08

Strategic planning

8.1 Introduction

8.2 Possible network options to meet reliability obligations for potential new loads

This chapter discusses plausible new loads within the resource rich areas of Queensland and the associated coastal port facilities, as well as the potential future electrification of mining and conversion of gas loads that may cause network limitations to emerge within the 10-year outlook period. It also discusses major projects referenced in the Queensland Energy and Jobs Plan (QEJP).

Key highlights

- Possible loads associated with new industrial processes, including industry based on hydrogen, and electrification of major industrial processes and mining operations, are emerging within the 10-year outlook period.
- Possible network impacts and options are provided for the Northern Bowen Basin coal mining area, North West Mineral province, Central Queensland to North Queensland (CQ-NQ) and Central West to Gladstone grid sections and supply within South East Queensland.
- The changing generation mix (and associated peak to average production ratios of variable renewable energy (VRE) plant) also has implications for investment in the transmission network, both inter-regionally and within Queensland, across critical grid sections.
- The 2022 Integrated System Plan (ISP) and QEJP released in September 2022 identify the development of Renewable Energy Zones (REZs) that could impact the utilisation and adequacy of the Central Queensland to South Queensland (CQ-SQ) and Central West to Gladstone grid sections, Darling Downs REZ to South East Queensland and Queensland to New South Wales (NSW) Interconnector (QNI).

8.1 Introduction

Chapter 3 provides details of several proposals for large mining, metal processing and other industrial loads whose development status is not yet at the stage that they have been included (either wholly or in part) in the Australian Energy Market Operator's (AEMO) Step Change scenario forecast. These load developments are listed in Table 3.1. The possible impact these uncertain loads may have on the performance and adequacy of the transmission system is discussed in Section 8.2.

In September 2022 the Queensland Government published the QEJP. The plan sets out the roadmap for the transformation of the energy system in Queensland to deliver clean, reliable and affordable energy. In November 2022, Powerlink published the Actioning the Queensland Energy and Jobs Plan document, which outlined initiatives and steps that Powerlink will undertake to support and enable the QEJP. One of the foundational investments to enable the energy transformation is the establishment of a new high voltage backbone SuperGrid capable of transporting large quantities of renewable energy and storage across the state. This new backbone system will be implemented in stages and provide one of the cornerstones for enabling energy transformation in Queensland. Powerlink worked closely with the Queensland Government in the development of the QEJP, including the establishment of new development areas for Queensland QREZs. Further detail of Powerlink's response to the QEJP is given in Chapter 2. AEMO's 2022 ISP is discussed in detail in Chapter 6.

8.1.1 Stakeholder and community engagement

Powerlink is committed to genuine and timely stakeholder engagement and as described in Section 1.8.1, all engagement activities are undertaken in accordance with our Stakeholder Engagement Framework and Community Engagement Strategy. Where applicable, planning approval for transmission lines will be facilitated under the Ministerial Infrastructure Designation process, as per the *Queensland Planning Act 2016* and where new easements are required Powerlink will apply the new SuperGrid Landholder Payment Framework that significantly boosts payments to landholders hosting new transmission infrastructure and offers payments to landholders on neighbouring adjacent properties.

8.2 Possible network options to meet reliability obligations for potential new loads

The proposals for the connection of new industrial processing loads, including new industry based on hydrogen, and electrification of major industrial processes and mining operations are emerging as the broader economy transforms to a lower carbon future.

Currently there is considerable interest from customers investigating electrification in the Northern Bowen Basin. More broadly across the state, there is also the potential for conversion of existing industrial and manufacturing processes from gas and/or diesel to electricity. Many of these loads are in the Gladstone zone. New industry loads based on hydrogen are also potentially located in South East Queensland and the Gladstone and Townsville zones.

In March 2023, the Queensland Government announced that it will build and own the network to the North West Minerals Provence (NWMP) (referred to as CopperString 2032 and formerly known as the CopperString 2.0 project). Powerlink is currently working with impacted landholders, equipment suppliers and Construction Partners to finalise the scope, estimate and construction schedule for final project approval by the Queensland Government. This will connect the current load to the national Electricity Market (NEM) and allow the broader NWMP to access lower cost electricity sources from the NEM.

These potential loads, including possible locations, are listed in Table 3.1. Together, these loads have the potential to significantly impact the performance of the transmission network supplying these areas, including power transfers that exceed the capability of the network. This could be due to plant ratings, voltage stability and/or transient stability. However, all of these loads will have a positive impact on the minimum load issues discussed in Section 3.2. This is particularly the case since the load profile for these mining, metal processing and industrial loads are typically relatively flat.

Powerlink has analysed the impact of these new loads on power transfers and assessed the adequacy of the network capability to meet the required needs. Where the capability of the regulated network is forecast to be exceeded, network developments that could be required to meet those needs have been identified. Options to address the network limitations can also include demand side management (DSM) and non-network solutions.

This section focuses on the most likely network development options only. As the proposed loads become committed, detailed planning analyses will inform and optimise the project scopes and cost estimates. Powerlink will undertake the relevant approval process to identify the preferred option (which may include a non-network option or component) that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the market.

The emergence and magnitude of network limitations resulting from the commitment of these loads will also depend on the location, type and capacity of new or withdrawn generation. For the purpose of this assessment the existing and committed generation in tables 7.1 and 7.2 has been taken into account when discussing the possible network limitations. However, where current interest in connecting further variable renewable energy (VRE) generation has occurred, that has the potential to materially impact the magnitude of the emerging limitation, this is also discussed in the following sections.

The emergence and magnitude of network limitations resulting from the commitment of these loads will also depend on the relative timing of the new high voltage SuperGrid transmission backbone that is required to transport large quantities of renewable energy and storage across the state. Powerlink will also consider these potential limitations holistically with any emerging condition based drivers as part of the longer term planning process and in conjunction with the ISP and QEJP.

Details of feasible network options are provided in sections 8.2.1 to 8.2.4, for the transmission grid sections potentially impacted by the possible new large loads in Table 3.1.

8.2.1 Northern Bowen Basin coal mining area

Based on AEMO's Step Change scenario forecast discussed in Chapter 3, and the committed generation listed in tables 7.1 and 7.2, network limitations are not forecast to exceed network reliability requirements established under Powerlink's planning standard (refer to Section 6.2.1).

However, there have been early discussions on new and expanded mining operations and on electrification of existing mining processes in the Northern Bowen Basin in line with global efforts to reduce carbon emissions. To achieve this, mines will need to replace diesel fuel within their operations through the introduction of a modern electrified mining fleet or the substitution of diesel fuel with hydrogen. Either way, fuel substitution may lead to significant increases in electrical demand and require significant supplies of renewable electricity.

Combined with new and expanded mining operations, electrification of existing mining processes could see load increase by up to approximately 630MW. These loads have not reached the required development status to be included in AEMO's Step Change scenario forecast for this TAPR.

This additional load within the Northern Bowen Basin area would result in voltage and thermal limitations on the 132kV transmission system upstream of their connection points. Critical contingencies include an outage of a 132kV transmission line between Nebo and Moranbah substations, or the 132kV transmission line between Lilyvale and Dysart substations (refer to Figure 6.11).

The impacts these loads may have on the CQ-NQ grid section and possible network solutions to address these is discussed in Section 8.2.2.

Possible network solutions

Mining operations in the Northern Bowen Basin rely heavily on the existing 132kV network to deliver electricity to the area. Much of this infrastructure has limited thermal capacity. To address the potential shortfall in capacity in the transmission and distribution networks, consultation with the customers in the Bowen Basin is required to assess the likely decarbonisation pathways under consideration (electrification or hydrogen), in order to forecast the potential energy demand, VRE supply, and transmission requirements.

Feasible network solutions to address the limitations are dependent on the magnitude, location and profile of load. The type of VRE generation interest in this area is predominately large-scale solar photovoltaic (PV). Given the coal mine load profile would be expected to be relatively flat, VRE generation is unlikely to fully address any emerging limitations.

Depending on the magnitude and location of load, possible network options may include one or more of the following:

- 132kV phase shifting transformers to improve the sharing of power flow in the Bowen Basin within the capability of the existing transmission assets
- construction of new 132kV transmission lines between the Nebo, Broadlea and Peak Downs areas
- construction of 132kV transmission line between Moranbah and a future substation north of Moranbah
- advance the rebuild of the 132kV transmission lines that supply the Northern Bowen Basin area as higher capacity 132kV lines with associated capacitive compensation to maintain voltage control. The existing 132kV lines are forecast to reach their end of technical service in the 2040s.

Powerlink has a vacant transmission corridor between Nebo and Broadlea and a double width easement from Moranbah to north of Newlands substations. New easements would need to be obtained to deliver the other network options described above.

8.2.2 CQ-NQ grid section transfer limit

Based on AEMO's Step Change scenario forecast outlined in Chapter 3 and the existing and committed generation listed in tables 7.1 and 7.2, network limitations impacting reliability are not forecast to occur within the 10-year outlook period.

However, midday power transfer levels are reversing from northern to southern transfers. The incidence of light loading on the transmission system is forecast to increase as additional VRE generators are fully commissioned in NQ. Voltage control is therefore becoming increasingly challenging and leading to high voltage violations. As outlined in Section 9.1, Powerlink has completed a RIT-T consultation recommending the installation of a 275kV shunt reactor at the Broadsound Substation. This reactor is planned to be commissioned in October 2024 (refer to Table 9.3).

As discussed in Section 8.2.1, there is the likelihood of new and expanded mines and electrification of existing mining operations in the Northern Bowen Basin. The NWMP is also anticipated to connect to the NEM in 2029 through CopperString 2032.

CopperString 2032 will connect to a new substation south of Powerlink's existing Ross Substation. The CopperString 2032 project will allow the NWMP to access lower cost electricity sources from the NEM. The existing NWMP load that would directly connect to the NEM is approximately 300MW.

During the development of this project there has been significant interest in connecting new mining loads within the NWMP (including existing load supplied from separate islanded systems) and at various locations along the length of the project. In consideration of this load potential proceeding, the scope of the initial project has been designed to support approximately 450MW of load. As further load commits, augmentation of the CopperString 2032 network and/or to Energy Queensland's network in the NWMP will be required.

As outlined in Section 2.3.1, CopperString 2032 will enable the connection of significant quantities of high quality wind energy in the Hughenden region for export to the coastal Queensland transmission system. The Hughenden region has been designated as Flinders REZ within the draft Queensland Government REZ Roadmap (refer Section 2.4). As a result, the section of CopperString 2032 between Hughenden and coastal Queensland transmission system (south of Ross Substation) is planned to be constructed at 500kV which will enable higher levels of hosting and transfer of renewable energy to the interconnected eastern transmission system.

The loads in Table 3.1 could result in an increase in northern Queensland demand of greater than 1,100MW. However these have not reached the required development status to be included in AEMO's Step Change scenario forecast for this TAPR.

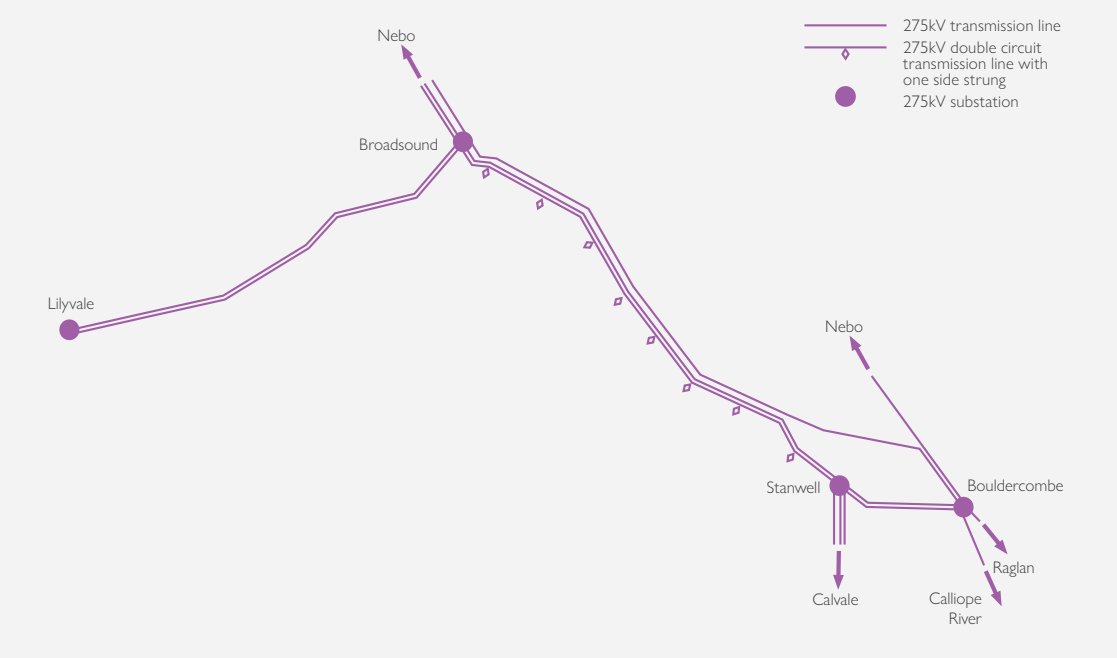
Network limitations on the CQ-NQ grid section may occur if a portion of these new loads commit. Power transfer capability into northern Queensland is limited by thermal ratings and voltage stability. Thermal limitations may occur on the Bouldercombe to Broadsound 275kV line following a critical contingency of a Stanwell to Broadsound 275kV transmission line. Voltage stability limitations may occur following the trip of the Townsville gas turbine or 275kV transmission line supplying northern Queensland.

Network congestion between Central Queensland and North Queensland will require dispatch of additional, out-of-merit-order generation in North Queensland. As generation costs are higher in northern Queensland, due to reliance on liquid fuels, it may be economic to advance the timing of augmentation to deliver positive net market benefits. The additional load in northern Queensland that could justify the network augmentation in preference to continued network support could be as low as 250MW.

Possible network solutions

In 2002, Powerlink constructed a 275kV double circuit transmission line from Stanwell to Broadsound with one circuit strung (refer to Figure 8.1). A feasible network solution to increase the power transfer capability to northern Queensland is to string the second side of this transmission line. No easement is required for this scope of work.

Figure 8.1 Stanwell/Broadsound area transmission network



8.2.3 Gladstone grid section transfer limit

Based on AEMO's Step Change scenario forecast discussed in Chapter 3, there is approximately 250MW of additional load connected in the Gladstone zone by 2031. This load is associated with electrification of a component of the existing industrial processes within the area.

While Powerlink has no connection point commitments from any direct connect customers in the Gladstone zone at the time of the publication of 2023 TAPR, Powerlink is engaging with customers that are committing to decarbonisation of their existing fossil fuelled operations and processes. There has also been a significant number of enquiries for the connection of new industrial processing loads in the Gladstone zone. The magnitude and timing of new and/or electrification load is uncertain. The quantity could range from 3.5GW to over 10GW (refer to Table 3.1).

With reduced operation of Gladstone Power Station (GPS) as the electricity industry transforms to a lower carbon future, in combination with electrification of existing industrial processes and development of new industry load, there will be a significant impact on the transmission capacity required to maintain reliability of supply in the Gladstone zone and power system security.

As highlighted in the QEJP, Powerlink will invest in the Central Queensland REZ, reinforcing the Gladstone system to support decarbonisation of the region.

Connecting additional load in the Gladstone zone will require further investment in transmission, both into and within the Gladstone zone. The additional transmission capacity required to meet this increase in load will only be considered in the context of the main network supplying the Gladstone zone. Network limitations downstream of the main transmission system would also need to be assessed based on specific customer load.

The network augmentations will also be considered holistically with end of technical life drivers and alignment with hosting renewable energy generation.

Possible network solutions

Feasible network solutions to facilitate efficient market operation and deliver reliability of supply obligations in the Gladstone zone may include:

- transmission line augmentation between Calvale and Calliope River substations with a high capacity 275kV double circuit transmission line. This augmentation, together with a third 275/132kV transformer at Calliope River Substation, is required to remove the reliance on the Gladstone PS for reliability of supply for the existing load in the Gladstone zone. This alone, would only support a small incremental load supplied from Larcom Creek Substation.
- rebuild of the transmission line between Larcom Creek and Calliope River substations with a high capacity 275kV double circuit transmission line.
- construction of a new high capacity 275kV double circuit transmission line between Bouldercombe and Larcom Creek Substation. This new build is adjacent (on an existing double width easement) to the existing single circuit 275kV line between Bouldercombe and Calliope River substations (feeder 812). This line traverses valuable wind resources in the area and will divert to Larcom Creek Substation at a suitable location where the future 500/275kV substation west of Gladstone under the QEJP will be located.
- construct a new high capacity 275kV double circuit transmission line between Stanwell and Bouldercombe substations.

The amount of additional load that may be supplied in the Gladstone zone following these works will depend on the relative distribution of the load between the Larcom Creek, Calliope River and Wurdong substation. Additional network augmentations would be required within the Gladstone zone to connect this load.

Depending on the Gladstone load scenario further augmentation will be required. Feasible network solutions include:

- establishing the 500/275kV substation west of Gladstone and associated 500kV connections to deliver power from variable renewable energy generation and firming resources
- additional 275kV connections from the 500/275kV Gladstone West Substation to Calliope River and/or Larcom Creek
- additional 275kV tie capacity between Calliope River and Larcom Creek substations.

Powerlink has a vacant easement between Calvale and Larcom Creek substations for a 275kV double circuit line. From this corridor (adjacent to the Cedavale Tee area) a vacant easement to Calliope River also largely exists. Powerlink is in the process of acquiring the remainder of this easement. Powerlink also has projects in place to acquire necessary easements and/or corridor widening to build a new double circuit line between Larcom Creek and Calliope River substations. Powerlink will also acquire a strategic substation site west of Gladstone (and associated corridors for 500kV and 275kV transmission infrastructure).

8.2.4 Southern Queensland region

Based on AEMO's Step Change scenario forecast discussed in Chapter 3, and the committed generation listed in tables 7.1 and 7.2, network limitations are not forecast to exceed network reliability requirements established under Powerlink's planning standard.

However, Powerlink is engaging in discussions with corporations for the development of significant new loads in southern Queensland. Fortescue Future Industries (FFI), Powerlink and Economic Development Queensland (EDQ) have signed an agreement to progress a facility at Gibson Island[1] (Southern Queensland Trade Coast Area) to produce around 50,000 tonnes of renewable hydrogen per year. Connection to Powerlink's transmission network is essential to allow electricity produced by VRE generation to power the proposed hydrogen project.

The hydrogen project will add up to 675MW in load in SEQ and connect to Powerlink's Murarrie Substation. The FFI operating strategy is to reduce load during peak periods on the network. This means that the required load can be accommodated within the existing network capability including during any critical network outage. A 675MW can be supplied, coincident with peak loads from the existing intact network. However, following a forced outage, overloads would occur without corrective action. This issue is proposed to be mitigated through implementation of a load run-back scheme.

The addition of this load does however reduce the available network capacity for future load growth in the area and advances the the timing of the identified need for when network limitations should be addressed.

Possible network solutions

Feasible network solutions to deliver reliability of supply following future load growth in the area include:

- 275kV transmission line augmentation between Blackwall, Belmont and Murarrie substations. This augmentation could involve transmission tower life extension and the application of high temperature conductor. No additional easements would be necessary under this development option.
- 275kV transmission line augmentation between Belmont and Murarrie substations. This augmentation could again involve the application of high temperature conductor. No additional easements would be necessary under this development option.
- The installation of power flow control technology to manage thermal overload between Blackwall and Belmont substations. Such devices would be installed within the existing substation boundaries.
- Establish a 275kV substation at Nudgee and 275kV cable/s between Nudgee and Murarrie substations. This option requires the acquisition of a new 275kV substation at Nudgee and the necessary easements to connect this substation to the Murarrie Substation. Underground cable would need to be deployed to connect Murarrie to the northern side of the Brisbane River.

Powerlink is also in discussions for development of a large data storage project powered by renewable energy and battery storage[2]. The project is located adjacent to Powerlink's South Pine Substation in North Brisbane. The data centre has a capacity of up to 270MW. In addition, the developer has submitted a planning application for a 750MW Battery energy storage system (BESS).

Depending on the combined operation of the load and BESS, thermal limitations may emerge on the 275kV circuits supplying the South Pine Substation.

Possible network solutions

Feasible network solutions to deliver reliability of supply to the data storage load include:

- Reconfiguration of the 275kV circuits between Blackwall, Rocklea and South Pine substations to establish two circuits between Blackwall and South Pine, with tees to Rocklea.

1 Refer to Powerlink's website.
2 Supernode powered by renewable energy.

- Construct 3.5km of double circuit 275kV line between Blackwall Substation and Karana Downs and rearrange existing circuits to create a double circuit 275kV line between Blackwall and South Pine substations and a double circuit 275kV line between Blackwall and Rocklea substations. The additional 3.5km double circuit line could be built (following appropriate approvals) within the existing easement corridor.
- Advance the rebuild of the 275kV network between Woolooga, Palmwoods and South Pine substations, in association with the Borumba Pumped Hydro Energy Storage (PHES) connection to the eastern backbone. Powerlink currently has a double width corridor adjacent to the existing 275kV single circuit line between Woolooga, Palmwoods and South Pine substations. The vacant corridor does not go all the way to South Pine. The last 20km single circuit lines would need to be rebuilt as double circuit lines to make the necessary connections to South Pine Substation.

Powerlink will also consider the emerging condition based drivers as part of the planning process to ensure the most cost effective solutions are delivered for customers. Such decisions will be undertaken using the RIT-T consultation process, where the benefits of non-network options will also be considered, including working with the proponent to identify mutually beneficial non-network options. This may include co-ordination of the BESS to minimise the impact of the load on the network. Load flexibility and/or post-contingent interruptability may also deferred or reduce the scale of network investment required.