CHAPTER 5

Future network development

5 Future network development

Key highlights

- Powerlink continues to adapt and respond to shifts in an increasingly uncertain operating environment, which has been further impacted by the restrictions of the COVID-19 pandemic.
- To deliver positive outcomes for customers, Powerlink applies a flexible and integrated approach to efficient investment decision making taking into consideration multiple factors including:
  - assessing whether an enduring need exists for assets and investigating alternate network configuration opportunities and/or non-network solutions, where feasible, to manage asset risks
  - assessing dynamic changes in Powerlink's operating environment to ensure network resilience
  - actively seeking opportunities to implement more cost effective prudent solutions whenever possible, such as transmission line refits, that avoid or delay the need to establish new transmission network infrastructure.
- The changing generation mix may lead to increased constraints across critical grid sections. Powerlink will consider these potential constraints holistically as part of the planning process and in conjunction with the findings of the most recent Integrated System Plan (ISP).
- Powerlink has identified a need for additional reactive support to manage high voltages associated with light load conditions in central and south-east Queensland in the five-year outlook period.
- As recommended by the 2018 ISP and since the publication of the 2019 Transmission Annual Planning Report, (TAPR) Powerlink and TransGrid concluded a Regulatory Investment Test for Transmission (RIT-T) to assess the market benefits of expanding the New South Wales (NSW)-Queensland transmission transfer capacity. The resulting transmission network project will support more efficient generation sharing between NSW and Queensland and improve the overall reliability of the transmission system by 2022.

5.1 Introduction

Powerlink Queensland as a Transmission Network Service Provider (TNSP) in the National Electricity Market (NEM) and as the appointed Jurisdictional Planning Body (JPB) by the Queensland Government is responsible for transmission network planning for the national grid within Queensland. Powerlink's obligation is to plan the transmission system to reliably and economically supply load while managing risks associated with the condition and performance of existing assets in accordance with the requirements of the National Electricity Rules (NER), Queensland's Electricity Act 1994 (the Act) and its Transmission Authority.

The NER (Clause 5.12.2(c)(3)) requires the TAPR to provide 'a forecast of constraints and inability to meet the network performance requirements set out in schedule 5.1 or relevant legislation or regulations of a participating jurisdiction over one, three and five years'. In addition, there is a requirement (Clause 5.12.2(c)(4)) to provide estimated load reductions that would defer forecast limitations for a period of 12 months and to state any intent to issue request for proposals for augmentation, replacement of network assets or non-network alternatives. The NER (Clause 5.12.2(c)) also requires the TAPR to be consistent with the TAPR Guidelines and include information pertinent to all proposed:

- augmentations to the network (Clause 5.12.2(c)(5))
- replacements of network assets (Clause 5.12.2(c)(5))
- network asset retirements or asset de-ratings that would result in a network constraint in the 10-year outlook period (Clause 5.12.2(c) (1A)).

This chapter on proposed future network developments contains:

- discussion on Powerlink's integrated planning approach to network development
- information regarding assets reaching the end of their service life and options to address the risks arising from ageing assets remaining in-service, including asset reinvestment, non-network solutions, potential network reconfigurations, asset retirements or de-ratings

- identification of emerging future limitations[1] with potential to affect supply reliability including estimated load reductions required to defer these forecast limitations by 12 months (Clause 5.12.2(c)(4)(iii))
- a statement of intent to issue request for proposals for augmentation, the proposed replacement of ageing network assets or non-network alternatives identified as part of the annual planning review (Clause 5.12.2(c)(4)(iv))
- a summary of network limitations over the next five years (Clause 5.12.2.(c)(3))
- details in relation to the need to address the risks arising from ageing network assets remaining in-service and those limitations for which Powerlink intends to address or initiate consultation with market participants and interested parties
- the manner in which proposed augmentations and the replacement of network assets relate to the Australian Energy Market Operator (AEMO)'s most recent ISP (Clause 5.12.2.(c)(6)) and
- a Table summarising possible connection point proposals.

Where appropriate all transmission network, distribution network or non-network (either demand management or local generation) alternatives are considered as options for investment or reinvestment. Submissions for non-network alternatives are invited by contacting networkassessments@powerlink.com.au.

5.2 ISP alignment

The 2020 ISP published by AEMO in July (which incorporates components of the superseded National Transmission Network Development Plan) provides an independent, strategic view of the efficient development of the NEM transmission network over a 20-year planning horizon.

Powerlink will proactively monitor the changing outlook for the Queensland region and take into consideration the impact of emerging technologies, withdrawal of gas and coal-fired generation and the integration of variable renewable energy (VRE) generation in future transmission plans. These plans may include:

- reinvesting in assets to extend their end of technical service life
- removing some assets without replacement
- determining optimal sections of the network for new connection (in particular renewable generation) as discussed in detail in Chapter 8 and where applicable, in conjunction with the ISP
- replacing existing assets with assets of a different type, configuration or capacity
- investing in assets to maintain planning standards, including Powerlink's obligations for system strength and voltage control
- non-network solutions.

[1] Identification of forecast limitations in this chapter does not mean that there is an imminent supply reliability risk. The NER requires identification of limitations which are expected to occur some years into the future, assuming that demand for electricity is consistent with the forecast in this TAPR.

5.3 Flexible and integrated approach to network development

Powerlink's planning for future network development will focus on pursuing flexible solutions which can adapt to the changing environment. This will deliver positive outcomes for customers while ensuring the ongoing safe and reliable supply of electricity and may include optimising the network topography based on the analysis of future network needs due to:

- forecast demand
- new customer access requirements (including possible Renewable Energy Zones (REZ))
- potential power system development pathways signalled in the ISP
- anomalies in Powerlink's operating environment or changes in technical characteristics (e.g. minimum demand, system strength, voltage limitations) during the transition to more VRE generation
- existing network configuration
- safety, condition and compliance based risks related to existing assets.

This planning process includes consideration of a broad range of options to address identified needs described in Table 5.1. Irrespective of the option or range of options used to address an identified need, where Powerlink identifies that there is a credible option greater than $6 million, Powerlink is required to undertake a RIT-T. The RIT-T describes the need, the credible options identified and provides the requirements for non-network alternatives.

Table 5.1 Examples of planning options

Option	Description
Augmentation	Increases the capacity of the existing transmission network, e.g. the establishment of a new substation, installation of additional plant at existing substations or construction of new transmission lines. This is driven by the need to meet prevailing network limitations and customer supply requirements.
System services	The assessment of future network requirements to meet overall power system performance standards and support the secure operation of the power system. This includes the provision of system strength services and inertia services.
Reinvestment	Asset reinvestment planning ensures that existing network assets are assessed for their enduring network requirements in a manner that is economic, safe and reliable. This may result in like-for-like replacement, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity. Condition and risk assessment of individual components may also result in the staged replacement of an asset where it is technically and economically feasible.
Network reconfiguration	The assessment of future network requirements may identify the reconfiguration of existing assets as the most economical option. This may involve asset retirement coupled with the installation of plant or equipment at an alternative location that offers a lower cost substitute for the required network functionality.
Asset de-rating or retirement	May include strategies to de-rate, decommission and/or demolish an asset and is considered in cases where needs have diminished in order to achieve long-term economic benefits.
Line refit	Powerlink utilises a line reinvestment strategy called line refit to extend the service life of a transmission line and provide cost benefits through the deferral of future transmission line rebuilds. Line refit may include structural repairs, foundation works, replacement of line components and hardware and the abrasive blasting of tower steelwork followed by painting.
Non-network alternatives	Non-network solutions are not limited to, but may include network support from existing and/or new generation or demand side management (DSM) initiatives (either from individual providers or aggregators) which may reduce, negate or defer the need for network investment solutions.
Operational measures	Network constraints may be managed during specific periods using short-term operational measures, e.g. switching of transmission lines or redispatch of generation in order to defer or negate network investment.

5.4 Forecast capital expenditure

The energy industry is going through a period of transformation driven by shifts in economic outlook, customer behaviour, government policy and regulation and emerging technologies that have reshaped the environment in which Powerlink delivers its transmission services. This has been further impacted by the COVID-19 pandemic.

In this changed environment, Powerlink is focussing on assessing the enduring need for key ageing assets that are approaching the end of their service life, and maintaining network resilience. Powerlink is also seeking alternative investment options through network reconfiguration to manage asset condition and/or non-network solutions where economic and technically feasible.

Powerlink has a focussed and strategic approach in determining when it is appropriate to refit or replace ageing transmission assets and how to implement these works cost effectively, such as targeted asset replacement or staged works that avoid or delay the need to establish new transmission network infrastructure. This approach is aimed at delivering positive outcomes for customers.

The 10-year outlook period discussed in the 2020 TAPR runs from 2020/21 to 2030/31 and traverses both the 2017-22 and 2023-27 regulatory periods and beyond.

5.5 Forecast network limitations

As outlined in Section 1.7.1, under its Transmission Authority, Powerlink must plan and develop its network so that it can supply the forecast maximum demand with the system intact. The planning standard, which came into effect from July 2014, permits Powerlink to plan and develop the network on the basis that some load may be interrupted during a single network contingency event. Forward planning allows Powerlink adequate time to identify emerging limitations and to implement appropriate network and/or non-network solutions to maintain transmission services which meet the planning standard.

Emerging limitations may be triggered by thermal plant ratings (including fault current ratings), protection relay load limits, voltage stability and/or transient stability. Appendix E lists the indicative maximum short circuit currents and fault rating of the lowest rated plant at each Powerlink substation and voltage level, accounting for committed projects listed in Chapter 9 and existing and committed generation listed in Chapter 6.

Based on AEMO's Central scenario forecast discussed in Chapter 2, the maximum demand for electricity remains relatively flat in the next five years. Powerlink does not anticipate undertaking any significant augmentation works during this period based on load growth alone. However, the changing generation mix may lead to increased constraints across critical grid sections. Powerlink will consider these potential constraints holistically with the emerging condition based drivers as part of the planning process and in conjunction with the 2020 ISP.

In Powerlink's Revenue Determination 2017-2022[2], projects that could be triggered by the commitment of large mining or industrial block loads were identified as contingent projects. Contingent projects and their triggers are discussed in detail in sections 7.3 and 7.4.

In accordance with the NER, Powerlink undertakes consultations with AEMO, Registered Participants and interested parties on feasible solutions to address forecast network limitations through the RIT-T process. Solutions may include provision of network support from existing and/or new generators, DSM initiatives (either from individual providers or aggregators) and network augmentations.

[2] Information on Powerlink's Revenue Proposal for the 2023-2027 regulatory period is available on Powerlink's website.

5.5.1 Summary of forecast network limitations within the next five years

Powerlink has identified that due to declining minimum demand and increasing penetration of VRE generation, there is an emerging need for additional reactive plant in various zones in Queensland to manage potential over-voltages, and meet system strength requirements. Table 5.2[3] summarises limitations identified in the Powerlink's transmission network which are discussed in sections 5.7.4 and 5.7.10 and noted in AEMO's Network Support and Control Ancillary Services (NSCAS) Report published in December 2019.

Table 5.2: Limitations in the five-year outlook period

Limitation	Zone	Reason for anticipated limitation	Time limitation may be reached			Reference
			1-year outlook (2020/21)	3-year outlook (up to 2023/24)	5-year outlook (up to 2025/26)	
System Strength Services in Queensland to address Fault Level Shortfall at Ross (1)	Far North	AEMO declared system strength shortfall April 2020		Immediate shortfall with services required to be in place by 31 August 2021		Section 5.7.1
Managing voltages in Queensland	Central West			2020/21 (1)		Section 5.7.4
	Moreton			2022/23		Section 5.7.10

Note:

(1) The network risk associated with this limitation is currently being managed through a range of short-term operational measures until such time as the most economic long-term solution can be implemented.

Based on AEMO's Central scenario forecast discussed in Chapter 2 there are no other network limitations forecast to occur in Queensland in the next five years[4].

5.5.2 Summary of forecast network limitations beyond five years

The timing of forecast network limitations may be influenced by a number of factors such as load growth, industrial developments, new and retiring generation, the planning standard and joint planning with other Network Service Providers (NSP). As a result, it is possible for the timing of forecast network limitations identified in a previous year's TAPR to shift beyond the previously identified timing. However, there were no forecast network limitations identified in Powerlink's transmission network in the 2019 TAPR which fall into this category in 2020.

5.6 Consultations

Network development to meet forecast demand is dependent on the location and capacity of generation developments and the pattern of generation dispatch in the competitive electricity market. Uncertainty about the generation pattern creates uncertainty about the power flows on the network and subsequently, which parts of the network will experience limitations. This uncertainty is a feature of the competitive electricity market and historically has been particularly evident in the Queensland region. Notwithstanding the discussion in sections 5.7.6 and 7.2, Powerlink has not anticipated any material changes to network power flows which may require any major augmentation driven network development. This is due to a combination of several factors including a relatively flat maximum demand forecast in the 10-year outlook period and Powerlink's planning criteria (refer to chapters 1 and 2).

[3] Refer to NER Clause 5.12.2(c)(3).
[4] Refer to NER Clause 5.12.2(c)(3).

Proposals for transmission investments and reinvestments over $6 million are progressed under the provisions of Clause 5.16.4 (not actionable ISP projects) and 5.16A (actionable ISP projects) of the NER. In particular, for projects which are not actionable ISP projects, and where action is considered necessary, Powerlink will:

- notify of anticipated limitations or risks arising from ageing network assets remaining in-service within the timeframe required for action
- seek input, initially via the TAPR, on potential solutions to network limitations which may result in transmission network or non-network investments in the 10-year outlook period
- issue detailed information outlining emerging network limitations or the risks arising from ageing network assets remaining in-service to assist non-network solutions as possible genuine alternatives to network investments to be identified
- consult with AEMO, Registered Participants and interested parties on credible options (network or non-network) to address emerging limitations or the risks arising from ageing network assets remaining in-service
- carry out detailed analysis on credible options that Powerlink may propose to address identified network limitations or the risks arising from ageing network assets remaining in-service
- consult with AEMO, Registered Participants and interested parties on all credible options (network and non-network) and the preferred option
- implement the preferred option in the event an investment (network and/or non-network) is found to satisfy the RIT-T.

Alternatively, transmission investments may be undertaken under the 'funded augmentation' provisions of the NER.

It should be noted that the information provided regarding Powerlink's network development plans may change and should be confirmed with Powerlink before any action is taken based on the information contained in this TAPR or the accompanying TAPR templates[5].

5.6.1 Current consultations – proposed transmission investments

Commencing August 2010 proposals for transmission investments over $6 million addressing network limitations (augmentation works) are progressed under the provisions of Clause 5.16.4 of the NER. In September 2017 this NER requirement, i.e. to undertake a RIT-T, was extended[6] to include the proposed replacement of network assets. More recently, from 1 July 2020 a new process is in place for projects which have been identified in AEMO's ISP as actionable ISP projects (Clause 5.16A).[7]

Powerlink carries out separate consultation processes for each proposed new transmission investment or reinvestment over $6 million by utilising the applicable RIT-T consultation process. The majority of Regulatory Investment Test for Transmission (RIT-T) consultations undertaken by Powerlink relate to projects which are not actionable ISP projects (refer to Figure 5.1).

5 In accordance with the AER's TAPR Guidelines published in December 2018.
6 Replacement expenditure planning arrangements Rule 2017 No. 5.
7 National Electricity Amendment ISP Rule 2020.

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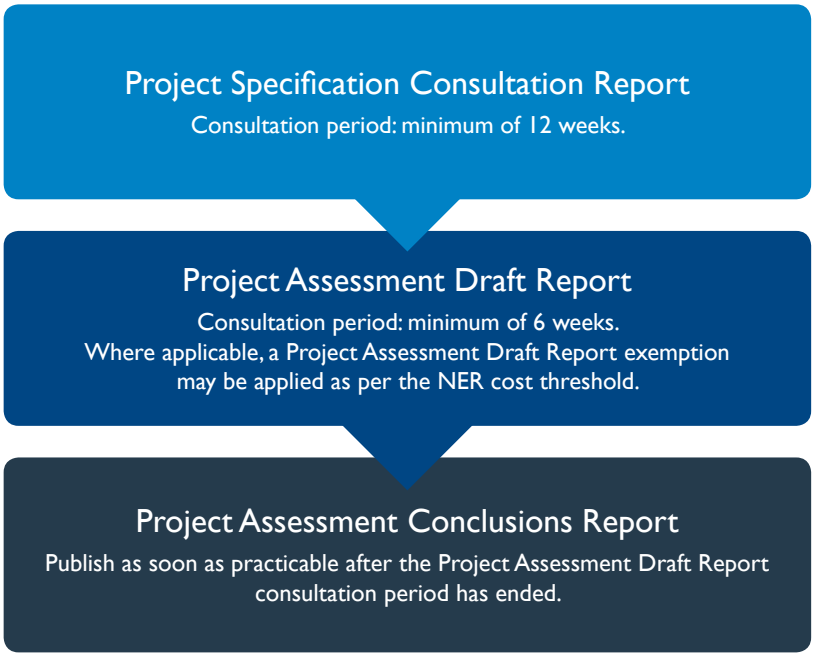
Figure 5.1 Overview of the RIT-T consultation process for projects which are not actionable ISP projects



The consultations completed since publication of the 2019 TAPR are listed in Table 5.3 (refer to Chapter 9). Nine of the 10 RIT-Ts completed were in relation to reinvestments in Powerlink's transmission network

Table 5.3: RIT-T consultations completed since publication of the 2019 TAPR

Consultation
Maintaining reliability of supply at Kamerunga Substation
Addressing the secondary systems condition risks at Cairns
Maintaining reliability of supply between Clare South and Townsville South
Maintaining power transfer capability and reliability of supply at Lilyvale
Addressing the secondary systems condition risks in the Gladstone South area
Maintaining reliability of supply in the Blackwater area
Addressing the secondary systems condition risks at Kemmis
Addressing the secondary systems condition risks at Mudgeeraba
Addressing the secondary systems condition risks at Mt England
Expanding NSW-Queensland transmission transfer capacity (in conjunction with TransGrid)

There are no RIT-T consultations under way as at 30 September 2020.

Other consultations (non RIT-T) currently under way are listed in Table 5.4.

Table 5.4: Other consultations currently under way

Consultation	Reference
Request for system strength services in Queensland to address fault level shortfall at Ross	Section 5.7.1

Registered Participants and interested parties are referred to the consultation documents which are published and made available on Powerlink's website for further information.

5.6.2 Future consultations – proposed transmission investments

Anticipated consultations

Reinvestment in the transmission network to manage the risks arising from ageing assets remaining in-service will form the majority of Powerlink's capital expenditure program of work moving forward. These emerging risks over the 10-year outlook period are discussed in Section 5.7. Table 5.5 summarises consultations Powerlink anticipates undertaking within the next 12 months under the Australian Energy Regulator's (AER) RIT-T to address either the proposed reinvestment in a network asset or limitation.

Table 5.5: Anticipated consultations in the forthcoming 12 months (to October 2021) (1)

Consultation	Reference
Maintaining reliability of supply in the Cairns area	Section 5.7.1
Addressing the secondary systems condition risks at Innisfail	Section 5.7.1
Managing CQ voltages	Section 5.7.4
Maintaining reliability of supply to Gladstone South	Section 5.7.5
Maintaining reliability of supply in the Gladstone region	Section 5.7.5
Maintaining reliability of supply between central and southern Queensland	Section 5.7.6
Maintaining reliability of supply in the Tarong and Chinchilla areas	Section 5.7.7
Addressing the secondary systems condition risks at Murarrie	Section 5.7.10
Managing power transfer capability and reliability of supply at Redbank Plains	Section 5.7.10

Note:

(1) The anticipated consultations listed in Table 5.5 reflect the RIT-T status as at 30 September 2020.

5.6.3 Connection point proposals

Planning of new or augmented connections involves consultation between Powerlink and the connecting party, determination of technical requirements and completion of connection agreements. New connections can result from joint planning with the relevant Distribution Network Service Provider (DNSP)[8] or be initiated by generators or customers.

Table 5.6 lists possible connection works that may be required within the 10-year outlook period.

Table 5.6 Connection point proposals

Connection point name	Proposal	Zone
Moura Solar Farm	New solar farm	Central West
Rodds Bay Solar Farm	New solar farm	Gladstone
Woolooga Energy Park Solar Farm	New solar farm	Wide Bay
Bluegrass Solar Farm	New solar farm	Surat
Columboola Solar Farm	New solar farm	Surat
Western Downs Green Power Hub Solar Farm	New solar farm	Bulli

Note:

When Powerlink constructs a new line or substation as a non-regulated customer connection (e.g. conventional generator, renewable generator, mine or industrial development), the costs of acquiring easements, constructing and operating the transmission line and/or substation are paid for by the company making the connection request.

Table 5.6 lists the projects that are in the public domain, either as approved or through publication by the proponents. Powerlink does not include projects that are not public.

Table 5.7 summarises connection point activities[9] undertaken by Powerlink since publication of the 2019 TAPR. Additional details on potential new generation connections are available in the relevant TAPR template located on Powerlink's website as noted in Appendix B.

Table 5.7 Connection point activities

Generator Location	Number of Applications	Generator Type and Technology
North	3	Solar, Pumped Storage Hydro & Wind
Central	4	Solar, Wind
South	7	Solar, Wind & Storage
Total	14	

5.7 Proposed network developments

As the Queensland transmission network experienced considerable growth in the period from 1960 to 1980, there are now many transmission assets between 40 and 60 years old. It has been identified that a number of these assets are approaching the end of their technical service life and reinvestment in some form is required within the 10-year outlook period in order to manage emerging risks related to safety, reliability and other factors. Moving forward, Powerlink's capital expenditure program of work focuses on reinvestment in the transmission network to manage the identified risks arising from the condition of these ageing assets.

[8] In Queensland, Energex and Ergon Energy (part of the Energy Queensland Group) are the DNSPs.
[9] More broadly, key connection information in relation to the NEM can be found on AEMO website.

In conjunction with condition assessments and risk identification, as assets approach their anticipated end of technical service life, possible reinvestment options undergo detailed planning studies to confirm alignment with future reinvestment, optimisation and delivery strategies. These studies have the potential to provide Powerlink with an opportunity to:

- improve and further refine options under consideration
- consider other options from those originally identified which may deliver a greater benefit to customers.

Information regarding possible reinvestment alternatives and anticipated timing is updated annually within the TAPR and includes discussion on significant changes which have occurred since publication of the previous year's TAPR together with the latest information available at the time.

Where applicable, in relation to proposed expenditure for the replacement of network assets or network augmentations, Powerlink will consult with AEMO, Registered Participants and interested parties on feasible solutions identified through the RIT-T. The latest information on RIT-T publications can be found on Powerlink's website.

Proposed network developments discussed within this chapter identify the most likely network solution, although as mentioned, this has the potential to change with ongoing detailed analysis of asset condition and risks, network requirements or as a result of RIT-T consultations.

Other than the emerging high voltage conditions discussed in the 2019 NSCAS Report[10] and based on the current information available, Powerlink considers all of the possible network developments discussed in this chapter are outside of the scope of the most recent ISP, NSCAS Report and Power System Frequency Risk Review (PSFRR)[11]. The Final 2020 ISP released in July identified three future ISP projects – Queensland/New South Wales Interconnector (QNI), Medium and Large interconnector upgrades, Central to Southern Queensland Transmission Link and Gladstone Grid Reinforcements. Powerlink will provide the necessary preparatory activities by 30 June 2021 to inform the development of the 2022 ISP. These projects are discussed further in Section 7.4.

Powerlink also reviews the rating of assets throughout the transmission network periodically and has not identified any required asset de-ratings that would result in a system limitation as part of the 2020 annual planning review[12].

An analysis of reinvestment needs and potential limitations has been performed across Powerlink's standard geographic zones (refer to sections 5.7.1 to 5.7.11). For clarity, possible network reinvestments have been separated into two periods.

Possible network reinvestments within five years

This includes the financial period from 2020/21 to 2025/26 for possible near term reinvestments when:

- confirmation of the enduring network need and timing occurs
- detailed planning studies are underway or have recently been finalised.

Possible network reinvestments within six to 10 years

This includes the financial period from 2026/27 to 2030/31, for possible medium to long-term reinvestments. Powerlink takes a balanced, prudent and proportionate approach to the consideration of reinvestment needs to address the risks arising from network assets in the medium to long-term and undertakes detailed planning analysis and condition assessment closer to the possible reinvestment date, typically within five years.

10 AEMO's 2019 NSCAS Report December 2019, page 9.
11 NER Clauses 5.12.2(6) and (6A).
12 NER Clause 5.12.2(c)(1A).

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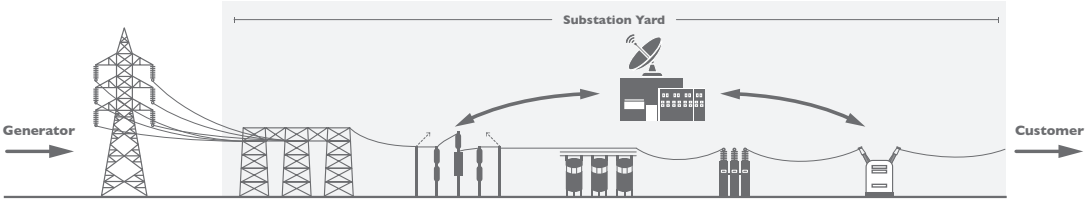
In addition, due to the current dynamic operating environment, there is less certainty regarding the needs or drivers for reinvestments in these later years of the annual planning review period. As a result, considerations in this period have a greater potential to change when compared to near term investments. Possible reinvestment considerations within six to 10 years will need to be flexible in order to adapt to externally driven changes as the NEM evolves and customer behaviours change. Any significant adjustments which may occur as a result of changes will be updated and discussed in subsequent TAPRs.

Powerlink also takes a value-driven approach to the management of asset risks to ensure an appropriate balance between reliability and the cost of transmission services which ultimately benefits customers. Each year, taking the most recent assessment of asset condition and risk into consideration, Powerlink reviews possible commissioning dates and where safe, technically feasible and prudent, capital expenditure is delayed. As a result, there may be timing variances between the possible commissioning dates identified in the 2019 TAPR and 2020 TAPR and TAPR Templates. Significant timing differences are noted in the analysis of the program of work within this chapter (refer to sections 5.7.1 to 5.7.11).

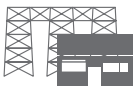
The functions performed by the major transmission network assets discussed in this chapter and which form the majority of Powerlink's capital expenditure in the 10-year outlook period are illustrated in Figure 5.2.

Figure 5.2 The functions of major transmission assets



Transmission line

A transmission line consists of tower structures, high voltage conductors and insulators and transports bulk electricity via substations to distribution points that operate at lower voltages.



Substation

A substation, which is made up of primary plant, secondary systems, telecommunications equipment and buildings, connects two or more transmission lines to the transmission network and usually includes at least one transformer at the site.

A substation that connects to transmission lines, but does not include a transformer, is known as a switching station.

- **Substation bay**
  A substation bay connects and disconnects network assets during faults and also allows maintenance and repairs to occur. A typical substation bay is made up of a circuit breaker (opened to disconnect a network element), isolators and earth switches (to ensure that maintenance and repairs can be carried out safely), and equipment to monitor and control the bay components.

- **Static VAR Compensator (SVC)**
  A SVC is used where needed, to smooth voltage fluctuations, which may occur from time-to-time on the transmission network. This enables more power to be transferred on the transmission network and also assists in the control of voltage.

- **Capacitor Bank**
  A capacitor bank maintains voltage levels by improving the 'power factor'. This enables more power to be transferred on the transmission network.

- **Transformer**
  A transformer is used to change the voltage of the electricity flowing on the network. At the generation connection point, the voltage is 'stepped up' to transport higher levels of electricity at a higher voltage, usually 132kV or 275kV, along the transmission network. Typically at a distribution point, the voltage is 'stepped down' to allow the transfer of electricity to the distribution system, which operates at a lower voltage than the transmission network.

- **Bus reactor**
  A bus reactor is used to control voltages on the high voltage system. Bus reactors are used especially during light load conditions to manage high voltages which may occur on the network.

Secondary systems

Secondary systems equipment assists in the control, protection and safe operation of transmission assets that transfer electricity in the transmission network.

Telecommunication systems

Telecommunication systems are used to transfer a variety of data about the operation and security of the transmission network including metering data for AEMO.

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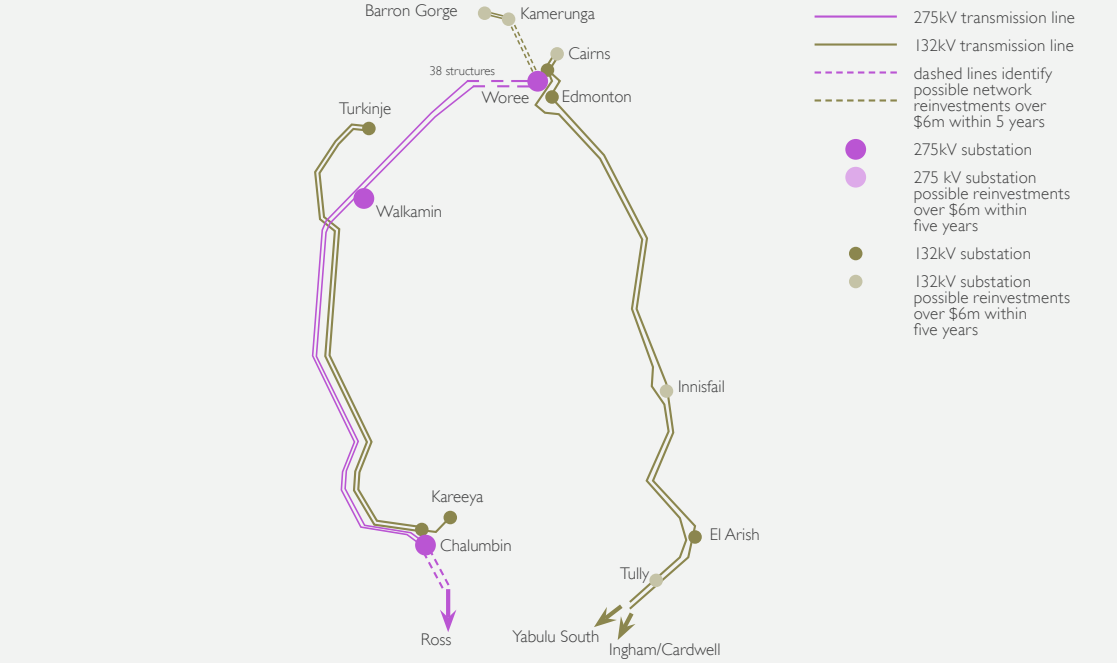
5.7.1 Far North zone

Existing network

The Far North zone is supplied by a 275kV transmission network with major injection points at the Chalumbin and Woree, and a coastal 132kV network from Yabulu South to Tully to Woree. This network supplies the Energy Queensland distribution network feeding the surrounding areas of Turkinje and Cairns, from Tully to Cooktown. The network also connects various renewable generators including the hydro power stations at Barron Gorge and Kareeya, and Mt Emerald Wind Farm near Walkamin (refer to Figure 5.3).

Figure 5.3 Far North zone transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the Far North zone within the next five years to meet reliability obligations.

Possible network investments to address non-load driven network constraints in the next five years

Current Expression of interest (EOI): System strength services in Queensland to address fault level shortfall at Ross

During April 2020, AEMO issued a formal Notice of a fault level shortfall of 90MVA at the Ross 275kV fault level node, the most northern fault level node located in Queensland[13]. The Notice requires Powerlink to address this shortfall by 31 August 2021. With the agreement of AEMO and in accordance with Clause 5.20C.3 of the NER, Powerlink issued a Request for system strength services in April 2020 seeking expressions of interest (EOI) from market participants for offers for system strength remediation services.

However, fault current is only an attribute of system strength and the stability issue being observed is located further north in the transmission network near Cairns. To enable interested parties to understand the nature of the stability problem and to better inform submissions, Powerlink published a clarification document in April 2020.

[13] Under the NER, system strength is measured by fault level at designated fault level nodes (Clause 5.20C.1(b)).

Powerlink received a very positive response to the EOI offering a range of system strength support services to address the fault level shortfall at Ross and have been working closely with the AEMO on the proposed remediation approach. AEMO has now approved the approach for the short-term, up until the end of December 2020. As a result, Powerlink has entered into a short-term agreement with CleanCo Queensland to provide system strength services through utilising its assets in Far North Queensland (FNQ).

In addition, during August 2020 AEMO provided preliminary confirmation that, subject to the final exchange of modelling and other details, inverter tuning could reduce the overall system strength requirement at Ross. Consequently Powerlink has entered into an agreement with Daydream, Hamilton, Hayman and Whitsunday Solar Farms in NQ to validate the expected positive benefits of inverter tuning during the daytime.

Powerlink will continue to work closely with proponents of non-network solutions and AEMO to develop more complete and technically feasible short and long-term solutions to the System Strength Shortfall and undertake the relevant formal approval process in accordance with the NER when the optimal solution has been identified. Powerlink will also discuss the outcome in the 2021 TAPR in accordance with clauses 5.20C.3(f) and (g) of the NER.

Possible network reinvestments within five years

Network reinvestments in Far North zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can deliver a safe, cost effective and reliable supply of electricity to meet the load requirements of customers in the Far North zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Transmission lines

Woree to Kamerunga 132kV transmission lines

Potential consultation: Maintaining reliability of supply to Cairns northern beaches area

The Woree to Kamerunga 132kV double circuit transmission lines were constructed in 1963. Originally connected to Cairns, it provides critical supply to the Cairns northern beaches region, as well as connecting the Barron Gorge Hydro Power Station to the backbone 275kV network.

Project driver:

Emerging conditions risks due to structural corrosion.

In 2014 life extension works were performed on certain components of this transmission line that were nearing the end of their operational life. However, it is anticipated that reinvestment will again be required by 2026. The location of the existing structures poses access and construction work challenges. A possible end of technical service life strategy for this transmission line is replacement on a new easement. Investigations for easement alternatives are currently underway.

Project timing: December 2026

Possible network solutions

- Maintaining the existing 132kV network topography through a new double circuit transmission line from Woree and Kamerunga substations by December 2026
- Network reconfiguration by establishing two single circuit 132kV transmission lines between Woree to Kamerunga substations, or via Cairns North substation, by December 2026.

Proposed network solution: Maintaining 132kV network topology through a new double circuit transmission line on a new easement from Woree to Kamerunga substations at an estimated cost of $40 million[14], by December 2026.

Powerlink considers the proposed network solution will not have a material inter-network impact.

[14] This excludes easement costs yet to be determined.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 22kV network of up to a peak 70MW, and up to a peak 1200MWh per day on a continuous basis. It should be noted that this transmission line also facilitates generation connection in the area.

Ross to Chalumbin to Woree 275kV transmission lines

Anticipated consultation: Maintaining reliability of supply in the Cairns region

The majority of electricity used in the Cairns region is transported from central and north Queensland on Powerlink's 275kV system to Ross, near Townsville. From Ross it is transferred via a double circuit 275kV transmission line to Chalumbin, then via a double circuit transmission line, between Chalumbin and the Woree Substation on the outskirts of Cairns. These 275kV transmission lines also provide supply to Turkinje, and connection to the Mt Emerald Wind Farm and Kareeya Hydro Power Station. Additional connections are made through the parallel 132kV transmission network that provides supply to the coastal communities between Townsville and Cairns.

The double circuit 275kV transmission line between Ross and Chalumbin substations is 244km in length and comprises 528 steel lattice towers. The line was commissioned in 1989 and traverses the rugged terrain of the NQ tropical rain forest, passing through environmentally sensitive, protected areas and crossing numerous regional roads and rivers. Those sections of the line that are elevated and bordering on the Wet Tropics are exhibiting higher levels of atmospheric corrosion than sections in the more protected or dryer areas.

Non-homogeneity of the line condition presents a cost effective opportunity for a staggered refit intervention addressing towers in the different condition with different levels of refit intensity. Subject to the outcome of a RIT-T, this approach is anticipated to deliver the most economic outcome for customers while providing a uniform end of life for all towers on the line.

The Chalumbin to Woree section of line was built in 1998 and is approximately 140km in length. While the condition of a large majority of the line is consistent with its age, this is not the case for the final 16km into Cairns between Davies Creek and Bayview Heights. This final section contains 32 towers that traverse the environmentally sensitive World Heritage Wet Tropics area and terminates near Trinity Inlet Marine Park. These towers have been designed to allow over spanning to minimise corridor clearing. However the extended height has increased exposure to coastal winds and it is subject to a comprehensive maintenance program. Previous inspections indicated an extensive refit including painting on all 32 towers. Due to the environmentally sensitive and geographic conditions in this region, and to ensure reliability of supply to customers, the required renewal works will be complex and need to be completed in stages outside of summer peak load and wet seasons. As a result it has been identified that an extended delivery timeframe of at least six years will be required with consultation anticipated to commence within the next 12 months.

Project driver:

Emerging conditions risks due to structural corrosion.

Project timing: staged to December 2026

Taking into account the most recent information received, subsequent analysis and understanding of the risks arising from:

- the condition and network connectivity of both of the 275kV transmission lines
- ongoing network supply needs in the Far North and Ross zones
- the complexity of undertaking works in environmentally sensitive areas and
- the associated delivery of any potential network solutions in the required timeframe including consideration of the impact of outages

There is an opportunity for Powerlink to consider an integrated approach to optimise any potential reinvestment required, delivering positive outcomes for customers. Given the size of the proposed investment and the associated technical requirements, undertaking an integrated, staged approach may also increase the potential to utilise non-network solutions.

Possible network solutions

Maintaining the existing 275kV network topography and capacity through staged line refits or selective rebuild on:

- Chalumbin to Woree 275kV transmission line by 2024, and Ross to Chalumbin 275kV transmission line to achieve 15 to 20 year life extension by December 2026.
- potential network reconfiguration through a combination of staged line refits or replacement of the existing 275kV transmission lines as per options above, and uprating one circuit of the 132kV coastal transmission line to 275kV by December 2026.

Proposed network solution: Maintaining 275kV network topology through staged line refit projects of the Chalumbin to Woree 275kV transmission line at an estimated cost of $30 to $40 million by December 2024, and the Ross to Chalumbin 275kV transmission line at an estimated cost of $85 to $165 million by December 2026.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

The Ross to Chalumbin transmission lines provide injection to the Far North area of close to 400MW at peak and up to 7,000MWh per day.

The Chalumbin to Woree transmission lines provide injection to the Cairns area of over 275MW at peak and approximately 4,000MWh per day. Voltage stability governs the maximum supportable power transfer that can be injected into the Cairns and FNQ area.

It should be noted that the network configuration facilitates the provision of voltage control and system strength from local synchronous generation. This would need to be taken into consideration for all non-network solutions.

Substations

Innisfail 132kV Substation

Anticipated consultation: Addressing the secondary systems condition risks at Innisfail

Innisfail Substation is a 132/22kV bulk supply point for Ergon Energy in FNQ. The 132kV assets were built as part of the Kareeya Power Station hydroelectricity project during the late 1950s, which established the 132kV transmission system to provide electricity to expanding coastal communities in the region. Innisfail Substation was rebuilt in 2003 and the secondary systems installed as part of this rebuild are anticipated to reach end of technical service life around 2023.

Project driver:

Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.

Project timing: December 2024

Possible network solutions

- Selected replacement of the secondary systems components by December 2024
- Full replacement of all secondary systems and associated panels in a new building by December 2024.

Proposed network solution: full replacement of all secondary systems and associated panels in a new building at an estimated cost of $11 million by December 2024.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 22kV network at Innisfail of up to a peak of 30MW, and up to a 560MWh per day on a continuous basis. This would facilitate the removal of Innisfail Substation and connection of the Innisfail to Edmonton transmission line to the Innisfail to El Arish transmission line.

Edmonton 132/22kV Substation

Anticipated consultation: Addressing the secondary systems condition risks at Edmonton

Edmonton Substation, established in 2005, is an essential 132kV switching station and bulk supply point for Ergon Energy that provides supply to coastal communities between Townsville and Cairns and support to the Cairns area in the event of a contingency on the 275kV lines supplying FNQ. Majority of Edmonton secondary systems are anticipated to reach end of technical service life around 2026.

Project driver:

Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.

Project timing: June 2026

Possible network solutions

- Selected replacement of secondary systems components by June 2026
- Full replacement of secondary systems components by June 2026.

Proposed network solution: Selected replacement of secondary systems at an estimated cost of $6 million by June 2026

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 22kV network at Edmonton of up to 55MW at peak and up to 770MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Possible network reinvestments in the Far North zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Far North zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.8 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.8. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.8 Possible network reinvestments in the Far North zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 275kV transmission lines between Chalumbin and Woree substations (section between Davies Creek and Bayview Heights)	Staged line refit works on steel lattice structures	Maintain supply reliability to the Far North and Ross zones	Staged works by June 2024 (1)	New transmission line (2)	$30m to $40m (3)
Line refit works on the 275kV transmission lines between Ross and Chalumbin substations	Staged line refit works on steel lattice structures	Maintain supply reliability to the Far North and Ross zones	Staged works by December 2026	New transmission line (2)	$85m to $165m (4)
Substations					
Retirement of one 132/22kV Cairns transformer	Retirement of one 132kV Cairns transformer including primary plant reconfiguration works (5) (6)	Maintain supply reliability to the Far North zone	December 2022	Replacement of the transformer	$3m (1) (3)
Tully 132/22kV transformer replacement	Replacement of the transformer	Maintain supply reliability to the Far North zone	June 2024	Life extension of the existing transformer	$5m
Innisfail 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	December 2024 (1)	Replacement of selected secondary systems equipment (2)	$11m (3)
Chalumbin 275/132kV secondary systems replacement	Selective replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	December 2025	Full replacement of 132kV secondary systems	$5m
Edmonton 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	June 2026	Selected replacement of 132kV secondary systems (2)	$6m

Notes:

(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

(2) The envelope for non-network solutions is defined in Section 5.7.1.

(3) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

(4) The project cost will be dependent upon assessment of technical feasibility and commercial analysis of first intervention options to maintain network topography before second intervention is required.

(5) Due to the extent of available headroom, the retirement of this transformer does not bring about a need for non-network solutions to avoid or defer load at risk or future network limitations, based on AEMO's Central scenario forecast discussed in Chapter 2.

(6) Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Far North zone from around 2026/27 to 2030/31 (refer to Table 5.9).

Table 5.9 Possible network reinvestments in the Far North zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative costs
Transmission Lines					
Rebuild the 132kV transmission line between Woree and Kamerunga substations	New 132kV double circuit transmission line	Maintain supply reliability to the Far North zone	December 2026 (1)	Two 132kV single circuit transmission lines (2)	$40m (3)
275/132kV substation establishment to maintain supply to Turkinje substation	Establishment of 275/132kV switching substation near Turkinje including two transformers	Maintain supply reliability to Turkinje area	June 2029	Refit of the Chalumbin to Turkinje 132kV transmission line	$37m
Substations					
Barron Gorge 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	December 2026	Selected replacement of 132kV secondary systems	$3m
Turkinje 132kV primary plant replacement	Selected replacement of 132kV primary plant	Maintain supply reliability to the Far North zone	December 2026	Full replacement of 132kV primary plant	$3m (3)
Kamerunga 132/22kV Transformer Replacement	Replacement of the transformer	Maintain supply reliability to Cairns northern beaches area	December 2028	Significant load transfers in distribution network Early replacement with higher capacity transformer by 2023 triggered by load growth	$5m
Chalumbin 275kV and 132kV primary plant replacement	Selected replacement of 275kV and 132kV primary plant	Maintain supply reliability to the Far North zone	December 2028 (1)	Full replacement of all 275kV and 132kV primary plant and secondary systems	$7m (3)
Woree 275kV and 132kV secondary systems replacement	Selected replacement of 275kV and 132kV secondary systems	Maintain supply reliability to the Far North zone	June 2029 (1)	Full replacement of 275kV and 132kV secondary systems	$16m
El Arish 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	June 2031	Full replacement of 275kV and 132kV secondary systems	$5m

Notes:

(1) The change in timing of the network solution is based upon updated information on the condition of the assets.

(2) The envelope for non-network solutions is defined in Section 5.7.1.

(3) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

Possible asset retirements in the 10-year outlook period[15]

Retirement of one of the 132/22kV transformers at Cairns Substation.

Planning analysis has shown that, based on AEMO's Central scenario forecast discussed in Chapter 2, there is no enduring need for one of the three transformers at Cairns Substation, which is approaching end of technical service life within the next five years. Retirement of the transformer provides cost savings through the avoidance of capital expenditure to address the condition and compliance risks arising from the asset remaining in-service. Some primary plant reconfiguration may be required to realise the benefits of these cost savings at an indicative cost of $3 million. There may also be additional works and associated costs on Ergon Energy's network which requires joint planning closer to the proposed retirement in December 2022 (refer to Table 5.8).

Retirement of the 132kV transmission line between Chalumbin and Turkinje substations.

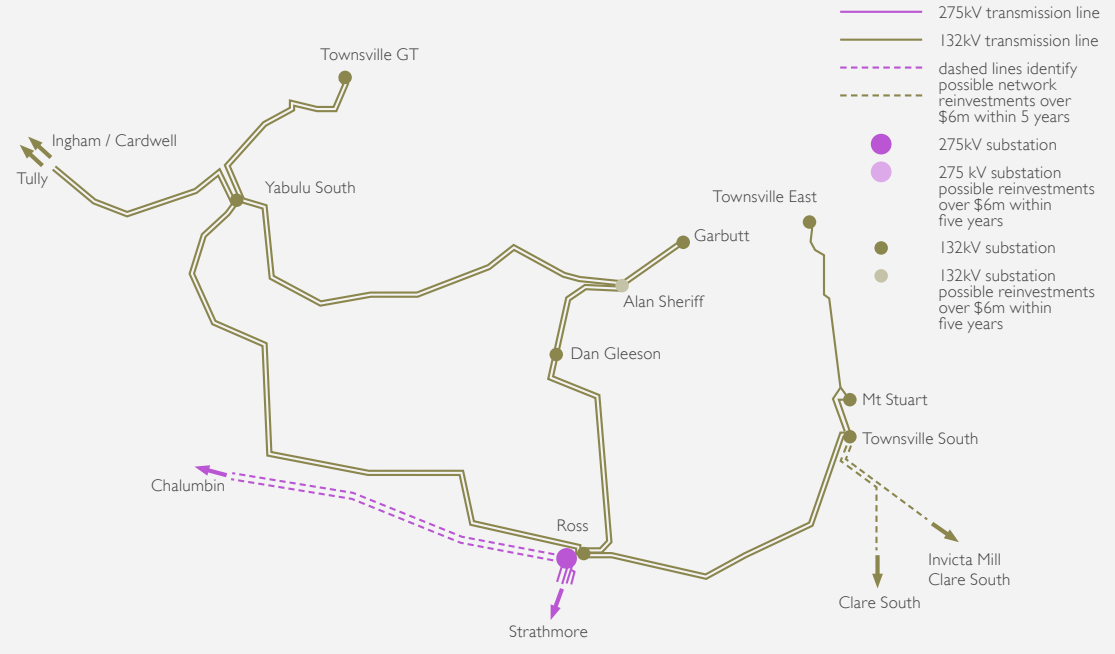
Condition assessment has identified emerging condition risks arising from the condition of 132kV transmission line between Chalumbin and Turkinje around 2029. At this time, an option would be to establish a 275/132kV switching station near Turkinje to provide 132kV connection and retirement of the existing 132kV transmission line.

5.7.2 Ross zone

Existing network

The 132kV network between Collinsville and Townsville was developed in the 1960s and 1970s to supply mining, commercial and residential loads. The 275kV network within the zone was developed more than a decade later to reinforce supply into Townsville and FNQ. Parts of the 132kV network are located closer to the coast in a high salt laden wind environment leading to accelerated structural corrosion (refer to figures 5.4 and 5.5).

Figure 5.4 Northern Ross zone transmission network



[15] Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

Figure 5.5 Southern Ross zone transmission network

Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the Ross zone within the next five years to meet reliability obligations.

Possible network reinvestments within five years

Network reinvestments in Ross zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the Ross zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Substations

Ingham South 132kV Substation

Potential consultation: Addressing the secondary systems condition risks at Ingham South

Ingham South Substation was established in 2005 and is a major injection point into Ergon Energy's 66kV distribution network providing supply to the Ingham area. The secondary systems installed are anticipated to reach end of technical service life around 2025.

Project driver:

Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.

Project timing: June 2025

Possible network solutions

- Selected replacement of the secondary systems components by June 2025.
- Full replacement of all secondary systems and associated panels in a new building by June 2025.

Proposed network solution: Full replacement of secondary systems at an estimated cost of $6 million by June 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 66kV network at Ingham South of up to 20MW and up to 280MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Alan Sherriff 132kV Substation

Potential consultation: Addressing the secondary systems condition risks at Alan Sherriff

Alan Sherriff Substation was established in 2002 as a two transformer substation, and replaced the 132kV switching functions at Garbutt in 2004. The substation is a major injection point into Ergon Energy's 66kV distribution network providing supply to the Townsville area.

Project driver:

Addressing the secondary systems condition risks at Alan Sherriff Substation.

Project timing: June 2025

Possible network solutions

- Full replacement of all secondary systems.
- Selected replacement of secondary systems, with decommissioning or extended maintenance of the two bays associated with the Dan Gleeson to Alan Sheriff transmission line.

Proposed network solution: Selected replacement of secondary systems at estimated cost of $11 million by June 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 11kV network in north east Townsville of up to 25MW at peak and up to 450MWh per day. Reconfiguration of the 132kV network at Alan Sherriff, and of the Townsville 66kV network around Townsville, would be required to facilitate removal of Alan Sherriff Substation.

Possible network reinvestments in the Ross zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Ross zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.10 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.11. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.10 Possible network reinvestments in the Ross zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Ingham South 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2025	Selected replacement of 132kV secondary systems (1)	$6m
Garbutt 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2025	Selected replacement of 132kV secondary systems	$5m
Alan Sherriff 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2025	Full replacement of 132kV secondary systems (1)	$11m

Note:

(1) The envelope for non-network solutions is defined in this Section 5.7.2.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Ross zone from around 2026/27 to 2030/31 (refer to Table 5.11).

Table 5.11 Possible network reinvestments in the Ross zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 132kV transmission line between Townsville South and Ross substations	Targeted line refit works on steel lattice structures	Maintain supply reliability in the Ross zone	June 2028	New 132kV transmission line Targeted line refit works on steel lattice structures with painting	$2m
Line refit works on the 132kV transmission line between Ross and Dan Gleeson substations	Line refit works on steel lattice structures	Maintain supply reliability to the Ross zone	June 2028	New 132kV transmission line	$8m
Line refit works on the 132kV transmission lines between Collinsville, Strathmore and Clare South substations	Line refit works on steel lattice structures	Maintain supply reliability to the Ross zone	June 2030 (1)	New 132kV transmission line	$20m
Line refit works on the northern end of the 275kV transmission lines between Strathmore and Ross substations	Targeted line refit works on the 275kV steel lattice towers	Maintain supply reliability between Strathmore and Ross	June 2030 (1)	New transmission line	$6m
Substations					
Townsville East 132kV secondary systems replacement	Staged replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2028	Full replacement of secondary systems	$3m
Townsville South 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2028	Full replacement of 132kV secondary systems	$15m
Yabulu South 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2029	Full replacement of 132kV secondary systems	$7m
Clare South 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2029	Full replacement of 132kV secondary systems	$11m
Ross 275/132kV secondary systems replacement	Selective replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2030	Full replacement of secondary systems	$8m

Table 5.11 Possible network reinvestments in the Ross zone within six to 10 years *(continued)*

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Bowen North 132kV secondary systems replacement	Selective replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2031	Full replacement of secondary systems	$3m

Note:

(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

Possible asset retirements in the 10-year outlook period

Dan Gleeson to Alan Sherriff 132kV transmission line

The 132kV transmission line between Dan Gleeson and Alan Sherriff substations was constructed in the 1960s and is located in the south-western suburbs of Townsville. Foundation repair on this transmission line was completed in 2016 to allow the continued safe operation in the medium term. Planning studies are currently underway to assess the viability of potentially retiring this transmission line.

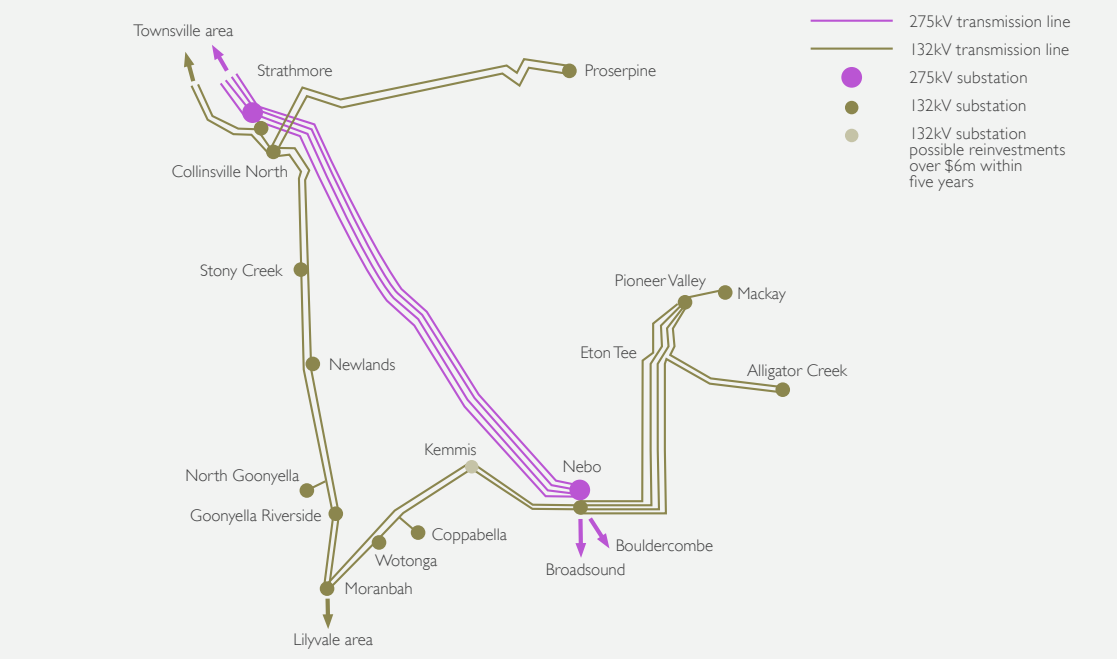
5.7.3 North zone

Existing network

Three 275kV circuits between Nebo (in the south) and Strathmore (in the north) substations form part of the 275kV transmission network supplying the North zone. Double circuit inland and coastal 132kV transmission lines supply regional centres and infrastructure related to mines, coal haulage and ports arising from the Bowen Basin mines (refer to Figure 5.6).

The coastal network in this zone is characterised by transmission line infrastructure in a corrosive environment which make it susceptible to premature ageing.

Figure 5.6 North zone transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the North zone within the next five years to meet reliability obligations.

Increasing local demand in the Proserpine area is expected to lead to some load at risk. The critical contingency is an outage of the 275/132kV Strathmore transformer.

Based on AEMO's Central scenario forecast discussed in Chapter 2, this places load at risk of 10MW from summer 2020/21, which is within the 50MW and 600MWh limits established under Powerlink's planning standard (refer to Section 1.8).

High voltages associated with light load conditions are currently managed with existing reactive sources. However, midday power transfer levels are forecast to reduce as additional VRE generators are commissioned in NQ. As a result, voltage control is forecast to become increasingly challenging for longer durations. This is discussed in sections 5.7.4 and 6.6.2.

Strathmore 275/132kV Substation

Potential consultation: Addressing the Static VAr Compensator (SVC) secondary systems condition risks at Strathmore

Strathmore Substation was established in 2001. The substation is a major injection point into Ergon Energy's 66kV. It consists of a 275kV and 132kV switchyards.

Project driver:

Addressing the SVC secondary systems condition risks at Strathmore Substation.

Project timing: June 2026

Possible network solutions

- Selected replacement of the secondary systems associated with the SVC.
- Full replacement of all secondary systems associated with the SVC.
- Full replacement of secondary systems associated with the SVC and selected secondary systems for the 275kV/132kV switchyard.

Proposed network solution: Full replacement of secondary systems associated with the SVC at Strathmore at estimated cost of $6 million by June 2026

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide dynamic voltage support of up to 150MVArs capacitive and 80MVArs inductive.

Possible network reinvestments in the North zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the North zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.12 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.12. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Network reinvestments in the North zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the North zone into the future. This may result in like for like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Table 5.12 Possible network reinvestments in the North zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Nebo 132/11kV transformer replacements	Replacement of two 132/11kV transformers	Maintain supply reliability to the North zone	June 2022	Establish 11kV supply from surrounding network	$5m (2)
Alligator Creek 132kV primary plant replacement	Selective replacement of 132kV primary plant	Maintain supply reliability in the North zone	June 2022 (1)	Full replacement of 132kV primary plant	$4m
North Goonyella 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the North zone	December 2023 (1)	Selective replacement of 132kV secondary systems	$2m
Newlands 132kV primary plant replacement	Staged replacement of 132kV primary plant	Maintain supply reliability in the North zone	December 2023 (1)	Replacement of all 132kV primary plant	$5m (3)
Strathmore SVC secondary systems replacement	Full replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2026	Staged replacement of secondary systems (1)	$6m
Strathmore 275kV and 132kV partial secondary systems replacement - Stage 2	Selective replacement of 275 and 132kV secondary systems in a new prefabricated building	Maintain supply reliability to the North zone	December 2028	Selected replacement of 275 and 132kv secondary systems in existing panels	$14m

Notes:

(1) The envelope for non-network solutions is defined in this Section 5.7.3

(2) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

(3) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to required scope of works.

(4) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the North zone from around 2026/27 to 2030/31 (refer to Table 5.13).

Table 5.13 Possible network reinvestments in the North zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 132kV transmission line between Nebo Substation and Eton tee	Line refit works on steel lattice structures	Maintain supply reliability to the North zone	December 2027 (1)	New transmission line	$31m
Substations					
Kemmis 132/66kV transformer replacement	Replacement of one 132/66kV transformers	Maintain supply reliability to the North zone	June 2028	Establish 66kV supply from surrounding network	$4m
Alligator Creek SVC and 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the North zone	June 2028	Staged replacement of 132kV secondary systems	$15m
Pioneer Valley 132kV primary plant replacement	Selective replacement of 132kV secondary systems equipment	Maintain supply reliability to the North zone	December 2028	Full replacement of 132kV secondary systems	$6m
Mackay 132/33kV transformer replacement	Replacement of one 132/33kV transformer	Maintain supply reliability to the North zone	June 2030	Establish 33kV supply from surrounding network	$5m

Note:

(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

Possible asset retirements within the 10-year outlook period

Pioneer Valley to Eton tee 132kV transmission line

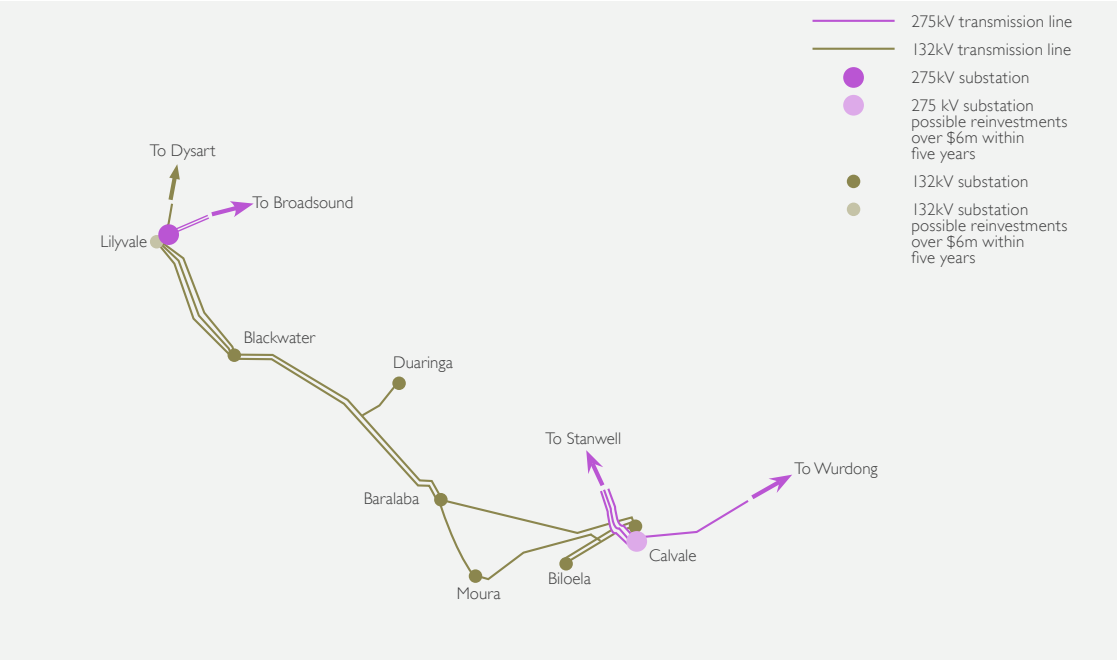
Subject to the outcome of further analysis, Powerlink may retire the inland transmission line at the end of its service life anticipated around 2027.

5.7.4 Central West zone

Existing network

The Central West 132kV network was developed between the mid-1960s and late 1970s to meet the evolving requirements of mining activity in the southern Bowen Basin. The 132kV injection points for the network are taken from Calvale and Lilyvale 275kV substations. The network is located more than 150km from the coast in a dry environment making infrastructure less susceptible to corrosion. As a result transmission lines and substations in this region have met (and in many instances exceeded) their anticipated service life but will require replacement or rebuilding in the near future (refer to Figure 5.7).

Figure 5.7 Central West 132kV transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2 and the committed generation described in tables 6.1 and 6.2, there is no additional capacity forecast to be required in the Central West zone within the next five years to meet reliability obligations.

Possible network investments to address non-load driven network constraints in the next five years

High voltages associated with light load conditions are currently managed with existing reactive sources. However, midday power transfer levels are forecast to reduce as additional VRE generators are commissioned in NQ, leading to greater utilisation of voltage control plant in the Central Queensland (CQ) and NQ zones. As a result, voltage control is forecast to become increasingly challenging for longer durations and potentially lead to high voltage (HV) violations (that is, voltages exceed defined safe operating limits).

Powerlink has in the past used operational line switching to reduce voltages to within safe operating limits. Line switching can lead to reduced reliability arising from non-credible events, and can lead to reduced system strength.

The lines required to be switched to mitigate higher operational voltages in NQ and CQ, are the lines that have the largest impact on the system strength in NQ. The reduction in system strength from line switching may breach Powerlink's obligations under clauses 11.101.2 and 4.6.6 of the NER, as amended by the National Electricity Amendment (Managing power system fault levels) Rule 2017 No. 10 (Fault Levels Rule) and this may result in VRE generators in NQ being constrained to ensure system strength is maintained.

Anticipated consultation: Managing CQ voltages

Project driver:

Voltage control during light load conditions.

Powerlink has identified a need for additional reactive support, to:

- Maintain voltages within operational and design limits during minimum demand periods and to maintain the power system in a secure operating state;
- Reduce reliability impact from the de-energisation of 275kV transmission lines; and
- Reduce market constraints to meet system strength requirements.

Project timing: December 2021

Possible network solutions

- Installation of a 150MVAr 300kV bus reactor at Broadsound
- Installation of a 150MVAr 300kV bus reactor at Nebo

Proposed network solution: Installation of a 150MVAr 300kV bus reactor at Broadsound at an estimated cost of $9 million by June 2023

The network risk associated with this limitation is currently being managed through a range of short-term operational measures including rescheduling of outages and the selective switching out of lines as required, until such time as the most economic long-term solution can be implemented. Subject to the outcome of a RIT-T consultation, the earliest likely timing of delivery of works for a network solution, which has been impacted by the restrictions of the COVID-19 pandemic, is June 2023.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Under system normal conditions, network support would need to provide voltage control equivalent to the proposed reactor at or near Nebo or Broadsound, being 126MVAr at the 275kV bus. Reactive support would be required to be available on a continuous basis, and not be coupled to generation output. The nature of this limitation is that the voltage control would be required to operate on a continuous basis.

Possible network reinvestments within five years

Network reinvestments in Central West zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the Central West zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Substations

Powerlink has identified opportunities to reconfigure the network in the Central West zone providing efficiencies and cost savings by:

- reducing the number of transformers at Bouldercombe Substation, where as an outcome of a RIT-T, two of the existing transformers will be retired and replaced by a single transformer by December 2021; and
- re-arrangement of the 132kV network around Callide A Substation by the establishment of a second transformer at Calvale Substation and retirement of Callide A Substation and the Callide A to Gladstone South transmission line. A committed project is currently underway to establish a second transformer at Calvale Substation (refer to Table 9.3).

Possible network investments in the Central West zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Central West zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.14 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.14. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.14 Possible network investments in the Central West zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
150MVAr 300kV bus reactor at Broadsound	Installation of a 150MVAr 300kV bus reactor at Broadsound Substation	Voltage control in CQ	June 2023	Installation of a 150MVAr 300kV bus reactor at Nebo (1)	$9m
Blackwater 132kV primary plant replacement	Selective replacement of 132kV primary plant	Maintain supply reliability in the Central West zone	June 2025	Full replacement of 132kV primary plant	$3m
Biloela 132kV secondary systems replacement	Selective replacement of 132kV secondary systems	Maintain supply reliability in the Central West zone	June 2025	Full replacement of 132kV secondary systems	$4m
Lilyvale 132kV secondary systems replacement	Selective replacement of 132kV secondary systems	Maintain supply in the Central West zone	June 2025	Full replacement of 132kV secondary systems	$3m

Note:

(1) The envelope for non-network solutions is defined in Section 5.7.4.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Central West zone from around 2026/27 to 2030/31 (refer to Table 5.15).

Table 5.15 Possible network reinvestments in the Central West zones within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 275kV transmission line between Bouldercombe and Nebo substations	Line refit works on the 275kV transmission line	Maintain supply reliability in the Central West zone	December 2027	Stanwell to Broadsound 2nd side stringing New 275kV transmission line between Bouldercombe and Broadsound substation	$24m
Line refit works on the 132kV transmission line between Callide A, Biloela and Moura	Line refit works on the 132kV transmission line and repair selected foundations	Maintain supply reliability in the Central West zone	June 2028	Rebuild the 132kV transmission lines as a double circuit from Callide A to Moura	$5m
Substations					
Broadsound 275kV primary plant replacement	Selective replacement of 275kV primary plant	Maintain supply reliability in the Central West zone	December 2026	Full replacement of 275kV primary plant	$15m
Calvale 275kV primary plant replacement	Selective replacement of 275kV primary plant	Maintain supply reliability in the Central West zone	December 2026	Full replacement of 275kV primary plant	$17m
Broadsound 275kV secondary systems replacement	Selective replacement of 275kV secondary systems	Maintain supply reliability in the Central West zone	June 2027	Full replacement of 275kV secondary systems	$4m
Blackwater 132kV secondary systems replacement	Selective replacement of 132kV secondary systems	Maintain supply reliability in the Central West zone	June 2029	Full replacement of 132kV secondary systems	$13m

Possible asset retirements within the 10-year outlook period[16]

Subject to the outcome of further analysis and RIT-T consultation, Powerlink may retire the single circuit transmission lines between Callide and Baralaba, and Baralaba and Moura at the end of its technical service life anticipated around 2028, if a new 132kV double circuit transmission line is constructed between Calvale and Moura substations.

[16] Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

5.7.5 Gladstone zone

Existing network

The Gladstone 275kV network was initially developed in the 1970s with the Gladstone Power Station and has evolved over time with the addition of the Wurdong Substation and supply into Boyne Smelters Limited (BSL) in the early 1990s (refer to Figure 5.8).

Figure 5.8 Gladstone transmission network

Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required in the Gladstone zone within the next five years to meet reliability obligations.

Possible network reinvestments within five years

Network reinvestments in Gladstone zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations - resulting in poor customer, safety and environmental outcomes.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can deliver a safe, cost effective and reliable supply of electricity to meet the load requirements of customers in the Gladstone zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Transmission lines

Larcom Creek to Calliope 275kV transmission lines

Potential consultation: Maintaining reliability of supply in the Gladstone region

The transmission line between Calliope River and Larcom Creek was constructed in 1977 and is located in CQ immediately adjacent to the Gladstone industrial area. This built section covers the distance between Calliope River and Larcom Creek via Yarwun substations. A proportion of the transmission line traverses tidal marine environment and due to its proximity to the large-scale industrial areas and the coast it is constantly exposed to high levels of salt laden air and industrial pollutants.

Project driver:

Emerging conditions risks due to structural corrosion.

Project timing: June 2025

Possible network solutions

- Line refit works on steel lattice structures
- Rebuild the 275kV transmission line between Calliope River and Larcom Creek as SCST construction
- Rebuild the 275kV transmission line between Calliope River and Larcom Creek as DCST construction

Proposed network solution: Line refit works between Larcom Creek and Calliope River at an estimated cost of $10 million, by June 2024.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to 66kV and 132kV loads at Yarwun and Raglan of up to 160MW and up to 3200MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Wurdong to Boyne Island 275kV transmission line

Potential consultation: Maintaining reliability of supply in the Gladstone region

The transmission line provides supply to the Boyne Smelter from the Wurdong substation and was constructed in 1991, Due to its proximity to Boyne Smelter, Gladstone industrial precinct and the coast, it is constantly exposed to high levels of salt laden air and industrial pollutants. As a result, particularly in the more exposed locations, a high percentage of galvanised tower bolts and members are exhibiting evidence extensive corrosion and the line receives additional maintenance to keep it in a serviceable condition.

Project driver:

Emerging condition risks due to structural corrosion.

Project timing: December 2024

Possible network solutions

- Line refit works on steel lattice structures
- Rebuild the 275kV transmission line between Wurdong and Boyne as SCST construction
- Rebuild the 275kV transmission line between Wurdong and Boyne as DCST construction

Proposed network solution: Refit the single circuit transmission line between Wurdong and Boyne substations, at an estimated cost of $7 million, by December 2024

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 275kV network at Boyne Island of approximately 400MW and approximately 10,000MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Callemondah to Gladstone South 132kV transmission lines

Potential consultation: Maintaining reliability of supply to Gladstone South

The Callemondah to Gladstone South 132kV double circuit transmission line was constructed in 1977. The transmission line facilitates supply to Gladstone South Substation which is an Ergon Energy bulk supply point and the connection point for Queensland Alumina Limited (QAL).

Project driver:

Emerging conditions risks due to structural corrosion.

Project timing: December 2023

Possible network solutions

- Rebuild the 132kV transmission line between Callemondah and Gladstone South substations
- Line refit works on steel lattice structures

Proposed network solution: Rebuild the double circuit transmission line between Callemondah and Gladstone South substations, at an estimated cost of $17 million, by December 2023

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 132kV network at Gladstone South of up to 160MW at peak and up to 1,820MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Substations

Callemondah Substation

Callemondah Substation was established in 1985 and provides supply to the Aurizon supply network. The secondary systems are anticipated to reach end of technical service life around 2024.

Potential consultation: Maintaining reliability of supply at Callemondah

Project driver:

Addressing the 132kV primary plant and secondary systems condition risks.

Project timing: June 2024

Possible network solutions

- Full primary plant and secondary systems replacement by June 2024.
- Selective primary plant and secondary systems replacement by June 2024.

Proposed network solution: Selective primary plant and secondary systems replacement at Callemondah Substation at an estimated cost of $7 million by June 2024

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 132kV network at Gladstone South and/or Aurizon load at Callemondah, totalling up to 180MW and up to 2,500MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Possible network reinvestments in the Gladstone zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Gladstone zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.16 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.16. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.16 Possible network reinvestments in the Gladstone zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 132kV transmission line between Callemondah and Gladstone South substations	Rebuild the 132kV transmission line between Callemondah and Gladstone South Substation (1)	Maintain supply reliability in the Gladstone zone	December 2023	Line refit works on steel lattice structures (2)	$17m
Line refit between Larcom Creek and Mt Miller substation	Line refit works on steel lattice structures (2)	Maintain supply reliability in the Gladstone zone	June 2024	Rebuild the 275kV transmission line between Mt Miller and Larcom Creek substation (2)	$10m
Line refit works on the 275kV transmission line between Wurdong and Boyne Island	Line refit works on steel lattice structures	Maintain supply reliability in the Gladstone zone	December 2024	Rebuild the 275kV transmission line between Wurdong and Boyne Island (2)	$7m
Substations					
Callemondah selective 132kV primary plant and secondary systems replacement	Selective replacement of 132kV primary plant and secondary systems	Maintain supply reliability in the Gladstone zone	June 2024	Full replacement of 132kV primary plant and secondary systems (2)	$7m

Notes:

(1) The envelope for non-network solutions is defined in Section 5.7.5.

(2) More detailed option analysis and consideration of the associated scope of works to address emerging condition risks on this transmission line has been undertaken since the publication of the 2019 TAPR. This new analysis has supported the development of new strategies and options providing an opportunity to deliver a more cost effective solution than previously identified, delivering positive outcomes for customers.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Gladstone zone from around 2026/27 to 2030/31 (refer to Table 5.17).

Table 5.17 Possible network reinvestments in the Gladstone zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on 275kV transmission line between Mt Miller and Boulderombe substations	Line refit works on steel lattice structures	Maintain supply reliability in the Gladstone zone	December 2027	Advancement of the rebuild the 275kV transmission line between Mt Miller and Boulderombe as a DCST and dismantle the inland circuit	$5m
Rebuild the 275kV transmission line between Raglan and Larcom Creek substations	Rebuild the 275kV transmission line between Raglan and Larcom Creek as a double circuit line (1)	Maintain supply reliability in the Gladstone zone	June 2030	Line refit works on steel lattice structures Rebuild the 275kV transmission line between Raglan and Larcom Creek as a single circuit line	$33m
Rebuild the 275kV transmission line between Raglan and Boulderombe substations	Rebuild the 275kV transmission line between Raglan and Boulderombe (1)	Maintain supply reliability in the Gladstone zone	June 2031	Line refit works on steel lattice structures Rebuild the 275kV transmission line between Raglan and Larcom Creek as a single circuit line	$75m
Substations					
Rockhampton 132kV secondary systems replacement	Selective replacement of 132kV secondary systems	Maintain reliability at Rockhampton	December 2026	Full replacement of 132kV secondary systems	$4m
Larcom Creek secondary systems replacement	Selective replacement of 275kV secondary systems	Maintain supply reliability in the Gladstone zone	June 2029	Full replacement of the 275kV secondary systems	$8m
Yarwun 132kV secondary systems replacement	Full replacement of the 132kV secondary systems	Maintain supply reliability in the Gladstone zone	June 2029	Selective replacement of 132kV secondary systems	$10m

Note:

(1) More detailed option analysis and consideration of the associated scope of works to address emerging condition risks on this transmission line has been undertaken since the publication of the 2019 TAPR. This new analysis has supported the development of new strategies and options providing an opportunity to deliver positive outcomes for customers in the longer term.

Possible asset retirements within the 10-year outlook period[17]

Callide A to Gladstone South 132kV transmission double circuit line

The 132kV transmission line was constructed in the mid-1960s to support the loads in the Gladstone area. Due to reconfiguration in the area, this transmission line will be retired from service at the end of technical service life within the 10-year outlook period.

5.7.6 Wide Bay zone

Existing network

The Wide Bay zone supplies loads in the Maryborough and Bundaberg region and also forms part of Powerlink's eastern Central Queensland to South Queensland (CQ-SQ) transmission corridor. This corridor was constructed in the 1970s and 1980s and consists of single circuit 275kV transmission lines between Calliope River and South Pine (refer to Figure 5.8). These transmission lines traverse a variety of environmental conditions and as a result exhibit different corrosion rates and risk profiles.

Figure 5.9 CQ-SQ transmission network

Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required in the Wide Bay zone within the next five years to meet reliability obligations.

Transmission network overview

In the NEM, generators compete for dispatch. Briefly, a generator's dispatch level depends on its bid in relation to other generators' bids, demand and available transmission capacity. Congestion occurs when transmission capacity prevents the optimum economic dispatch. Affected generators are said to be 'constrained' by the amount unable to be economically dispatched. Forecast of market constraint durations and levels are sensitive to highly uncertain variables including changes in bidding behaviour, investment patterns, fuel cost dynamics, environmental conditions and demand levels. It is important to note that there is no load at risk or potential for loss of supply to customers associated with network congestion.

[17] Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

In its current form, the CQ-SQ transmission network offers a great deal of flexibility for possible generation dispatches, however occasionally imposes constraints to market operation. Over time the utilisation of the CQ-SQ grid sections is expected to increase as new NQ and CQ VRE generating systems connect to the transmission network (refer to Section 5.7.5, Section 6.6.4 and Section 7.3.2). In addition, the incidence of congestion may increase as additional southerly transfer capacity on QNI is released following the now committed QNI upgrade project (refer to Section 5.7.14). The incidence of congestion may increase if further upgrades to QNI are shown to be economically justified (refer to Section 7.3.2).

The 2020 ISP identified a Central to Southern Queensland network project as a Future ISP project with a timing in the mid-2030s, recommending that Powerlink undertake preparatory activities to better inform the optimal timing in future revisions of the ISP.

Possible network reinvestments within five years

Network reinvestments in Wide Bay zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the Wide Bay zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Transmission Lines

Potential consultation: Maintaining reliability of supply between central and southern Queensland

The coastal CQ-SQ transmission network between Calliope River and South Pine substations was progressively developed in the 1970s and 1980s to support loads in the Gladstone area and facilitate power transfer between central and southern Queensland. This corridor provides the major injection points at Gin Gin, Teebar Creek, Woolooga and Palmwoods 275/132kV for the Wide Bay and Sunshine Coast areas. The Ergon Energy 132kV and Energex 132/110kV sub-transmission systems supply bulk supply points in these areas.

The coastal CQ-SQ transmission network assets are expected to reach the end of their technical service life within the next 20 years. A key consideration is that this corridor is comprised solely of single circuit 275kV towers that may make cost effective refit strategies less viable compared to double circuit tower rebuilds.

Project driver:

Emerging condition and compliance risks related to structural corrosion.

With varying distance from the ocean, and localised industrial pollution, the Calliope River to South Pine 275kV single circuit transmission lines are subject to different environmental and atmospheric conditions and have, over time, experienced structural degradation at different rates.

Emerging condition and compliance risks have been identified on the following assets:

Within the next five years:

- Three 275kV single circuit transmission lines from Calliope River to Wurdong Tee built in 1972, 1976 and 1981 (structural repair due to above ground corrosion)
- One 275kV single circuit transmission line from Woolooga to South Pine built in 1972 (structural repair due to above ground corrosion)

Within the next six to 10 years:

- One 275kV single circuit transmission lines from Woolooga to Gin Gin built in 1972 (structural repair due to above ground corrosion)
- Three 275kV single circuit transmission lines from Wurdong Tee to Gin Gin built in 1972, 1976 and 1981 (structural repair due to above ground corrosion)
- One 275kV single circuit transmission line form South Pine to Palmwoods built in 1976 (structural repair due to above ground corrosion)

Project timing: December 2024 to December 2029

Possible network solutions

The current long-term network solution strategy based on existing network topology and requirements, is to rebuild two of the 275kV single circuit transmission lines from Calliope River to South Pine as a double circuit. The third circuit between Calliope and Woolooga substations is expected to be economic to maintain in the medium term through targeted refit, and if this circuit is dismantled in the longer term, supply to Wurdong from Calliope River via a dedicated 275kV double circuit would need to be established. This strategy will be commercially assessed and adjusted to align with future generation and network developments, in particular if further planning analysis identify triggers to increase capacity or alternative network configuration options.

Strategies to address the transmission line sections with advanced corrosion in the five-year outlook will be commercially assessed in consideration of long-term options for reconfiguring the 275kV transmission lines. The longer term network solution options include:

- network rationalisation (potentially three single circuits to one double circuit) involving a staged program of line rebuild of the coastal corridor as a new double circuit 275kV transmission line at the end of the technical service life of the existing circuits;
- network rationalisation (potentially three single circuits to one double circuit) involving a staged rebuild of the coastal corridor as a new double circuit 275kV transmission line at the end of the technical service life of the existing circuits, using a program of targeted line refits to defer rebuild of individual CQ-SQ sections (where this deferral is economic)
- maintaining the existing three single circuit 275kV transmission lines through a combination of stage rebuild and line refit projects; or
- network rationalisation (potentially three single circuits to one double circuit in sections) of the coastal corridor involving staged line refit and rebuild on the coastal corridor, and reinforcement of the CQ-SQ section via reinforcement of the western CQ-SQ transmission corridor.

Proposed network solution within the next 10 years:

- Rebuild of the two of the three single circuit transmission lines between Calliope River and Wurdong Tee as a double circuit at an estimated cost of $27 million by June 2024.
- Line refit works on the remaining single circuit 275kV transmission line between Calliope River Substation and Wurdong Tee at an estimated cost of $6 million by June 2026.
- Targeted refit of the three single circuit transmission lines between Calliope River (Wurdong Tee) and Gin Gin substations at an estimated cost of $75 million by December 2027.
- Line refit works on the 275kV transmission single circuit transmission line between Woolooga and South Pine substations at an estimated cost of $20 to $30 million by June 2026.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

The coastal CQ-SQ transmission network provides essential supply between the generation in central and north Queensland and the loads in southern Queensland. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Powerlink considers that a non-network solution may have material intra-regional and other impacts.

Possible network reinvestments in the Wide Bay zone within five years[18]

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Wide Bay zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.18 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.18. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.18 Possible network reinvestments in the Wide Bay zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Rebuild of the transmission line between Calliope River Substation and the Wurdong Tee (1)	New double circuit transmission line for the first 15km out of Calliope River substation	Maintain supply reliability to the CQ-SQ transmission corridor (and Gladstone zone)	June 2024	Refit the two single circuit 275kV transmission lines	$27m
Line refit works on the 275kV transmission line between Calliope River Substation and Wurdong Tee (1)	Refit the single circuit 275kV transmission line between Calliope River Substation and Wurdong Tee	Maintain supply reliability in the CQ-SQ transmission corridor (and Gladstone zone)	June 2026	Rebuild the 275kV transmission line as a double circuit	$6m
Line refit works on the 275kV transmission line between Woolooga and South Pine substations	Refit the 275kV transmission line between Woolooga and South Pine substations	Maintain supply reliability to the Moreton zone	June 2026	Rebuild the 275kV transmission line between Woolooga and South Pine substations	$20m to $30m

Note:

(1) These reinvestments have been combined into one template "Targeted reinvestment in the 275kV transmission line between Calliope River and (Wurdong Tee) Wurdong substations".

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Wide Bay zone from around 2026/27 to 2030/31 (refer to Table 5.19).

[18] Subject to the outcome of a regulatory consultation, one of the proposed solutions to address voltage limitations in SE Queensland involves the installation of bus reactors at multiple locations in the transmission network, including one at Woolooga Substation (refer to Section 5.7.10).

Table 5.19 Possible network reinvestments in the Wide Bay zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Targeted reinvestment in the 275kV transmission lines between Wurdong Tee and Gin Gin substation	Refit the 275kV transmission line between Wurdong Tee and Gin Gin Substation	Maintain supply to the Wide Bay zone	December 2027	Targeted Refit and partial double circuit rebuild of the 275kV transmission line between Wurdong Tee and Gin Gin Substation New 275kV DCST transmission line	$75m
Line refit works on the 275kV transmission line between South Pine and Palmwoods substations	Line refit works on steel lattice structures	Maintain supply to the Wide Bay zone	June 2028	Rebuild 275kV transmission line between South Pine and Palmwoods substations	$12m
Line refit works on the 275kV transmission line between Gin Gin and Woolooga substations	Rebuild the 275kV transmission line between Gin Gin and Woolooga substations	Maintain supply to the Wide Bay zone	December 2030	Refit the 275kV transmission line between Gin Gin and Woolooga substations	$21m
Substations					
Palmwoods 275kV and 132kV selective primary plant replacement	Selective replacement of 275/132kV primary plant	Maintain supply to the Wide Bay zone	June 2028	Full replacement of 275/132kV primary plant	$15m
Teebar Creek secondary systems replacement	Full replacement of 132kV and 275kV secondary systems	Maintain supply to the Wide Bay zone	June 2028	Selective replacement of 132kV and 275kV secondary systems	$18m
Woolooga 275kV and 132kV selective primary plant and secondary systems replacement	Selective replacement of 275/132kV primary plant and full replacement of 132kV and 275kV secondary systems (including SVC)	Maintain supply to the Wide Bay zone	June 2029	Selective replacement of 132kV and 275kV secondary systems	$38m
Gin Gin 275kV secondary systems replacement	Selective replacement of 275kV secondary systems	Maintain supply to the Wide Bay zone	June 2031	Full replacement of 275kV secondary systems	$10m

Possible asset retirements within the 10-year outlook period

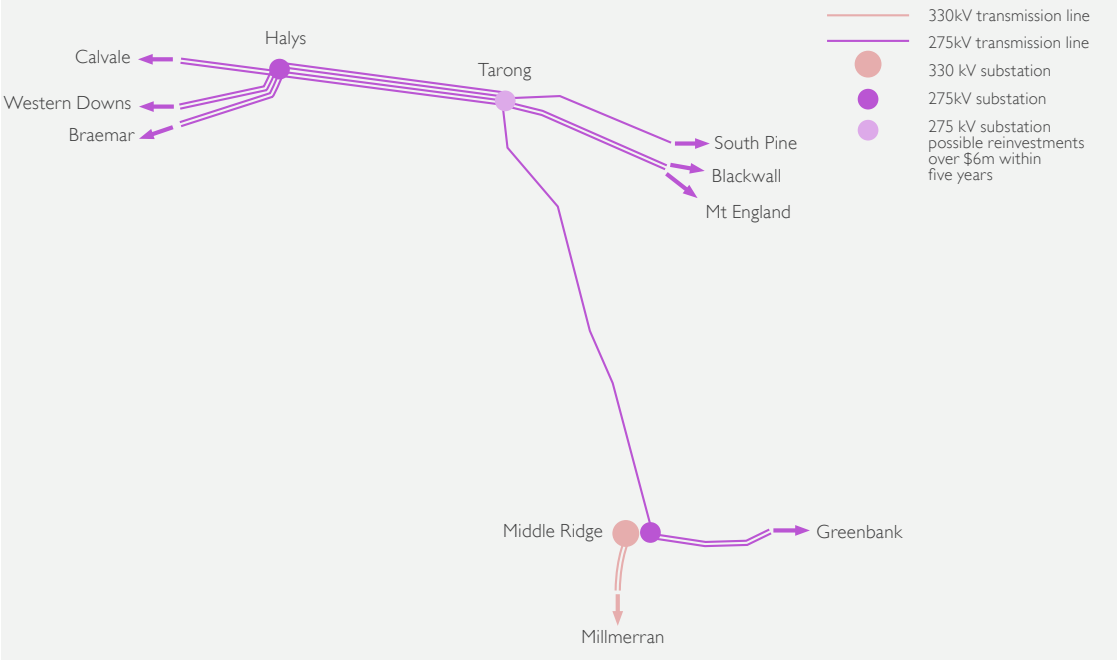
Current planning analysis has not identified any potential asset retirements in the Wide Bay zone within the next 10 years.

5.7.7 South West zone

Existing network

The South West zone is defined as the Tarong and Middle Ridge areas west of Postman's Ridge (refer to Figure 5.10).

Figure 5.10 South West area 275kV network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the South West zone within the next five years to meet reliability obligations.

Possible network reinvestments within five years

Network reinvestments in South West zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the South West zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Substations

Chinchilla 132kV Substation[19]

Chinchilla Substation was commissioned in 1986 to supply bulk electricity to the distribution network in the area and is supplied via double circuit 132kV transmission lines from Tarong and Columboola substations.

[19] While Chinchilla Substation is not located within the South West zone, as part of Powerlink's integrated planning approach to a RIT-T the benefits of a potential network reconfiguration will be undertaken.

Project driver:

Emerging condition and compliance risks.

Chinchilla's secondary systems and the majority of primary plant at Chinchilla Substation are approaching the end of their respective technical lives. The substation's secondary systems and circuit breakers have become obsolete and are no longer supported by the manufacture, with only limited spares available.

Project timing: June 2024

Possible network solutions

- Replace all primary plant and secondary systems at Chinchilla substation
- Transformer-ending the Chinchilla Substation with supply from the Surat Basin network, decommissioning selected primary plant at Chinchilla and reconfiguring the substation's secondary systems

Proposed network solution: Transformer ending Chinchilla substation from Columboola substation at an estimated cost of $8 million by June 2024

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 132kV network at Chinchilla of up to 25MW and up to 400MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Tarong 275kV Substation

Tarong Substation is located in the South West Queensland transmission network and is a critical part of the 275kV network supplying South East Queensland (SEQ). Located approximately 130km north-west of Brisbane, Tarong Substation is a major part of the 275kV transmission backbone connecting generators to the major load centres in the south-east of the State. It also provides the major injection point for local, rural and bulk mining loads in south-west Queensland.

The Tarong Substation was established in conjunction with the Tarong Power Station in 1982. The substation consists of one switchyard of 275kV operating voltage and one switchyard of 132kV and 66kV operating voltages. Powerlink owns the 275kV, 132kV and 66kV assets on site.

Potential consultation: Maintaining reliability of supply in the Tarong and Chinchilla areas

Project driver:

Emerging condition and compliance risks.

Emerging risks arising from the condition of the existing 275/66kV and 275/132kV transformers at Tarong Substation. All four transformers are nearing the end of their respective service lives, with recent condition assessments revealing a range of increasing network and safety risks arising from their continued operation. The fault level rating of these original transformers is also below the present fault level of the substation and operational constraints are required to manage this following a credible contingency event under particular network conditions.

Project timing: June 2024

Possible network solutions

- Maintain network topology by replacement of the two 275/66kV and two 275/132kV transformers
- Network reconfiguration by replacement of the two 275/66kV and decommissioning the two 275/132kV transformers
- Network reconfiguration by replacement of the two 275/66kV and one 275/132kV transformers (while decommissioning the other)
- Network reconfiguration by replacement of both 275/132kV and decommissioning the two 275/66kV transformers and replacing with two 132/66kV transformers

Proposed network solution: Network reconfiguration by replacement of the two 275/66kV transformers at an estimated cost of $16 million by June 2024. The two 275/132kV transformers are to be decommissioned.

Possible non-network solutions

To replace the functionality of one of the existing transformers, a non-network solution would be required to provide up to 50MW and up to 850MWh per day on a continuous basis following an outage of the transformer, and to be in-service within six hours following a contingency to meet the requirements of Powerlink's reliability criteria. The network support would also be required to provide supply for planned outages.

The non-network solution must also be able to provide auxiliary supply to Tarong Power Station, which can be up to 38MW.

Possible network reinvestments in the South West zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the South West zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.20 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.20. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.20 Possible network reinvestments in the South West zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Chinchilla 132kV substation replacement (3)	Selected replacement of 132kV secondary systems and transformer ending from Columboola	Maintain supply reliability in the South West zone	June 2024 (1)	Replacement of the entire 132kV secondary systems and switchyard (2)	$8m
Tarong 275/66kV transformers replacement	Replacement of 275/66kV transformers and decommissioning the 275/132kV transformers at Tarong Substation (3)	Maintain supply reliability in the South West zone	December 2024	Life extension of existing transformers (2)	$16m
Tarong 275kV primary plant replacement	Selected replacement of 275kV primary plant	Maintain supply reliability in the South West zone	June 2025	Full replacement of 275kV primary plant	$2m

Notes:

(1) Based on the most recent analysis and understanding of the risks arising from the condition of the primary plant at Chinchilla Substation, the proposed network solution has been advanced from the possible commissioning date of December 2026 as advised in the 2019 TAPR.

(2) The envelope for non-network solutions is defined in Section 5.7.7.

(3) Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the South West zone from around 2026/27 to 2030/31 (refer to Table 5.21).

Table 5.21 Possible network reinvestments in the South West zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Middle Ridge 275kV and 110kV secondary systems replacement	Selective replacement of 275kV and 110kV secondary systems	Maintain supply reliability in the South West zone	December 2026	Full replacement of 275kV and 110kV secondary systems	$38m
Oakey 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the South West zone	June 2029	Staged replacement of 110kV secondary system	$3m
Tarong 275kV secondary systems replacement	Selective replacement of 275kV secondary systems	Maintain supply reliability in the South West zone	June 2030	Full replacement of 275kV secondary systems	$16m

Possible asset retirements within the 10-year outlook period[20]

Condition assessment has identified emerging condition risks arising from the condition of two 275/132kV transformers at Tarong Substation by 2024. Planning studies have confirmed the potential to subsequently retire both transformers based on AEMO's Central scenario forecast discussed in Chapter 2. Consequently, it is considered likely the 275/132kV transformers at Tarong Substation will be retired at end of technical service life.

Condition assessment has identified emerging condition risks arising from the condition of 132kV primary plant at Chinchilla Substation by 2024. At this time, an option would be a reduced scope replacement that would involve transformer ending from Columboola 132kV Substation, and retirement of the 132kV primary plant arising from the connection to Tarong Substation.

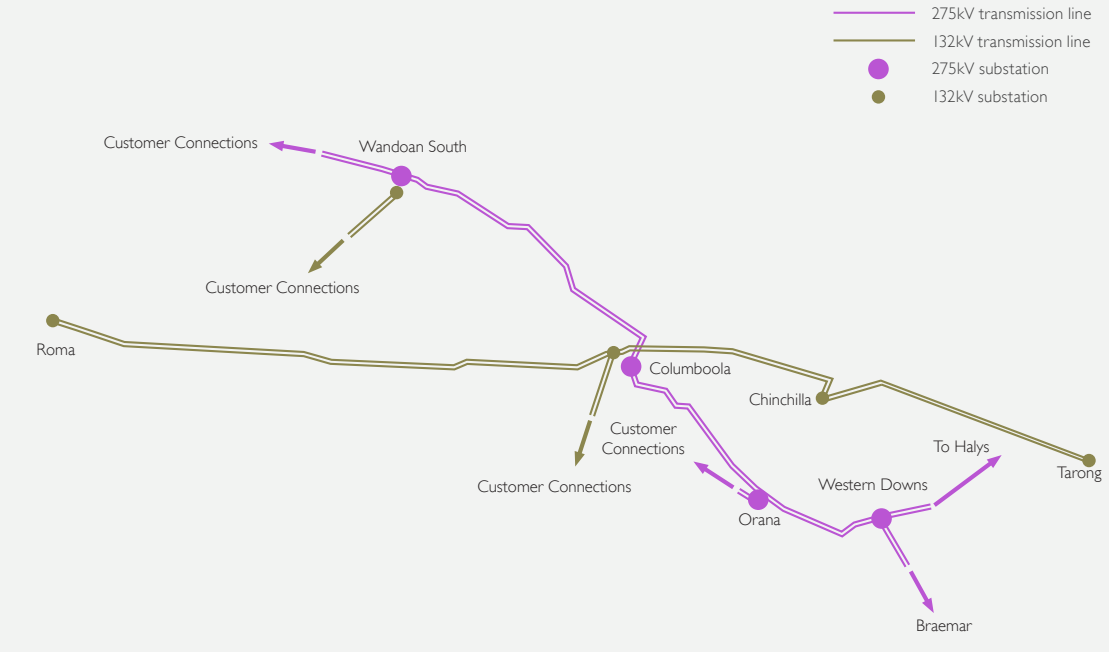
5.7.8 Surat zone

Existing network

The Surat Basin zone is defined as the area north west of Western Downs Substation. The area has significant development potential given the vast reserves of gas and coal and more recently VRE. Electricity demand in the area is forecast to continue to grow due to new developments of VRE projects, coal seam gas (CSG) upstream processing facilities by multiple proponents, together with the supporting infrastructure and services (refer to Figure 5.11).

[20] Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

Figure 5.11 Surat Basin North West area transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the Surat zone within the next five years to meet reliability obligations.

Possible network reinvestments within the 10-year outlook period

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Surat zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.21 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.21. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Surat zone towards the end of the 10-year outlook period, from around 2026/27 to 2030/31 (refer to Table 5.22).

Table 5.22 Possible network reinvestments in the Surat zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Columboola 132kV secondary system replacement	Selective replacement of 132kV secondary systems	Maintain supply reliability in the Surat zone	June 2031	Full replacement of secondary systems	$15m

Possible asset retirements within the 10-year outlook period

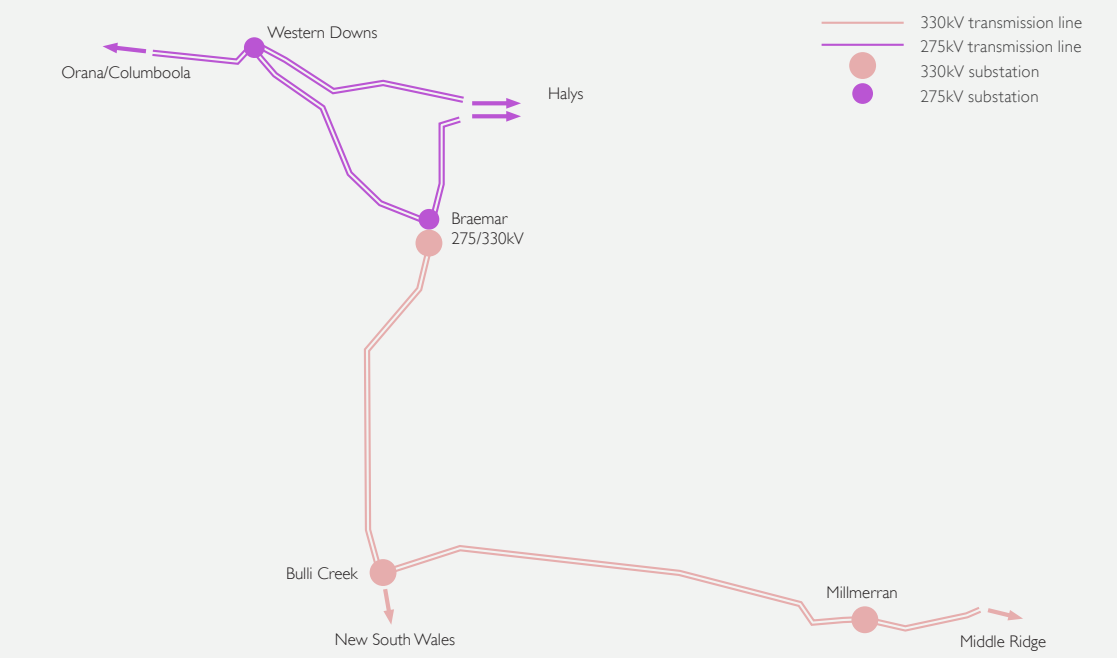
Current planning analysis has not identified any potential asset retirements in the South West zone within the 10-year outlook period.

5.7.9 Bulli zone

Existing network

The Bulli zone is defined as the area surrounding Goondiwindi and the 275/330kV network south of Kogan Creek and west of Millmerran (refer to Figure 5.12).

Figure 5.12 Bulli area transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the Bulli zone within the next five years to meet reliability obligations.

Possible network reinvestments in the Bulli zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Bulli zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.23 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.23. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Network reinvestments in the Bulli zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the North zone into the future. This may result in like for like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Table 5.23 Possible network reinvestments in the Bulli zone within five years[21]

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Millmerran 330kV secondary systems replacement	Selective replacement of 330kV secondary systems	Maintain supply reliability in the Bulli zone	June 2025	Full replacement of secondary systems	$5m

Possible network reinvestments within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Bulli zone from around 2026/27 to 2030/31 (refer to Table 5.24).

Table 5.24 Possible network reinvestments in the Bulli zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Bulli Creek 330/132kV transformer replacement	Replace one 330/132kV transformer at Bulli Creek Substation	Maintain supply reliability in the Bulli zone	June 2031	Retirement of 330/132kV transformers with non-network support	$7m

Possible asset retirements within the 10-year outlook period

Current planning analysis has not identified any potential asset retirements in the Bulli zone within the 10-year outlook period.

5.7.10 Moreton zone

Existing network

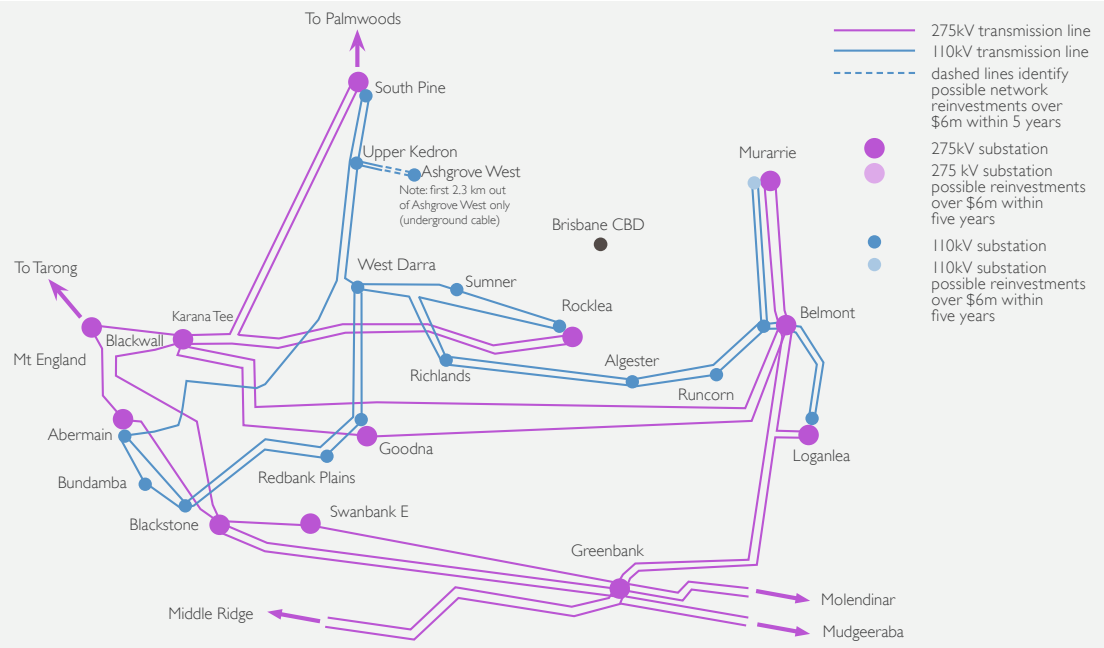
The Moreton zone includes a mix of 110kV and 275kV transmission networks servicing a number of significant load centres in SEQ, including the Sunshine Coast, greater Brisbane, Ipswich and northern Gold Coast regions (refer to Figure 5.13).

Future investment needs in the Moreton zone are substantially arising from the condition and performance of 110kV and 275kV assets in the greater Brisbane area. The 110kV network in the greater Brisbane area was progressively developed from the early 1960s and 1970s, with the 275kV network being developed and reinforced in response to load growth from the early 1970s. Multiple Powerlink 275/110kV injection points now interconnect with the Energex network to form two 110kV rings supplying the Brisbane Central Business District (CBD).

[21] Based on the most recent condition assessment and on the scope of works required, Bulli Creek 132kV secondary systems replacement listed in the 2019 TAPR will be addressed by an operational project.

5 Future network development

Figure 5.13 Greater Brisbane transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2 and the committed generation described in tables 6.1 and 6.2, there is no additional capacity forecast to be required in the Moreton zone within the next five years to meet reliability obligations.

Possible network investments to address non-load driven network constraints in the next five years

Potential consultation: Managing voltages in south-east Queensland

High voltages associated with light load conditions are currently managed in south-east Queensland with existing reactive sources and operational methods. Voltage control is forecast to become increasingly challenging for longer durations, as minimum demand continues to fall.

Project driver:

Voltage control during light load conditions.

Powerlink has identified a need for additional reactive support, to:

- Maintain voltages within operational and design limits during minimum demand periods, to maintain the power system in a secure operating state
- Reduce reliability and system strength impacts from the de-energisation of transmission lines

Project timing: December 2023

Possible network solutions

- Installation of three bus reactors, one each at Woolooga, Blackstone and Greenbank substations.
- Installation of three bus reactors, one each at Woolooga, Blackstone and Belmont substations.

Proposed network solution: Installation of three bus reactors, one each at Woolooga, Blackstone and Greenbank substations, at an estimated cost of $27 million by December 2023

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

To address the requirement, Powerlink would be seeking additional voltage control in SEQ which is able to provide sufficient voltage control to various locations in the Moreton region. The nature of this limitation is that the voltage control would be required to operate on a continuous basis.

Possible network reinvestments within five years

Network reinvestments in Moreton zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the Moreton zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Transmission lines

The 110kV and 275kV transmission lines in the greater Brisbane area are located between 20km and 40km from the coast, traversing a mix of industrial, high density urban and semi-urban areas. The majority of assets are reasonably protected from the prevailing coastal winds and are exposed to moderate levels of pollution related to the urban environment. These assets have, over time, experienced structural corrosion at similar rates, with end of technical service life for most transmission line assets expected to occur towards to end of the 2020s and into the early 2030s.

With the maximum demand forecast relatively flat in the next five years, and based on the development of the network over the last 40 years, planning studies have identified a number of 110kV transmission line assets that could potentially be retired. Given the uncertainty in future demand growth, Powerlink proposes to implement low cost maintenance strategies to keep the transmission lines in-service for a reasonable period. Future decommissioning remains an option once demand growth is better understood.

Detailed analysis will be ongoing to evaluate the possible retirement of the following transmission lines at the end of technical service life:

- West Darra to Upper Kedron
- West Darra to Goodna
- Richlands to Algester.

This ongoing review, together with further joint planning with Energex, may result in a future RIT-T in the late 2020s.

Underground 110kV cable between Upper Kedron and Ashgrove West

Potential consultation: Maintain reliability of supply to the Brisbane metropolitan area

The 110kV transmission line between Upper Kedron and Ashgrove West substations was established in 1978, as one of the principle sources of supply to the north-west Brisbane area. Predominantly an overhead transmission line, with the final 2.3km long section to Ashgrove West Substation being an underground cable.

Project driver:

Emerging condition, end of technical service life and compliance risks for the Upper Kedron to Ashgrove West oil-filled underground cables.

Project timing: June 2026

Possible network solutions

- Replacement of the existing cables with new cables in a new easement by June 2026.
- Replacement of existing cables with new cables in the existing easement by June 2026.

Proposed network solution: Replacement of the oil-filled cables with new cables in a new easement at an estimated cost of $13 million by June 2026

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

The Upper Kedron to Ashgrove West cables provide supply of up to 220MW at peak to Brisbane's inner north-west suburbs. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Substations

Redbank Plains 110kV Substation

Potential consultation: Maintaining power transfer capability and reliability of supply at Redbank Plains Substation

Redbank Plains Substation was established to provide electricity to the expanding communities west of Brisbane in 1986 and serves as a bulk supply injection point to the Energex distribution network.

Project driver:

Addressing the 110kV primary plant condition risks.

Project timing: June 2024

Possible network solutions

- Replacement of selected 110kV primary plant by June 2024
- Full replacement of 110kV primary plant by June 2024

Project driver:

Emerging condition driven risks arising from the condition of the existing 110/11kV transformers.

Redbank Plains 110/11kV 25MVA transformers 1 and 2 were installed onsite in 1985 and 1984 respectively. The transformers exhibit aged paper insulation and increased moisture levels in oil, possibly due to the numerous oil leaks from the main tanks. The high voltage bushings are the original porcelain housed oil insulated paper bushings, which have been in-service well past their technical service life.

Project timing: June 2024

Possible network solutions

- Life extend both 11/11kV transformers by June 2024
- Replace/life extend one 110/11kV transformer and engage non-network support by June 2024

Proposed network solution: Replacement of selected 110kV primary plant and life extension of both 110/11kV transformers at Redbank Plains Substation at an estimated cost of $8 million by June 2024.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Potential non-network solutions would need to provide supply to the 11kV network at Redbank Plains of up to 25MW at peak and up to 400MWh per day. The non-network solution would be required for a contingency and to be able to operate on a continuous basis until normal supply is restored. Supply would also be required for planned outages.

Murarrie 275/110kV Substation secondary systems replacements

Murarrie Substation was established in 2003 as a bulk supply point to service the industrial load around the Brisbane River and port areas. Murarrie secondary systems were commissioned between 2003 and 2006.

Anticipated consultation: Addressing the secondary systems condition risks at Murarrie

Project driver:

Emerging condition and compliance risks arising from the 110kV secondary systems at Murarrie Substation.

Project timing: June 2025

Possible network solutions

- Full replacement of all of the 110kV secondary systems upfront by June 2025
- Staged replacement on 110kV secondary systems by June 2025

Proposed network solution: Full replacement of the 110kV secondary systems at Murarrie Substation at an estimated cost of $21 million by June 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Murarrie Substation provides injection and switching to the CBD and south-eastern suburbs of Brisbane of over 300MW at peak. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Ashgrove West 110kV Substation

Ashgrove West Substation was established in 1979 to meet increased demand in the Brisbane CBD and the expanding residential areas to the north and west of Brisbane.

Anticipated consultation: Addressing the secondary systems condition risks at Ashgrove West

Project driver:

Emerging condition and compliance risks arising from the 110kV secondary systems at Ashgrove West Substation.

Project timing: June 2025

Possible network solutions

- Full replacement of all of the 110kV secondary systems upfront by June 2025
- Staged replacement on 110kV secondary systems by June 2025

Proposed network solution: Full replacement of the 110kV secondary systems at Ashgrove West Substation at an estimated cost of $6 million by June 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Ashgrove West is a key substation and part of the network supplying of up to 220MW at peak to Brisbane's inner north-west suburbs. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Possible network reinvestments in the Moreton zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Moreton zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.25 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.25 Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.25 Possible network reinvestments in the Moreton zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission Lines					
Replacement of the 110kV underground cable between Upper Kedron and Ashgrove West substations	Replace the 110kV underground cable between Upper Kedron and Ashgrove West substations using an alternate easement	Maintain supply reliability in the Moreton zone	June 2026 (1)	Replace the 110kV underground cable between Upper Kedron and Ashgrove West substations using the existing easement (2)	$13m
Substations					
South-east Queensland bus reactors	Install 275kV bus reactors at Woolooga, Blackstone and Greenbank susbstations	Maintain system voltages within limits	December 2023	Install 275kV bus reactors at Woolooga, Blackstone and Belmont Substations Non-network solution yielding the same voltage control capacity (2)	$27m
Redbank Plains 110kV primary plant and 110/11kV transformers replacement	Selective replacement of 110kV primary plant and life extension of two 110/11kV transformers	Maintain reliability of supply at Redbank Plains Substation	June 2024	Full replacement of 110kV primary plant, replace one 110/11kV transformer and engage non-network support (2)	$8m (3)
Ashgrove West 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2025 (1)	Staged replacement of 110kV secondary systems (2)	$6m
Murarrie 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the CBD and Moreton zone	June 2025 (1)	Staged replacement of 110kV secondary systems	$21m
South Pine 275/110kV transformer life extension	Life extension of a single 275kV/110kV transformer	Maintain supply reliability in the Moreton zone	June 2025 (1)	Retirement of a single 275kV/110kV transformer with non-network support	$2m

Notes:
(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.
(2) The envelope for non-network solutions is defined in Section 5.7.10.
(3) Compared to the 2019 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the scope of works and the construction costs of recently completed projects.

Possible network reinvestments in the Moreton zone within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Moreton zone from around 2026/27 to 2030/31 (refer to Table 5.26).

Table 5.26 Possible network reinvestments in the Moreton zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 110kV transmission line between Belmont and Murarrie substations	Line refit works on steel lattice structures	Maintain supply reliability in the Moreton zone	June 2028 (1)	Rebuild the 110kV transmission lines between Belmont and Murarrie substations	$2m
Line refit works on the 110kV transmission line between Richlands and Algester substations	Refit the 110kV transmission line between Richlands and Algester substations	Maintain supply reliability in the Moreton zone	June 2028 (1)	Potential retirement of the transmission line between Richlands and Algester substations	$2m
Line refit works on the 110kV transmission line between Blackstone and Abermain substations	Refit the 110kV transmission line between Blackstone and Abermain substations	Maintain supply reliability in the Moreton zone	June 2029 (1)	Rebuild the 110kV transmission line between Blackstone and Abermain substations	$8m (2)
Line refit works on the 275kV transmission line between Bergins Hill and Karana Downs	Refit the 275kV transmission line between Bergins Hill and Karana Downs substations	Maintain supply reliability in the Moreton zone	June 2030 (1)	Rebuild or replace the transmission line between Bergins Hill and Karana Downs substations	$4m
Line refit works on the 275kV transmission line between Karana Downs and South Pine	Refit the 275kV transmission line between Karana Downs and South Pine substations	Maintain supply reliability in the Moreton zone	June 2030 (1)	Rebuild the 275kV transmission line between Karana Downs and South Pine substations	$8m
Line refit works on the 110kV transmission lines between Swanbank, Redbank Plains and West Darra substations	Refit the 110kV transmission lines between Swanbank, Redbank Plains and West Darra substations	Maintain supply reliability in the Moreton zone	June 2030 (1)	Rebuild the 110kV transmission lines between Swanbank, Redbank Plains and West Darra substations	$11m (2)

Table 5.26 Possible network reinvestments in the Moreton zone within six to 10 years *(continued)*

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Line refit works on the 275kV transmission line between Bergins Hill, Goodna and Belmont substations	Refit the 275kV transmission line between Bergins Hill, Goodna and Belmont substations	Maintain supply reliability in Moreton zone	December 2030	Rebuild the 275kV transmission line between Bergins Hill, Goodna and Belmont substations	$36m
Substations					
Goodna 275kV and 110kV secondary systems replacement	Full replacement of 275kV and 110kV secondary systems	Maintain supply reliability in the Moreton zone	December 2026 (1)	Staged replacement of 275kV and 110kV secondary systems	$16m
Sumner 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2027 (1)	Staged replacement of 110kV secondary systems	$4m
Greenbank SVC and 275kV secondary systems replacement	Full replacement of 275kV SVC and secondary systems	Maintain supply reliability in the Moreton and Gold Coast zones	June 2028 (1)	Staged replacement of 275kV SVC and secondary systems	$31m
South Pine SVC secondary systems replacement	Full replacement of SVC secondary systems	Maintain supply reliability in the Moreton zone	June 2028 (1)	Staged replacement of SVC secondary systems	$6m
Algester 110kV secondary systems replacements	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2028	Staged replacement of 110kV secondary systems	$10m
West Darra 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2028 (1)	Staged replacement of 110kV secondary systems	$10m
Rocklea 275/110kV transformer replacement	Replacement of one 275/110kV transformer at Rocklea	Maintain supply reliability in the Moreton zone	June 2028 (1)	Life extension of one 275/110kV transformer at Rocklea	$6m (2)
Rocklea 110kV primary plant replacement	Full replacement of 110kV primary plant	Maintain supply reliability in the Moreton zone	June 2028(1)	Staged replacement of 110kV primary plant	$5m (2)
Loganlea 275kV primary plant replacement	Full replacement of 275kV primary plant	Maintain supply reliability in the Moreton zone	June 2028 (1)	Staged replacement of 275kV primary plant	$5m (2)
Bundamba 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2028	Staged replacement of 110kV primary plant	$6m

Table 5.26 Possible network reinvestments in the Moreton zone within six to 10 years *(continued)*

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Goodna 110/33kV transformer augmentation	Installation of a 100MVA 110/33kV transformer	Maintain supply reliability in the Moreton zone	June 2029 (1)	Installation of a smaller 110/33kV transformer and non-network support	$6m
South Pine 275kV primary plant replacement	Staged replacement of 275kV primary plant	Maintain supply reliability in the Moreton zone	June 2030 (1)	Full replacement of 275kV primary plant	$5m (2)
Abermain 110kV secondary systems and primary plant replacement	Full replacement of 110kV secondary systems and staged replacement of primary plant	Maintain supply reliability in the Moreton zone	June 2030	Staged replacement of 110kV secondary systems and primary plant	$13m

Notes:

(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

(2) Compared to the 2019 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the scope of works and the construction costs of recently completed projects.

Possible asset retirements within the 10-year outlook period

Loganlea 110/33kV transformer

Based on the condition of one of the 110/33kV transformers at Loganlea, it is proposed to retire this transformer at the end of technical service life by June 2023. Powerlink considers that this will not impact on the ability to meet the obligations of Powerlink's reliability criteria. Further joint planning will be undertaken prior to a final decision being made.

Confirmed asset retirements within the 10-year outlook period

Belmont 275/110kV transformers

Based on the condition of the two transformers at Belmont Substation, Powerlink has approved projects to retire two of the four 275/110kV transformers by November 2021.

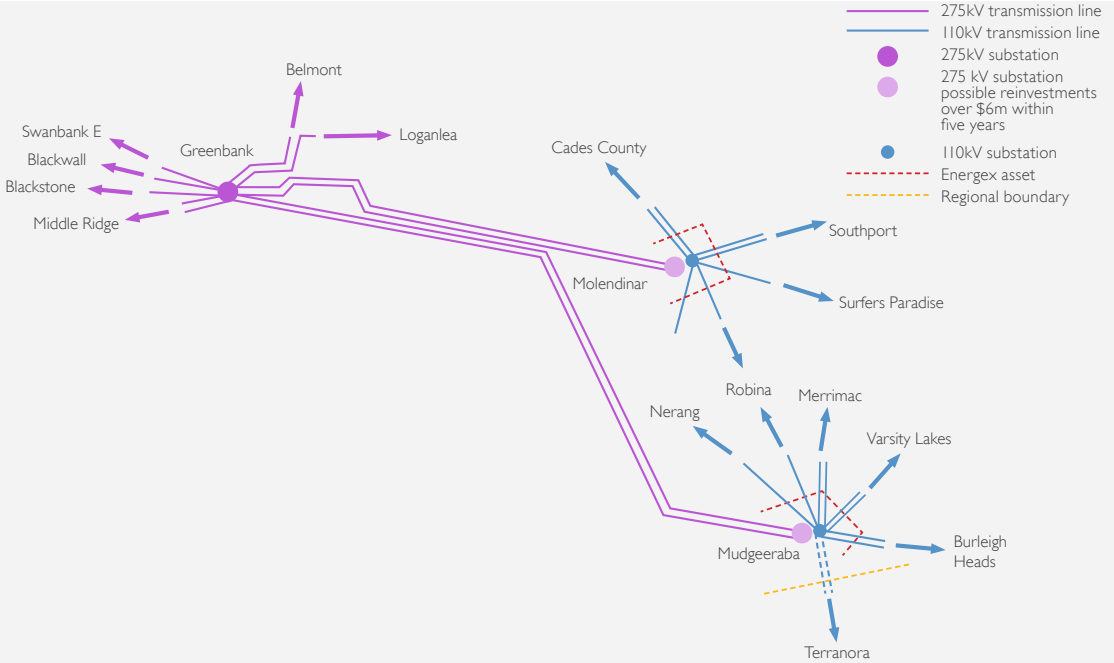
Since publication of the 2019 TAPR, it has been confirmed that retirement of these transformers will not result in load at risk in the Brisbane area. Powerlink considers the retirement of these two transformers will not have a material inter-network impact or a material impact to network users.

5.7.11 Gold Coast zone

Existing network

The Powerlink transmission system in the Gold Coast was originally constructed in the 1970s and 1980s. The Molendinar and Mudgeeraba substations are the two major injection points into the area (refer to Figure 5.13) via a double circuit 275kV transmission line between Greenbank and Molendinar substations, and two single circuit 275kV transmission lines between Greenbank and Mudgeeraba substations (refer to Figure 5.14).

Figure 5.14 Gold Coast transmission network



Possible load driven limitations

Based on AEMO's Central scenario forecast discussed in Chapter 2, there is no additional capacity forecast to be required as a result of network limitations in the Gold Coast zone within the next five years to meet reliability obligations.

Possible network reinvestments within five years

Network reinvestments in Gold Coast zone are related to addressing the risks arising from the condition of the existing network assets, which without corrective action, would result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and Rules' obligations.

By addressing the condition of these existing assets, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to meet the load requirements of customers in the Gold Coast zone into the future. This may result in like-for-like replacement, non-network solutions, network reconfiguration, asset retirement, line refit or replacement with an asset of lower capacity.

Transmission lines

Greenbank to Mudgeeraba 275kV transmission lines

Potential consultation: Maintain reliability of supply to the southern Gold Coast area

The two 275kV single circuit transmission lines were constructed in the mid-1970s and support the supply to Gold Coast and northern NSW.

Project driver:

Emerging condition driven risks related to an unacceptable level of corrosion.

Project timing: December 2028

Possible network solutions

Feasible network solutions to address the risks arising from these transmission lines may include:

- Maintaining the existing 275kV transmission line topography and capacity by way of a targeted line refit by December 2028.
- Replacement at the end of technical service life of the existing single circuits between Mudgeeraba and Greenbank with a new double circuit line, through staged rebuild.
- Decrease in transfer capacity into the Gold Coast and rationalisation of the transmission lines supplying the Gold Coast through a combination of line refit projects and decommissioning of some assets.

Proposed network solution: Maintain the existing topography by way of a targeted line refit at an estimated cost of $30 to $50 million by December 2028

To ensure reliability of supply to customers, the required renewal works will need to be completed in stages outside of summer peak load and outage co-ordination will be complex due to the significant renewal program in the Gold Coast area within the 10-year outlook. Due to these challenges it has been identified that an extended delivery timeframe of at least four years would be required with the potential for works to commence within the next five years.

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

The Greenbank to Mudgeeraba 275kV transmission lines provide injection to the southern Gold Coast and northern NSW area. Powerlink is not aware of any non-network proposals in this area that can address this requirement in its entirety. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Substations

Mudgeeraba 275/110kV Substation

Mudgeeraba 110kV Substation was established in 1972 and extended from the 1980s to 2000s due to load growth and is located within the southern end of zone of the Gold Coast. Further extensions included the establishment of a 275kV switchyard and associated secondary systems in 1992, which was further expanded in 2002. Mudgeeraba 275/110kV Substation is one of two 275kV injection points on the Gold Coast and is a major connection point for supply to the Gold Coast and northern NSW with the 110kV substation supplying distribution points including Robina, Nerang, Broadbeach, Burleigh and Terranora.

Mudgeeraba 110kV secondary systems

Potential consultation: Addressing the 110kV secondary systems condition risks at Mudgeeraba

Project driver:

Emerging condition risks arising from the condition of the 110kV secondary systems.

The 110kV secondary systems at Mudgeeraba were commissioned between 2001 and 2004.

Project timing: December 2025

Possible network solutions

- Staged replacement of the secondary systems components by December 2025.
- Full replacement of all secondary systems by December 2025.

Proposed network solution: Full replacement of secondary systems at an estimated cost of $11 million by December 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Mudgeeraba Substation provides injection and switching to the southern Gold Coast and northern NSW area. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Potential consultation: Addressing the 275kV and 110kV primary plant condition risks at Mudgeeraba

Project driver:

Emerging risks arising from the condition of the 275kV and 110kV primary plants.

Project timing: December 2025

Possible network solutions

- Selected replacement of primary plant by December 2025.
- Full replacement of all primary plant by December 2025.

Proposed network solution: selected replacement of primary plant at an estimated cost of $20 million by December 2025

Powerlink considers the proposed network solution will not have a material inter-network impact.

Possible non-network solutions

Mudgeeraba Substation provides injection and switching to the southern Gold Coast and northern NSW area. Powerlink would consider proposals from non-network providers that can significantly contribute to reducing the requirement in this region, as this may present opportunities in reconfiguring the network that would otherwise not be able to meet Powerlink's planning standard. Non-network solutions may include, but are not limited to local generation or DSM initiatives in the area.

Molendinar 275/110kV Substation

The 275kV secondary systems at Molendinar was originally established in 2003 and 2007, and based on the most recent condition assessment since publication of the 2019 TAPR, is expected to reach the end of technical service life within the 10-year outlook (refer to Table 5.28).

Possible network reinvestments in the Gold Coast zone within five years

Against the backdrop of a rapidly changing electricity sector, Powerlink's planning overview (10-year outlook period of the TAPR) includes consideration of a broad range of options to address the identified needs in the Gold Coast zone. As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 5.27 will be subject to detailed planning to confirm alignment with future reinvestment, optimisation and delivery strategies. This near-term analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works and deliver greater benefits to customers. This will be achieved through improving and further refining options or considering other options, including the associated delivery strategies, from those described in Table 5.27. Information in relation to potential projects, alternatives and possible commissioning needs will be revised annually within the TAPR based on the latest information available at the time.

Table 5.27 Possible network reinvestments in the Gold Coast zone within five years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Substations					
Mudgeeraba 110kV secondary systems replacement	Partial replacement of 110kV secondary systems	Maintain supply reliability in the Gold Coast zone	December 2025 (1)	Full replacement of 110kV secondary systems	$11m (2)
Mudgeeraba 275kV and 110kV primary plant replacement	Selected replacement of 110kV and 275kV equipment	Maintain supply reliability in the Gold Coast zone	December 2025	Staged replacement of 110kV primary plant in existing bays and selected 275kV equipment	$20m

Notes:

(1) The revised timing from the 2019 TAPR is based upon the latest condition assessment.

(2) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

Possible network reinvestments in the Gold Coast zone within six to 10 years

As a result of the annual planning review, Powerlink has identified that the following reinvestments are likely to be required to address the risks arising from network assets reaching end of technical service life and to maintain reliability of supply in the Gold Coast zone from around 2026/27 to 2030/31 (refer to Table 5.28).

Table 5.28 Possible network reinvestments in the Gold Coast zone within six to 10 years

Potential project	High level scope	Purpose	Possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on the 110kV transmission line between Mudgeeraba Substation and Terranora	Targeted line refit works on steel lattice structures	Maintain supply reliability from Queensland to NSW Interconnector	December 2028 (1)	Full line refit New transmission line	$5m
Targeted line refit works on sections of the 275kV transmission line between Greenbank and Mudgeeraba substations	Targeted line refit works on steel lattice structures	Maintain supply reliability in the Gold Coast zone	December 2028 (1)	New double circuit 275kV transmission line	$30m to $50m
Substations					
Molendinar 275kV secondary systems replacement	Full replacement of 275kV secondary systems	Maintain supply reliability in the Gold Coast zone	December 2026 (1)	Selected replacement of 275kV secondary systems	$16m (2)
Mudgeeraba 275/110kV No.1 Transformer Replacement	Replacement of the transformer	Maintain supply reliability to the Gold Coast Region	December 2030	Life extension of the existing transformer	$10m

Notes:

(1) Compared to the 2019 TAPR, the change in timing of the network solution is based upon updated information on the condition of the assets.

(2) Compared to the 2019 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to required scope of works.

Possible asset retirements within the 10-year outlook period

Current planning analysis has not identified any potential asset retirements in the Gold Coast zone within the 10-year outlook period.

5.7.12 Supply demand balance

The outlook for the supply demand balance for the Queensland region was published in the AEMO 2020 Electricity Statement of Opportunity (ESOO)[22]. Interested parties who require information regarding future supply demand balance should consult this document.

5.7.13 Existing interconnectors

The Queensland transmission network is interconnected to the NSW transmission system through the QNI transmission line and Terranora Interconnector transmission line.

The QNI maximum southerly capability is limited by voltage stability, transient stability, oscillatory stability, and line thermal rating considerations (as detailed in Section 6.6.10).

[22] Published by AEMO in August 2019.

The combined QNI plus Terranora Interconnector maximum northerly capability is limited by thermal ratings, voltage stability, transient stability and oscillatory stability (as detailed in Section 6.6.9).

The capability of these interconnectors can vary significantly depending on the status of plant, network conditions, weather and load levels in both Queensland and NSW. It is for these reasons that interconnector capability is regularly reviewed, particularly when new generation enters or leaves the market or transmission projects are commissioned in either region.

5.7.14 Expanding NSW-Queensland transmission transfer capacity

A RIT-T process to consider investment options on the QNI commenced in November 2018 and was completed in December 2019 with the publication of the 'Expanding NSW-Queensland transmission transfer capacity' Project Assessment Conclusion Report (PACR). This RIT-T focussed on consideration of the 2018 ISP recommended Group 1 QNI 'minor' upgrade and investigated the near-term options to increase overall net market benefits in the NEM through relieving congestion on the transmission network between NSW and Queensland. The PACR identified uprating the Liddell to Tamworth transmission lines, installing new dynamic reactive support at Tamworth and Dumaresq, and shunt capacitor banks at Tamworth, Dumaresq and Armidale as the preferred option which is expected to deliver the greatest net benefits. These works are anticipated to be completed by 2022, prior to the closure of Liddell Power Station.

The 2020 ISP identified further upgrades to the QNI capacity as part of the optimal development path. The 2020 ISP identified that this project would reduce costs and enhance system resilience. The project was not yet identified as 'actionable', but is expected to be so in the future. The proposed project is a staged 500kV line upgrade to share renewable energy, storage, and firming services between the regions after the closure of Eraring or to support REZ developments. Each stage is a 500kV line; the first forecast for completion by 2032-33 and the second by 2035-36.

Given the project is anticipated to become 'actionable' in a future ISP, AEMO is requesting that the inputs for this project (cost and capacity) be updated and refined for input into the 2022 ISP process. To that end AEMO has set out in the 2020 ISP, that Powerlink and TransGrid provide preparatory activities in relation to the future staged QNI project by 30 June 2021. Further to the preparatory activities, Powerlink and TransGrid will investigate the potential benefits of additional increases to transmission capacity between NSW and Queensland, beyond the capacity provided by the QNI Minor Upgrade.

Additional transmission capacity would need to deliver net market benefits, which could come from:

- Efficiently maintaining supply reliability in NSW following the closure of further coal-fired generation and the decline in ageing generator reliability
- Facilitating efficient development and dispatch of generation in areas with high quality renewable resources through improved network capacity and access to demand centres
- Enabling more efficient sharing of resources between NEM regions.

Options to deliver these benefits include:

- A 'Virtual transmission line' (VTL) comprised of grid-scale batteries on both sides of a constraint (for bidirectional limit increases), or a grid-scale battery on one side and braking resistor or generator tripping on the other side (for unidirectional limit increases)
- Transmission lines at 500kV or 330kV from Bayswater, Wollar or Liddell (NSW) to southern Queensland.

These options can be optimised with capacity to REZ developments and can be staged by geography, operating voltage and number of circuits to maximise net economic benefits (refer to Section 7.4.1).