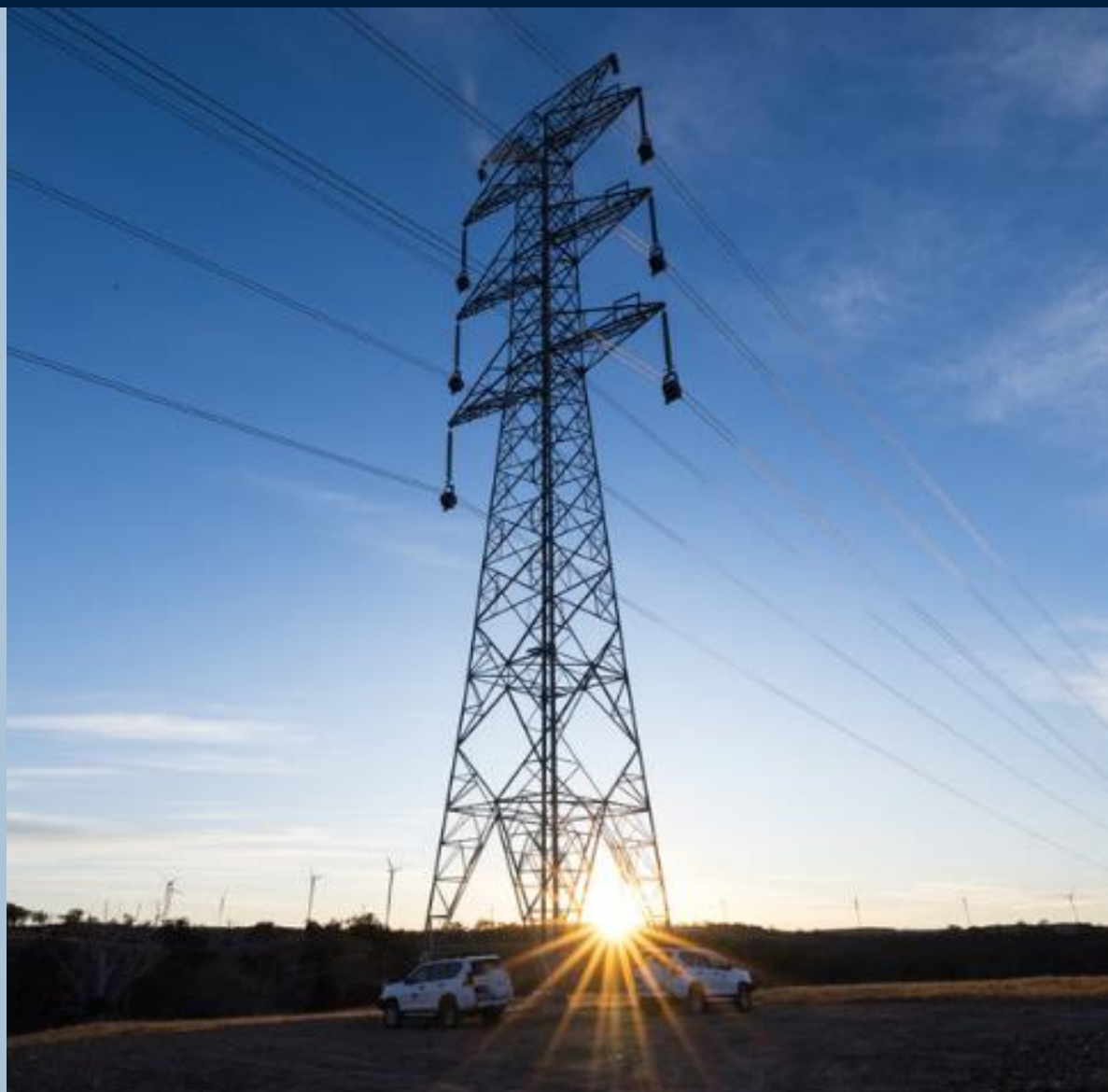
January 2024

Request for Power System Security Services in Central, Southern and Broader Queensland Regions

Final Report Part 2: System Strength at Gin Gin



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Executive Summary

In Queensland, the Australian Energy Market Operator (AEMO) determines system strength requirements and Powerlink Queensland is responsible for the provision of system strength services to AEMO. In December 2021, AEMO declared an immediate system strength shortfall of 44 to 65 megavolt-amperes (MVA) for the period 2021/22 to 2026/27 at the Gin Gin system strength node in Central Queensland. The shortfall was due to the projected decline of synchronous machines online in Central Queensland. AEMO has since updated the shortfall to up to 64MVA for the period to 1 December 2025.

Immediately following the declaration, Powerlink commenced an Expression of Interest (EOI) process for short and long-term non-network solutions to the fault level shortfall at the Gin Gin node. Powerlink also engaged directly with members of its Non-Network Engagement Stakeholder Register. Powerlink received eight different possible solutions across submissions from a range of proponents. Proposed solutions included various combinations of new installations such as pumped storage hydroelectric systems, synchronous generators, plant conversions to hybrid facilities, and Battery Energy Storage Systems with grid-forming inverters. Following detailed analysis of submissions, Powerlink concluded the addition of a clutch to the shaft between the gas turbine and the synchronous generator at the Townsville Power Station (TPS) was the least-cost option to address the shortfall. The modification will allow the TPS to operate in synchronous condenser mode when not generating.

The TPS is owned by Ratch Australia (Ratch), and Powerlink has entered into a System Strength Services Agreement with Ratch for the provision of system strength services. The addition of the clutch at the TPS is expected to be delivered by mid-2025. Until the modification is completed, Powerlink has modelled that the shortfall is expected to be for relatively short periods until mid-2025 coinciding with periods of low demand, and proposes to manage the shortfall operationally via constraints applied to inverter-based generators. Powerlink expects that operation of the TPS as either a generator or as a synchronous condenser will provide sufficient system strength for inverter-based generation facilities in North and Central Queensland to operate stably from mid-2025. In December 2023, AEMO approved the arrangements.

In March 2023, Powerlink commenced a Regulatory Investment Test for Transmission (RIT-T) to address system strength requirements in Queensland from December 2025. The RIT-T is part of Powerlink's response to the Efficient Management of System Strength on the Power System Rule (System Strength Rule), made by the Australian Energy Market Commission in October 2021. Under the System Strength Rule, Powerlink is required to take action to plan, procure and make available system strength services as set out in the 10-year forecast provided in AEMO's annual System Strength Reports. Powerlink must meet minimum fault level requirements from December 2025, and procure system strength to meet the efficient level of inverter-based generation in the 10-year forecast. Powerlink considers that the solution to the declared shortfall at the Gin Gin system strength node will also contribute to addressing minimum system strength requirements from December 2025.

1. Introduction

Queensland's electricity system is transforming from one based on dispatchable generation, such as from coal-fired power stations, to a mix of renewable sources including solar photovoltaic (PV), hydro and wind. The increased uptake of renewable sources, coupled with the retirement of conventional generation, creates significant challenges for power system operations in Queensland.

The Australian Energy Market Operator (AEMO) and Powerlink are responsible for the planning and delivery of power system security services in Queensland. AEMO's System Security Reports consider the need for services in Queensland, and other regions of the National Electricity Market (NEM), over a five to ten year horizon. The reports assess system strength requirements, inertia shortfalls and Network Support and Control Ancillary Services (NSCAS) needs. Where AEMO declares a gap/shortfall for a power system security service(s) in Queensland, Powerlink is obliged to make services available within the timeframe stipulated by AEMO.

In December 2021, AEMO declared an immediate:

- Reliability and Security Ancillary Service (RSAS) gap of approximately 120 megavolt-amperes absorbing reactive (MVAr) power in South East Queensland (SEQ), increasing to 250MVAr absorbing reactive power by 2026; and
- system strength shortfall of 44 to 65 megavolt-amperes (MVA) at the Gin Gin 275 kilovolt (kV) system strength node for the period 2021/22 to 2026/27, against the minimum (post-contingency) three phase fault level of 2,250MVA at the node.[1]

In December 2022, Powerlink published Final Report Part 1 that focused on the response to the RSAS gap.[2] This Final Report Part 2 outlines Powerlink's response to the system strength shortfall.

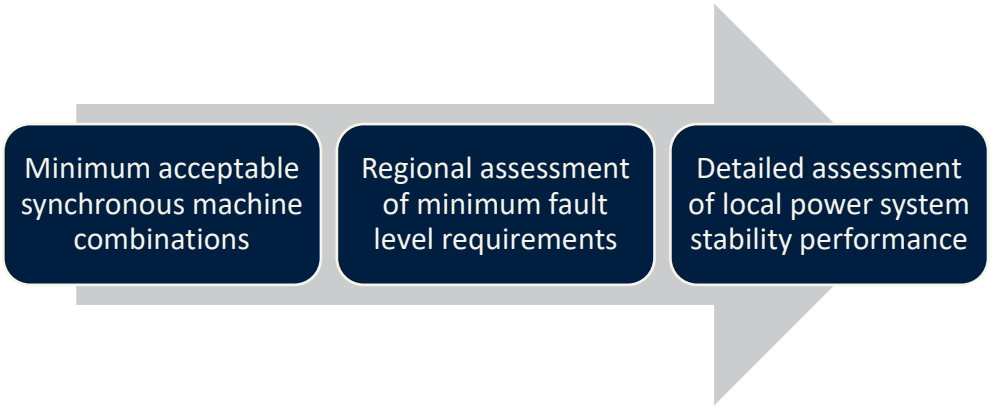
2. System Strength Shortfall at Gin Gin

System strength is a measure of the ability of the power system to remain stable under normal conditions and to return to a steady-state condition following a system disturbance. System strength can be considered low in areas with low levels of local synchronous generation, and deteriorates further with high penetration of inverter-based generation. System strength has traditionally been provided by conventional forms of generation, not because of their fuel source (such as coal, gas and hydro) but because of their 'synchronous' nature.

Under the National Electricity Rules (NER), system strength is measured by the three phase fault level at designated fault level nodes.[3] AEMO determines system strength requirements across then NEM by applying its System Strength Requirements Methodology.[4]

[1] AEMO, *2021 System Security Reports*, December 2021, pages 42 and 49.
[2] More information on Powerlink's longer-term solution to reactive power absorption capability in SEQ is available in the Project Assessment Conclusions Report for the Managing Voltages in South East Queensland RIT-T.
[3] National Electricity Rules, clause 5.20C.1.
[4] National Electricity Rules, clause 5.20C.1. AEMO released version 2.0 of the System Strength Requirements Methodology in September 2022, but version 1.0 was in place when AEMO declared the shortfall at Gin Gin.

At a high level, AEMO applies three steps to calculating fault levels, as shown below.



Source: AEMO, 2021 System Security Reports, December 2021, page 16.

As stated, in December 2021 AEMO declared a system strength shortfall of 44 to 65 MVA at the Gin Gin system strength node. AEMO declared the shortfall as it projected a decline in the number of synchronous machines online in Central Queensland in response to declining minimum demand and increasing variable renewable energy and distributed solar PV generation.[5] AEMO declared the shortfall on the basis that it forecast system strength services would fall below the minimum requirements for more than 1% of the time under typical dispatch patterns.[6]

In May 2022, AEMO updated the declaration to account for its replacement of the Progressive Change scenario with the Step Change scenario for the 2022 Integrated System Plan. The update increased the size of the shortfall at Gin Gin from 33MVA in 2022/23 to 90MVA in 2026/27.[7]

AEMO's System Strength Reports released in December 2022 and December 2023 stated that the shortfall at the Gin Gin node was 64MVA until 1 December 2025, at which time new requirements for the provision of system strength services would commence (see section 4 below).[8]

Typically, seven coal-fired synchronous machines in Central Queensland deliver sufficient system strength to meet minimum requirements. Although the declared system strength shortfall is at the Gin Gin node, the shortfall location in isolation does not necessarily capture technical components of the shortfall, or indicate from where the particular problem is most efficiently addressed. That is, options which address the technical power system performance issues elsewhere in Central and North Queensland may reduce or remove the fault level shortfall at the Gin Gin node. Technical components of the shortfall, and the location from which it should be addressed, can only be informed through system-wide Electromagnetic Transient-type analysis.

[5] AEMO, *2021 System Security Reports*, December 2021, page 42. The declaration was made under clause 5.20C.2 (Fault Level Shortfalls) of the NER, as in force at the time. Transitional arrangements in clause 11.143.13(a)(1) of the NER to support the *Efficient Management of System Strength on the Power System Rule* require Powerlink to continue to comply with the declaration.
[6] AEMO, *2021 System Security Reports*, December 2021, pages 11 and 102.
[7] AEMO, *Update to 2021 System Security Reports*, May 2022, page 23.
[8] AEMO, *2022 System Strength Report*, December 2022, page 41; AEMO, *2023 System Strength Report*, December 2023, pages 28 and 56.

3. Market Engagement

Powerlink was required to use reasonable endeavours to make system strength services available to AEMO by 31 March 2023, being the date by which AEMO requested Powerlink provide the services.[9]

Immediately following the fault level shortfall declaration, Powerlink commenced an Expression of Interest process for short and long-term non-network solutions to the fault level shortfall at the Gin Gin node.[10] Powerlink also engaged directly with members of its Non-Network Engagement Stakeholder Register.

Powerlink received eight different possible solutions across submissions from a range of proponents. Proposed solutions included various combinations of new installations such as pumped storage hydroelectric systems, synchronous generators, plant conversions to hybrid facilities, and Battery Energy Storage Systems with grid-forming inverters. Of the eight possible solutions, five were either unlikely to be delivered in time to be able to provide services to meet the shortfall, were withdrawn, or not able to meet the technical need of being dispatched during daylight hours. Powerlink subsequently progressed four options to detailed analysis, including a network solution for Powerlink to install a synchronous condenser in Central or North Queensland. Powerlink assessed each option against the following criteria:

- Economic assessment;
- Commitment/deliverability;
- Technical feasibility/constraints; and
- Operability.

Only one of the four options was able to commence operation by 31 March 2023. However, this solution would not have provided a material increase in system strength at the Gin Gin node to address the required need.

Of the three remaining options, Powerlink concluded the addition of a clutch to the shaft between the gas turbine and the synchronous generator at the Townsville Power Station (TPS) was the least-cost option to address the shortfall. The TPS is owned by Ratch Australia (Ratch), and Powerlink has entered into a System Strength Services Agreement with Ratch for the provision of system strength services. The addition of the clutch is expected to be delivered by mid-2025. Until the modification is completed, Powerlink has modelled that the shortfall is expected to be for relatively short periods until mid-2025 coinciding with periods of low demand, and proposes to manage the shortfall operationally via constraints applied to inverter-based generators. Powerlink expects that operation of the TPS as either a generator or as a synchronous condenser will provide sufficient system strength for inverter-based generation facilities in North and Central Queensland to operate stably from mid-2025. In December 2023 AEMO provided its approval of the arrangements to Powerlink, as required under the NER.[11]

[9] AEMO, *Update to 2021 System Security Reports*, May 2022, page 23. The reasonable endeavours requirement was in clause 5.20C.3(c)(1) of the NER when the shortfall was declared, and is now in clause S5.1.14(b) of the NER.
[10] National Electricity Rules, clause 5.20C.3(e).
[11] National Electricity Rules, clause 5.20C.4(e).

4. Addressing System Strength Requirements in Queensland from December 2025

In March 2023, Powerlink commenced a Regulatory Investment Test for Transmission (RIT-T) to address system strength requirements in Queensland from December 2025. The RIT-T is part of Powerlink's response to 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:

- evolved 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; and
- established a new framework for the supply, demand and coordination of system strength in the NEM.[12]

The System Strength Rule also replaced the fault level shortfall process followed by AEMO and Powerlink in regard to the shortfall at the Gin Gin node. However, transitional arrangements are in place to ensure Powerlink continues to address the declared shortfall, and can recover costs through Network Support Payments.[13]

Under the System Strength Rule, as of 2 December 2022, Powerlink is required to take action to plan, procure and make available system strength services as set out in the 10-year forecast provided in AEMO's annual System Strength Reports.[14] Powerlink must meet minimum fault level requirements from December 2025, and procure system strength to meet the efficient level of inverter-based generation in the 10-year forecast.

Submissions to the Project Specification Consultation Report closed in July 2023 and Powerlink is progressing the technical and economic analysis for the optimal portfolio of solutions anticipated to be required. Powerlink expects to publish the Project Assessment Draft Report (PADR) in the second quarter of 2024 that will identify the proposed portfolio of solutions to provide minimum and efficient levels of system strength. Powerlink considers that the solution to the declared shortfall at the Gin Gin system strength node will also contribute to addressing minimum system strength requirements from December 2025.

[12] AEMC, *Efficient Management of System Strength on the Power System*, Final Determination, October 2021, page ii.
[13] National Electricity Rules, clause 11.143.13.
[14] National Electricity Rules, clause S5.1.14.

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