationalised by AEMO. In these circumstances, AEMO may take action to maintain system security, including directing generating units or constraining IBR connected under the legacy system strength framework.

3.5.2 Efficient level system strength requirements

AEMO's latest forecast of IBR generation at the Gin Gin, Greenbank, Lilyvale, Ross and Western Downs nodes for the 10-year period from 2025/26 is shown in the 2025 Transition Plan³. AEMO noted that the forecast was primarily based on modelling undertaken for the Draft 2024 ISP.

All IBR connecting to Powerlink's network must undergo a Full Impact Assessment (FIA) or stability assessment using electromagnetic transient (EMT) models. This analysis is essential to identify any unstable interactions with other generators or voltage control equipment. This assessment follows AEMO's System Strength Impact Assessment Guidelines (SSIAG), which ensures any negative impacts on system strength are addressed as part of the connection application process. Further details on the assessment and modelling requirements are available in the SSIAG and AEMO's Power System Model Guidelines.

Powerlink focuses its effort on this detailed FIA assessment and does not prioritise the calculation of the Available Fault Level (AFL). Whilst AFL may be a useful indicator of system strength in certain cases, it is an indicative approximation and is only one part of the broader assessment required for a modern power system with increasing levels of IBR. AFL does not fully capture important dynamic system strength characteristics, including the ability to maintain and control voltage waveforms during steady state and post-disturbance conditions, transient and small-signal stability.

Recognising this is particularly important as new technologies, including grid-forming BESS, can provide system strength support that may not be fully reflected through traditional AFL measures. As a result, Powerlink prioritises the broader dynamic performance of the power system, ensuring that system operability, stability and resilience are appropriately assessed.

As stated, most IBR projects in Queensland are choosing to self-remediate their system strength impact, with the implication that Powerlink's procurement of efficient system strength is likely to be modest. Powerlink continues to monitor the need for efficient level system strength services, using AEMO's forecast as a starting point. As indicated in the System Strength RIT-T, Powerlink will engage with industry at the appropriate time should a need to procure efficient level services emerge.

3.5.3 Inertia requirements

AEMO updated the satisfactory and secure inertia levels for Queensland, as shown in Table 3.3.

Table 3.3 Queensland Inertia Requirements

Quantity	Value (2024)	Value (2025)
Satisfactory inertia level	12,000MWs	13,000MWs
Secure inertia level	13,700MWs	14,700MWs
Inertia sub-network allocation	10,500MWs	10,500MWs
Minimum regional interconnected inertia level	Not reported	10,500MWs
Likelihood of islanding	Likely	Likely

Sources: AEMO, 2024 *Inertia Report*, December 2024, page 14; AEMO, 2025 *Transition Plan for System Security, Appendix A2: Network Requirements*, December 2025, page 45.

Note:

(1) MWs denotes megawatt seconds.

³ AEMO, 2025 *Transition Plan for System Security, Appendix A2: Network Requirements*, December 2025, page 46.

AEMO stated that Queensland is considered likely to island during a significant weather event around the Queensland-New South Wales Interconnector (QNI) corridor, or during a planned outage of a line in the QNI corridor.

Powerlink is required to ensure sufficient supplies are available to meet Queensland's inertia sub-network allocation specified by AEMO under the NER from 2 December 2027. In the Transition Plan, Powerlink's binding inertia planning obligation from December 2027 is referenced to the Queensland inertia sub-network allocation (currently 10,500MW). However, as Queensland is assessed by AEMO as having a likely islanding risk, Powerlink must also consider the secure inertia level (currently 14,700MW) under Clause 5.20B.4 of the NER when demonstrating compliance with our Inertia Service Provider obligations.

Historically, inertia has been provided predominantly by synchronous generating units, including coal, gas and hydro generators. As the generation mix evolves, Powerlink is planning and procuring solutions to maintain adequate inertia levels and support ongoing power system security.

A key component of Powerlink's strategy is the deployment of synchronous condensers as part of the preferred option identified through the System Strength RIT-T. The synchronous condensers being procured are designed with flywheel technology to provide significant inertia in addition to their system strength and voltage support capabilities. The inertia contribution of these units (1,400MW per unit) is comparable to, and in some cases greater than, that provided by existing coal-fired generating units on a unit-for-unit basis.

Powerlink's assessments indicate that the requirements for minimum system strength will continue to necessitate the operation of a minimum number of synchronous machines within Queensland. This includes a combination of existing synchronous generating units and the new synchronous condensers as they are commissioned. Because these synchronous machines inherently provide inertia while delivering the fault current and voltage waveform support required for minimum system strength, the minimum system strength portfolio also contributes materially to meeting Queensland's inertia requirements.

Powerlink's analysis shows that the minimum level of synchronous generation required to satisfy Queensland system strength requirements is also sufficient to maintain inertia above Queensland's inertia sub-network allocation of 10,500MW throughout the assessment period to 2031. This assessment considers the inertia contribution from existing synchronous generating units together with the four synchronous condensers procured as part of Powerlink's system strength remediation activities. In addition, under Queensland islanded operating conditions, the preliminary assessment considered AEMO's assumed availability of 375MW of 1-second Frequency Control Ancillary Services (FCAS), together with the inertia contribution from 4,200MW of existing and committed grid-forming BESS. The results indicate that the combination of these services provides a level of frequency resilience consistent with the secure operating outcomes underpinning AEMO's secure inertia level assessment.

Accordingly, no additional inertia-specific remediation has been identified as required within the outlook period beyond the system strength solutions already committed or under implementation. Should future assessments identify emerging inertia requirements due to lower-than-expected availability of synchronous generation, procuring inertia from existing grid-forming BESS or fast frequency response services from existing BESS, is expected to provide cost-effective remediation options compared to procuring additional levels of physical inertia (from synchronous plant) to maintain secure frequency performance.

Powerlink will continue to monitor inertia requirements, generation retirement schedules, the availability of fast frequency response services, and the availability of synthetic inertia. Should future assessments identify a shortfall, Powerlink will undertake additional procurement activities as necessary to maintain compliance with our system security obligations.

3.5.4 NSCAS assessment

The NSCAS assessment considers whether the transmission system can remain within thermal and voltage limits, maintain adequate reactive margins, limit rapid voltage changes from reactive plant switching, and return to a secure operating state following a credible contingency or protected event.

AEMO assessed these NSCAS needs over a five-year outlook period and declared no gaps within the Queensland region.

3.6 System strength locational factors

System strength locational factors are part of the formula for system strength charges. System strength locational factors and nodes are included in Appendix J and shown in the TAPR Portal.