30 JUNE 2025

Addressing System Strength Requirements in Queensland from December 2025

Summary Project Assessment Conclusions Report

Preface

Powerlink Queensland is a Transmission Network Service Provider that owns, develops, operates and maintains Queensland's high-voltage electricity transmission network. The network transfers bulk power from Queensland generators to electricity distributors Energex and Ergon Energy (part of the Energy Queensland Group), and to a range of large industrial customers.

The National Electricity Rules (NER) requires Powerlink to carry out forward planning to identify future reliability of supply requirements, which may include replacement of network assets or augmentations of the transmission network. Powerlink must then identify, evaluate and compare network and non-network solutions (including, but not limited to, generation and demand side management) to identify the preferred option which can address future network requirements at the lowest net cost to electricity customers. Powerlink also has obligations under the NER to address power system security requirements identified by the Australian Energy Market Operator in its annual System Security Reports.

This Summary Project Assessment Conclusions Report (PACR) has been prepared in accordance with version 230 of the NER, and the Regulatory Investment Test for Transmission (RIT-T) Instrument (November 2024) and RIT-T Application Guidelines (November 2024). The RIT-T Instrument and Application Guidelines are made and administered by the Australian Energy Regulator (AER). Powerlink has also had regard to the AER's guidance note for the system strength framework (December 2024).

This summary focuses on key developments since the Project Assessment Draft Report was released in November 2024. The full PACR document, available on Powerlink's website, addresses all requirements for the PACR in accordance with the RIT-T framework under the NER and related instruments.

The main purpose of this document is to provide a summary of the identified need, credible options, and technical and commercial feasibility of the preferred option to address system strength requirements in Queensland from December 2025. More information on how Powerlink applies the RIT-T process is available on Powerlink's website.

A copy of this summary report will be made available to any person within three business days of a request being made. Requests should be directed to the Manager Portfolio Planning and Optimisation, by email (networkassessments@powerlink.com.au) or phone ((07) 3860 2111).

This summary PACR does not include references to regulatory requirements, published documents and reports that have been used to inform the report. The full PACR document includes all relevant references.

Powerlink acknowledges the Traditional Owners and their custodianship of the lands and waters of Queensland and, in particular, the lands on which we operate. We pay our respect to their Ancestors, Elders and knowledge holders and recognise their deep history and ongoing connection to Country.

Introduction

System strength is a measure of the ability of the network to maintain and control the voltage both during steady state operation and in response to a network disturbance, such as a sudden change in generation or load, or fault on the network. Low system strength in a particular location can adversely affect the security of the broader power system, such as through reducing the ability of generators to operate stably.

Queensland's energy system has historically comprised synchronous generation such as coal-fired power stations, gas turbines and hydro-electric plants. These large synchronous generators have also provided various services, including system strength, as a by-product of their dispatch for energy, enabling the power system to operate stably. The increased share of generation from renewable sources, particularly solar and wind generation, means that system strength is less freely available and must be planned for and delivered by other means.

A range of technologies, including synchronous condensers, grid-forming Battery Energy Storage Systems (BESS), Pumped Hydro Energy Storage (PHES) systems that can operate in synchronous condenser mode, and gas turbines with clutches to enable them to operate in synchronous condenser mode, can deliver system strength services largely without affecting their energy dispatch.

The Australian Energy Market Operator (AEMO) and Powerlink are responsible for the planning and delivery of power system security services in Queensland. These arrangements were fundamentally revised by the Efficient Management of System Strength on the Power System Rule (System Strength Rule), made by the Australian Energy Market Commission (AEMC) in October 2021. The System Strength Rule replaced the 'do no harm' framework, which required connecting generators to self-assess their impact on the local network's system strength levels and self-remediate any adverse impacts, with a new framework for the supply, demand and coordination of system strength in the National Electricity Market (NEM).

AEMO's annual System Security Reports consider the need for system strength services in Queensland and other regions of the NEM. For each of Queensland's five system strength nodes, AEMO's 2024 System Strength Report identified expected three phase fault levels, and forecasted the level and type of inverter-based resources (IBR) for 11 years from 2024/25. As the System Strength Service Provider for Queensland, Powerlink is required to plan for and procure system strength services for AEMO to enable from 2 December 2025.

This Regulatory Investment Test for Transmission (RIT-T) is a key part of Powerlink's implementation of the System Strength Rule. Powerlink commenced the System Strength RIT-T in March 2023 with publication of a Project Specification Consultation Report (PSCR). The PSCR invited proposals from proponents who considered they could offer potential non-network solutions that were both technically and economically feasible by 2030. In November 2024, Powerlink published the Project Assessment Draft Report (PADR), which outlined Powerlink's assessment of five portfolios of solutions to address system strength requirements. Powerlink also hosted a webinar in late November 2024 to support the release of the PADR. The webinar recording, slides and Q&A document are available on Powerlink's website.

Submissions on the PADR

Submissions on the PADR, and proposals for non-network solutions, were due in December 2024.

- Powerlink received around 50 (confidential) proposals from more than 25 proponents in response to the PADR. Approximately three-quarters of the proposals were for BESS, and the remainder for synchronous solutions.
- Some proponents updated existing proposals submitted in response to the PSCR, while several new proposals were also received, including some from proponents who had not previously engaged in the RIT-T process.

- Some proposals received in response to the PSCR were not updated, or were withdrawn, by proponents, at the PADR stage.
- No proposals for adding clutches to gas generating units in Central Queensland were received that Powerlink considers meet the RIT-T criteria for anticipated or committed projects.
- No proposals were submitted for system strength services from coal generating units, (new) PHES assets, or for a large grid-forming BESS that could (if proven to be technically feasible) contribute to minimum system strength requirements in Central Queensland by 2029.

Powerlink received no general submissions on the approach to, or outcomes of, the PADR.

In January and February 2025, Powerlink undertook a high-level technical assessment of all proposals received in response to the PADR, and shortlisted solutions for further commercial and technical assessment. Solutions that were not shortlisted were generally not in a location, and/or of a sufficient size, to be considered feasible for delivering system strength services. Proponents of a solution(s) that was not shortlisted were formally advised of the assessment of their solution(s) in March 2025.

Powerlink has also held meetings with a number of proponents of non-network solutions since August 2023. In some cases, multiple meetings have been held with proponents as Powerlink's assessment of system strength requirements has progressed, and/or proponents have sought to update Powerlink on their solution(s).

Powerlink thanks all proponents for their engagement in the RIT-T process, and for their responses to the PSCR proforma and/or PADR information request that further informed and shaped the analysis for this RIT-T.

Identified Need

The identified need in this RIT-T is to make system strength services available to AEMO to meet the following requirements in each year from 2 December 2025:

- Maintain the minimum three phase fault level specified by AEMO at each system strength node for the relevant year (minimum system strength); and
- Achieve stable voltage waveforms for the level and type of IBR and market network service facilities projected by AEMO at each system strength node for the relevant year in steady state conditions, and following a credible contingency event or protected event (efficient system strength).

The investment in system strength services is to ensure Powerlink's compliance with clause S5.1.14 of the National Electricity Rules (NER). This RIT-T is therefore considered a reliability corrective action under the NER.

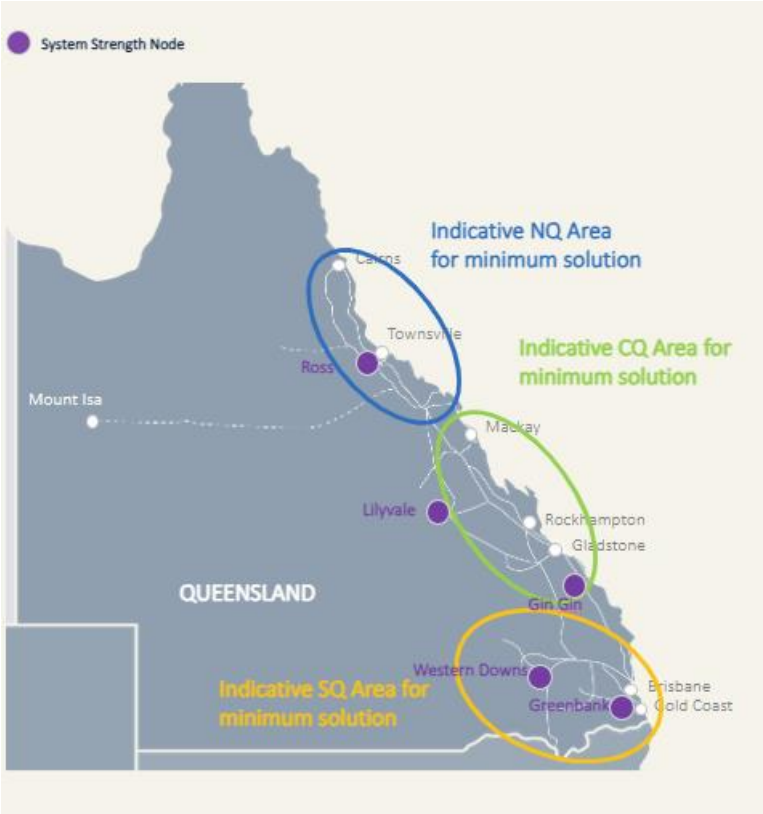
Minimum level system strength

The number of coal generating units in service at any point in time in Queensland is a primary consideration for Powerlink's ability to meet minimum system strength requirements. There are currently 22 coal generating units in Queensland, of which 14 are in Central Queensland and eight are in Southern Queensland. To provide sufficient system strength in Southern Queensland four units are required to be online at all times, and in Central Queensland six units are required to be online at all times.

Powerlink has applied AEMO's 2024 Integrated System Plan (ISP) coal generation forecasts for Southern and Central Queensland to the analysis for the RIT-T. The 2024 ISP projects all coal generation in Queensland to retire by 2035. Further, AEMO's recent System Strength Reports indicate that there could be periods of time from 2027/28 when insufficient units are online in Central or Southern Queensland for minimum system strength requirements to be met.

Figure 1 shows the indicative areas for minimum system strength solutions, which are unchanged from the PADR.

Figure 1: Indicative areas for minimum system strength solutions



In April 2025, the Queensland Government announced it would deliver a five-year Energy Roadmap in 2025, and provide funding for the refurbishment of the cooling tower at the Tarong Power Station in Southern Queensland, and to upgrade the Callide B1 and B2 coal generating units in Central Queensland. At the same time, the government updated the expected closure date of the Callide B1 and B2 units from 2028 to 2031.

Powerlink expects these developments will lead to an increase in the availability of system strength from energy dispatch within the planning horizon (December 2025 to December 2030) for this RIT-T. However, there are many factors that determine the amount of system strength that can be expected from energy dispatch, of which the expected retirement date of coal generating units is just one. As with all coal generating units, there could still be periods of time before December 2030 when either/both Callide B units are not online and providing system strength due to outages, low minimum demand, or for commercial reasons. In response to the government's announcements, Powerlink has added an additional 'change in government policy' reopening trigger for this RIT-T, as discussed below.

Efficient level system strength

In the PADR, Powerlink indicated that efficient level services would initially be needed in the Northern Queensland Area 1 (Ross) in 2026, with the majority of services needed in Southern, Central and Northern Queensland between 2028 and 2030. Primarily due to updated wind IBR forecasts, Powerlink considers efficient level services will be needed in the Ross area by 2027 rather than in 2026, and has identified potential BESS solutions for efficient services in the area.

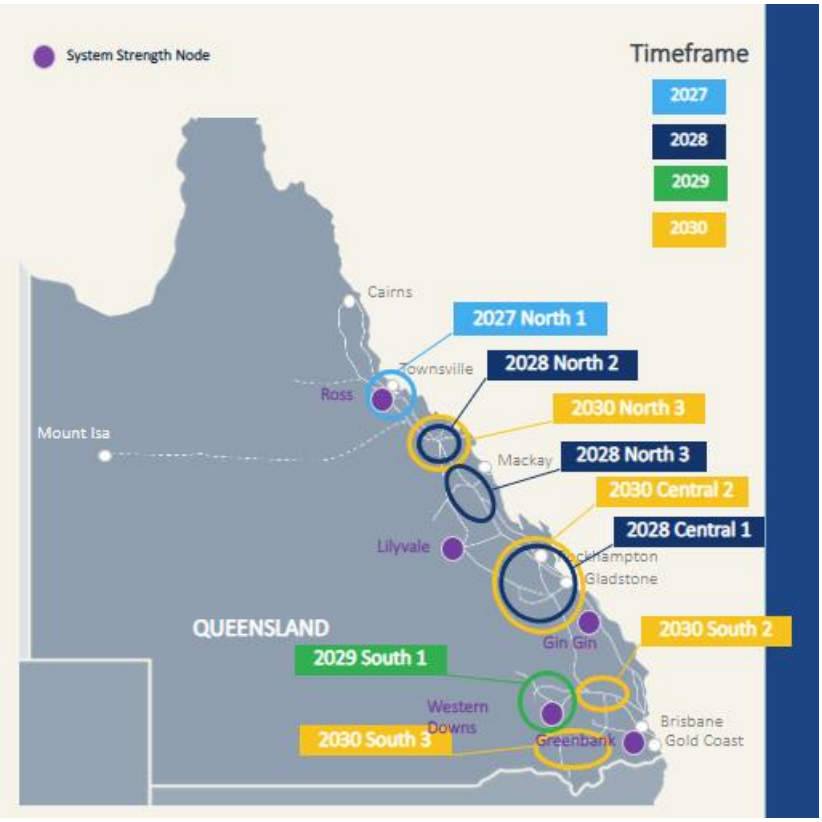
Powerlink considers the need for efficient level services in each region between 2028 and 2030 is uncertain.

- Forecasts for IBR installations are uncertain and commissioning/operational timeframes are difficult to predict, particularly in the 2028 to 2030 timeframe.
- All IBR is effectively treated as grid-following in AEMO modelling. Powerlink is aware that some solar/wind farms are self-remediating their system strength impacts, and it is uncertain how many IBR will choose to purchase system strength services from Powerlink.

Since publishing the PADR, Powerlink has undertaken further analysis of the need for efficient level services. The analysis involved comparison of AEMO's 2023 and 2024 IBR forecasts and Powerlink's recent connection information. The analysis found that AEMO's updated 2024 IBR forecasts did not have a material impact on PADR outcomes for efficient level services, and further detailed technical studies were not required at the PACR stage.

Figure 2 shows the indicative areas for efficient system strength solutions, with the only change from the PADR being the timeframe for the North 1 area changing to 2027 (from 2026).

Figure 2: Indicative areas for efficient system strength solutions



Credible Options

Powerlink adopted a portfolio formation approach to develop five different credible options at the PADR stage to address system strength requirements in Queensland from December 2025. Powerlink developed a Balanced Technology portfolio (Portfolio 1) that included investing in or contracting with a range of different technologies

for meeting the minimum system strength requirements, such as existing synchronous generation (including hydro generators), adding clutches to existing and future gas generating units, and synchronous condensers.

Four additional portfolios – Portfolio 1A (Balanced Technology with BESS in Minimum), Portfolio 2 (Synchronous Condensers), Portfolio 3 (Clutched Gas Turbines) and Portfolio 4 (Pumped Hydro Energy Storage) – each assumed a greater use of a particular technology for meeting the minimum requirements. For all portfolios, all assumed investment in and/or contracting with solutions was complete by June 2034. That is, no portfolio involved any new solutions beyond this point.

Each of the portfolios met both the minimum and efficient level requirements. The approach of having portfolios assume a greater use of a particular technology for meeting the minimum requirements enabled the PADR assessment to test the relative expected economic benefits of, and interactions between, the different technologies that are able to assist with meeting the minimum system strength requirements.

In light of the technology types, locations and expected service start dates for proposed solutions, the only portfolio from the options outlined in the PADR that is considered credible at this time is Portfolio 2 (Synchronous Condensers). This position has been directly informed by proposals received in response to the PADR.

Preferred Option

It is of the utmost importance that Powerlink meets its system strength obligations, as failing to do so could result in material outages for customers.

For the PADR, Powerlink undertook a cost-benefit analysis in accordance with the requirements of the RIT-T Instrument and RIT-T Application Guidelines. The analysis found Portfolio 2 (Synchronous Condensers) was the top-ranked option and delivered approximately $128 million greater net benefits than the second-ranked option (Portfolio 1).

The preferred option in the PADR, Portfolio 2 (Synchronous Condensers), has not changed and includes:

- nine synchronous condensers across Central and Southern Queensland by June 2034;
- contracting with synchronous units in Southern and Northern Queensland, for minimum level requirements; and
- contracting for grid-forming BESS in Southern, Central and Northern Queensland for efficient level requirements.

Powerlink has commenced investing in or contracting with up to three synchronous condensers needed in Central Queensland by March 2029. As outlined in Powerlink's assessment for the Gladstone Project Priority Transmission Investment, two of the initial synchronous condensers will address the anticipated closure of the Gladstone Power Station. Powerlink did not commit in the PADR to the additional (six) synchronous condensers as the economic assessment indicated that the preferred option could change if alternative solutions, such as gas generating units or PHES solutions that are able to operate in synchronous condenser mode, became anticipated or committed.

However, as noted above, proposals received in response to the PADR have not changed the preferred option to address minimum level system strength requirements. Further, the lead-time for procurement and delivery of synchronous condensers is currently around four years from the time of contract award. Accordingly, Powerlink will also now invest in or contract with up to three further synchronous condensers needed in Central Queensland by June 2030.

The PADR also showed that there were additional low regret non-network solutions for Southern Queensland. These solutions provide prudent insurance against the potential for more accelerated coal retirement in Southern Queensland and remain part of the preferred option for the PACR. Powerlink does not, at this time, consider investing in a synchronous condenser in Southern Queensland to be a low regret solution, and so is not proposing to commit now to this solution.

In terms of efficient level services beyond 2027, Powerlink anticipates re-engaging with industry at an appropriate time(s). Before a system strength contract could be finalised with any proponent, further detailed technical and commercial assessment will be required. Powerlink notes that there could also be changes to the need for efficient level services in Southern, Central or Northern Queensland over the planning horizon to 2030.

Since the PADR was released, Powerlink has issued a tender for supply of synchronous condensers for Central Queensland. However, Powerlink will not have updated cost estimates for synchronous condensers until tender proposals are received and assessed (which is currently expected to be in late-2025). Accordingly, Powerlink has retained the PADR cost estimate for (200 megavolt amperes) synchronous condensers of $135 million each in the cost-benefit analysis for the PACR. Powerlink does not consider that the absence of an updated estimate at this time is a material issue for this RIT-T as the identification of the preferred option is not sensitive to these assumed costs. Moreover, Powerlink has included a reopening trigger (discussed below) that captures a material increase in the cost of synchronous condensers, providing there is more than one credible option at that time.

Powerlink notes that only the prudent and efficient capital costs of the network components of the preferred option will factor into the Regulatory Asset Base (RAB) following this RIT-T. That is, it is not the total capital costs, nor the estimated net economic benefits, that factor into the RAB.

Costs for any non-network solutions will be reviewed by the Australian Energy Regulator as part of the new network support payment process for system security services.

Reopening Triggers

Powerlink seeks to maximise flexibility via the RIT-T to commit to investing in or contracting with a small number of synchronous condensers, while leveraging RIT-T reopening triggers to pivot to new system strength solutions as they become available.

Powerlink has finalised eight reopening triggers for this RIT-T:

1. Credible evidence of proposals for synchronous condenser operation of gas turbines (such as adding a clutch) or PHES solutions reaching committed or anticipated status (as defined under the RIT-T).
2. Credible evidence emerging that grid-forming BESS are able to be relied on to contribute to minimum fault level requirements, and proposals reaching committed or anticipated status (as defined under the RIT-T).
3. Credible evidence that the cost (as considered under the RIT-T) of adding clutches to gas turbines is going to be sufficiently greater than installing synchronous condensers that it changes what is considered optimal in Southern Queensland to meet the minimum requirements.
4. Credible evidence of expected real synchronous condenser costs increasing by approximately 75% compared to those used in the RIT-T analysis.
5. Credible evidence of commercial discount rates falling materially below the boundary value (2.15%) identified in this RIT-T.
6. Credible evidence of the demand for system strength requirements for projected IBR plants significantly increasing, or significantly reducing due to self-remediation and technological advancements in equipment.
7. Delayed availability of, and/or inability to conclude contracts with, proposed solutions, including contracting for solutions in Southern Queensland to meet the minimum or efficient requirements.

8. Credible evidence that a change(s) in retirement dates and/or operational arrangements for coal generating units changes the identified need for system strength requirements, and/or the preferred option in this RIT-T.

Powerlink has made minor changes to the third, sixth and seventh reopening triggers for the PACR, which are detailed in the full PACR document. The (new) eighth trigger responds to the Queensland Government's announcements of April 2025 regarding the Tarong and Callide B Power Stations.

Powerlink notes that the two reopening triggers seeking to capture material changes in the real cost of synchronous condensers and commercial discount rates are only relevant if the second ranked option (Portfolio 1) is considered credible (which it currently is not). Specifically, these triggers are based on the PADR boundary analysis for these two variables that tested when Portfolio 1 would be ranked ahead of Portfolio 2.

In addition, given the location, size and operational aspects of system strength requirements, it should also be noted that if proposals for synchronous condenser operation of gas turbines or PHES solutions do reach anticipated or committed status, this may not necessarily reduce the number of synchronous condenser units required.

If there are short-term delays with any of the solutions included in the preferred option that would jeopardise Powerlink's ability to meet its system strength requirements, Powerlink may need to contract with existing synchronous units to ensure customers' reliability is not compromised. Powerlink does not consider this would be a material change in circumstances given that contracting (in the short-term) with existing synchronous units would be the only solution available to Powerlink to ensure system security. The prudency and efficiency of costs would also be a relevant consideration for Powerlink should contracting with existing units be necessary to address a shortfall(s) for system strength.

If a material change in circumstances (including the activation of a reopening trigger) occurs, Powerlink may consider:

- updating the cost-benefit analysis of credible options and publishing a report on the results of the new analysis;
- conducting stakeholder consultation and publishing a report that summarises stakeholder views and the conclusions from the consultation; and/or
- initiating an Expression of Interest for non-network solutions.

Before responding to a material change in circumstances, Powerlink would notify the AER of the change and outline, for the AER's approval, the actions Powerlink proposes to undertake.

Powerlink's proposed approach to addressing system strength requirements going forward will result in better outcomes for electricity customers and aims to avoid Powerlink needing to undertake a new RIT-T, which would require significant time to complete and impact Powerlink's ability to deliver system strength services to AEMO. Powerlink's approach also supports the development of non-network solutions in being able to provide system strength services.

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