CHAPTER 6

Future network development

6 Future network development

Key highlights

- Powerlink continues to be proactive and adapt 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 and network risks
  - assessing dynamic changes in Powerlink's operating environment to ensure network resilience
  - enabling opportunities for the connection of new generation, including variable renewable energy (VRE) where technically and economically feasible to deliver positive benefits to customers
  - 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).
- As recommended by the 2020 ISP and since the publication of the 2020 Transmission Annual Planning Report (TAPR), Powerlink has undertaken the necessary preparatory activities to inform the analysis for the 2022 ISP.

6.1 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 alternatives are considered as options for investment or reinvestment. Submissions for non-network alternatives are invited by contacting networkassessments@powerlink.com.au

6.2 ISP alignment

The 2020 ISP published by AEMO in July 2020 provides an independent, strategic view of the efficient development of the NEM transmission network over a 20-year planning horizon. AEMO's draft 2022 ISP is anticipated to be published in December 2021.

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 10 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.

6.3 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 includes maximising opportunities for the connection of new generation, including VRE where technically and economically feasible. This approach will deliver positive outcomes for customers while ensuring the ongoing safe and reliable supply of electricity and may also 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, inertia, voltage limitations) during the transformation to more VRE generation

[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.

- 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 6.1. 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 Regulatory Investment Test for Transmission (RIT-T). The RIT-T describes the need, the credible options identified and provides the requirements for non-network alternatives.

Table 6.1 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, or where there may be net economic benefits to customers. An increase in network capacity may also unlock synergies to support the development of REZ.
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, abrasive blasting and painting.
Non-network alternatives	Non-network solutions are not limited to, but may include network support and system services from existing and/or new generation, demand side management (DSM) initiatives (either from individual providers or aggregators), and other forms of technologies (such as battery installations). These solutions may reduce, negate or defer the need for network investments.
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.

6.4 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.

6.5 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 11 and existing and committed generation listed in Chapter 8.

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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, including the effects of falling minimum demand, holistically with the emerging condition based drivers as part of the planning process and in conjunction with the most recent ISP.

In Powerlink's Revenue Determination 2023-27[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 Chapter 9.

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), other forms of technology (such as battery installations) and network augmentations.

6.5.1 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. Table 6.2[3] summarises limitations identified in Powerlink's transmission network and noted in AEMO's 2019 and 2020 Network Support and Control Ancillary Services (NSCAS) reports.

[2] Information on Powerlink's Revenue Proposal for the regulatory period is available on Powerlink's website.
[3] Refer to NER Clause 5.12.2(c)(3).

Table 6.2 Limitations in the five-year outlook period

Limitation	Zone	Reason for anticipated limitation	Time limitation may be reached			Reference
			1-year outlook (2021/22)	3-year outlook (up to 2024/25)	5-year outlook (up to 2026/27)	
Managing voltages in Queensland	Central West		2020/21 project in progress (1)			Table 11.6
	Moreton			2022/23 (2)		Section 6.7.10

Notes:

(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 preferred option identified in the RIT-T, installation of a 275k bus reactor at Broadsound Substation, is commissioned in June 2023.

(2) The network risk associated with this limitation is currently being managed through a range of operational measures until such time as the preferred option identified in the RIT-T which is currently underway (i.e. the staged installation of 120MVAr bus reactors at Woolooga, Blackstone and Belmont substations from June 2022 to December 2025, is complete) and/or a non-network solution identified through the RIT-T process is implemented.

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3 there are no other network limitations forecast to occur in Queensland in the next five years[4].

6.5.2 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 change from the previously identified timing. However, there were no forecast network limitations identified in Powerlink's transmission network in the 2020 TAPR which fall into this category in 2021.

6.6 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 Section 6.7.6, 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 3).

Proposals for transmission investments and reinvestments over $6 million are progressed under the provisions of clauses 5.16.3 and 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, including system strength and inertia shortfalls, 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

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

- 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 (Clause 5.18).

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].

6.6.1 Current consultations – proposed transmission investments

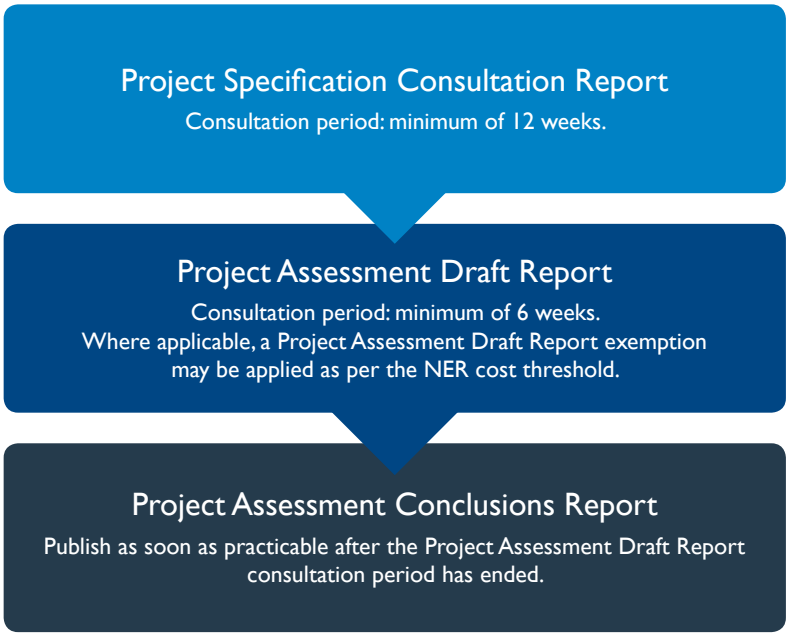
Commencing August 2010 proposals for transmission investments over $6 million addressing network limitations (augmentation works) are progressed under the provisions of Clause 5.16.4 of the NER. In September 2017 this NER requirement, to undertake a RIT-T, was extended[6] to include the proposed replacement of network assets. In July 2018 this was further extended to include proposed investments required to meet system strength and inertia shortfalls[7]. 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).

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 RIT-T consultations undertaken by Powerlink relate to projects which are not actionable ISP projects (refer to Figure 6.1).

5 In accordance with the AER's TAPR Guidelines published in December 2018 and made available in Powerlink's TAPR portal.
6 Replacement expenditure planning arrangements Rule 2017 No. 5.
7 A RIT-T exemption applies if the inertia or system strength services must be made available less than 18 months after the notice is given by AEMO under clauses 5.20B.3(c) and 5.20C.2(c).

6 Future network development

Figure 6.1 Overview of the RIT-T consultation process for projects which are not actionable ISP projects



The consultations completed since publication of the 2020 TAPR are listed in Table 6.3 (refer also to Table 11.6).

Table 6.3 RIT-T consultations completed since publication of the 2020 TAPR

Consultation
Managing voltage control in Central Queensland

RIT-T consultations currently underway are listed in Table 6.4

Table 6.4 RIT-T consultations currently underway

Consultation	Reference
Maintaining reliability of supply in the Cairns region – Stage 1	Section 6.7.1
Addressing the secondary systems condition risks at Innisfail	Section 6.7.1
Maintaining reliability of supply in the Tarong and Chinchilla local areas	Section 6.7.7
Managing voltages in South East Queensland	Section 6.7.10

Note:

(1) The consultations reflect the RIT-T status as at 30 September 2021.

Other consultations (non RIT-T) completed since publication of the 2020 TAPR are listed in Table 6.5.

Table 6.5 Other consultations completed since publication of the 2020 TAPR

Consultation	Reference
Request for system strength services in Queensland to address fault level shortfall at Ross	Section 6.7.1
Developing the Northern Queensland Renewable Energy Zone	Section 6.7.1

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

6.6.2 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 6.7. Table 6.6 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 6.6 Anticipated consultations in the forthcoming 12 months (to October 2022) (1)

Consultation	Reference
Maintaining reliability of supply at Nebo	Section 6.7.3
Maintaining reliability of supply in the Gladstone region	Section 6.7.5
Maintaining reliability to Gladstone South	Section 6.7.5
Managing power transfer capability and reliability of supply at Redbank Plains	Section 6.7.10
Addressing the secondary systems condition risks at Mudgeeraba	Section 6.7.11

Note:

(1) The anticipated consultations listed in Table 6.6 reflect the RIT-T status as at 30 September 2021.

Future ISP projects

The 2020 ISP did not identify any 'actionable' projects within Queensland. However, the 2020 ISP did identify several projects that are part of the optimal development path and may become actionable in future ISPs. Three such projects were nominated for Preparatory Activities. These include:

- QNI Medium and Large interconnector upgrades
- Central to Southern Queensland transmission link
- Gladstone grid reinforcement.

Preparatory activity reports for these projects were provided to AEMO on 30 June 2021 and are discussed further in Section 9.3. The commencement for consultation for these projects will be triggered by future ISPs[8].

6.6.3 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)[9] or be initiated by generators or customers.

Table 6.7 lists possible connection works that may be required within the 10-year outlook period.

[8] Refer to Clause 9.16A.4(c).

[9] In Queensland, Energex and Ergon Energy (part of the Energy Queensland Group) and Essential Energy are the DNSPs.

6 Future network development

Table 6.7 Connection point commitments[10]

Connection point name	Proposal	Zone
Kaban Green Power Hub	New wind farm	North
Kidston Pumped Storage Hydro	New pumped hydro energy storage	North
Moura Solar Farm	New solar farm	Central West
Rodds Bay Solar Farm	New solar farm	Gladstone
Bluegrass Solar Farm	New solar farm	Surat
Wandoan South Battery	New BESS	Surat
Edenvale Solar Farm	New solar farm	Bulli

Notes:

(1) 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.

(2) The listed connection point commitments are at various stages of progress, including the completion of Wandoan South Battery (refer to tables 11.1 and 11.2).

Table 6.8 summarises connection point activities[11] undertaken by Powerlink since publication of the 2020 TAPR. Additional details on potential new generation connections are available in the relevant TAPR template located on Powerlink's TAPR portal as noted in Appendix B.

Table 6.8 Connection point activities

Generator Location	Number of Applications	Number of Connection Agreements	Generator Type and Technology
North	3	2	Solar, Wind, Hydro, Storage
Central	9	0	Solar, Wind, Storage
South	11	2	Solar, Wind, Storage
Total	**23**	**4**	

6.7 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.

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.

[10] AEMO's definition of 'committed' from the System Strength Impact Assessment Guidelines (effective 1 July 2018) has been adopted in the 2021 TAPR.

[11] More broadly, key connection information in relation to the NEM can be found on AEMO's website.

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[12] 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)[13]. 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 2021 annual planning review[14].

An analysis of reinvestment needs and potential limitations has been performed across Powerlink's standard geographic zones (refer to sections 6.7.1 to 6.7.11). For clarity, possible network reinvestments have been separated into two periods.

Possible network reinvestments within five years

This includes the financial period from 2021/22 to 2026/27 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 2027/28 to 2031/32, 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.

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.

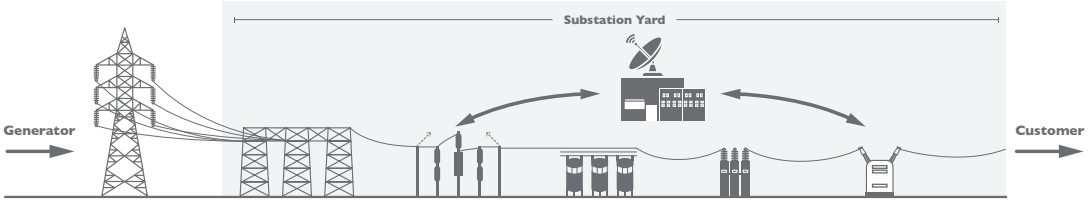
Powerlink also takes a value-driven approach to the management of asset risks to ensure an appropriate balance between reliability and the cost of transmission services which ultimately benefits customers. Each year, taking the most recent assessment of asset condition and risk into consideration, Powerlink 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 2020 TAPR and 2021 TAPR and TAPR Templates. Significant timing differences are noted in the analysis of the program of work within this chapter (refer to sections 6.7.1 to 6.7.11).

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 6.2.

[12] AEMO's 2019 NSCAS Report December 2019, page 9.
[13] NER Clauses 2.12.2(6) and (6A).
[14] NER Clause 5.12.2(c)(1A).

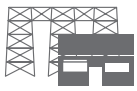
6 Future network development

Figure 6.2 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

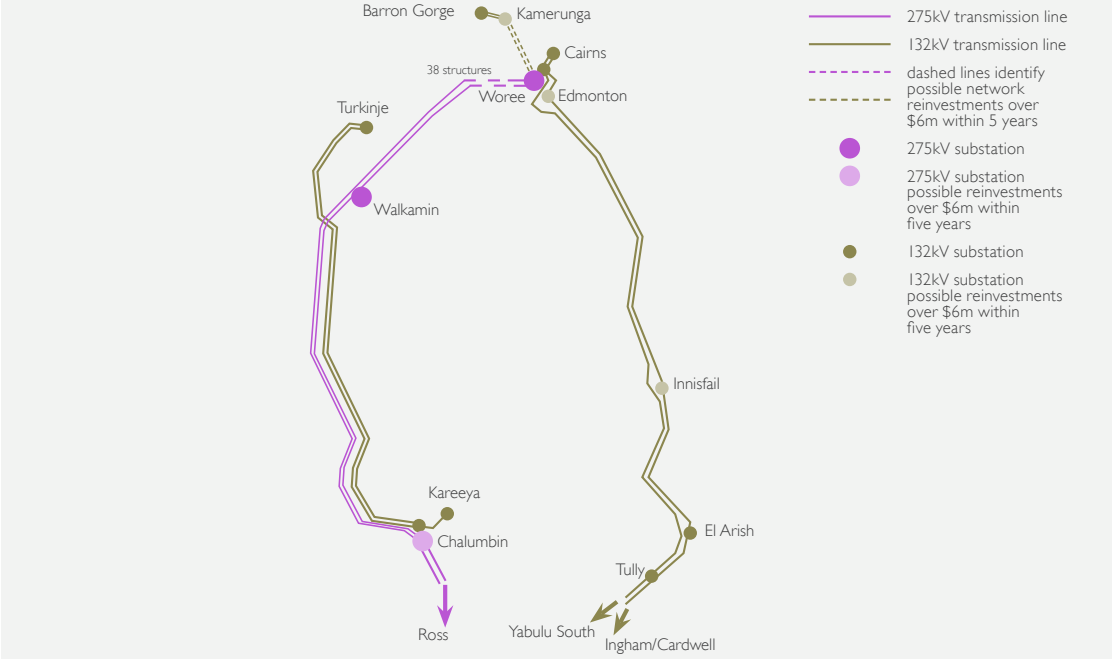
Telecommunication systems are used to transfer a variety of data about the operation and security of the transmission network including metering data for AEMO.

6.7.1 Far North zone

Existing network

The Far North zone is supplied by a 275kV transmission network with major injection points at Chalumbin and Woree, and a coastal 132kV network from Yabulu South to Tully to Woree. This network supplies the Ergon Energy 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 6.3).

Figure 6.3 North zone transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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.

Update on previously reported non-load driven network constraints

On 9 April 2020, the AEMO published a report 'Notice of Queensland System Strength Requirements and Ross Fault Level Shortfall' to the National Electricity Market (NEM) under Clause 5.20C.2(c) of the National Electricity Rules (NER). The report declared an immediate fault level shortfall at the Ross 275kV node and advised that system strength services should be in place to meet this shortfall by 31 August 2021. At that time, the shortfall was forecast by AEMO to continue beyond 2024-25.

Powerlink commenced an expression of interest (EOI) process for both short and long-term solutions to address the Queensland Fault Level Shortfall at Ross in April 2020 and received a very strong response offering a range of system strength support services.

In June 2020, AEMO approved the approach for the short-term solution under NER Clause 5.20C.4(e), up until the end of December 2020. As a result, Powerlink entered into a short-term agreement with CleanCo Queensland to provide system strength services through utilising its assets in Far North Queensland.

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 entered into an agreement with Daydream, Hamilton, Hayman and Whitsunday solar farms in North Queensland to validate the expected positive benefits of inverter tuning during the day time. Powerlink also worked with Mt Emerald Wind Farm and AEMO on changes to control settings.

In December 2020, Powerlink engaged with proponents on the status of the EOI prior to publishing an update document. The update discussed the encouraging results of modelling which indicated that these innovative technical solutions could significantly reduce the overall system strength requirement at Ross, subject to more robust analysis and AEMO's approval.

As a result of retuning of the solar farms and an update of the control settings at Mt Emerald Wind Farm, AEMO's due diligence assessment found that the system strength requirements at the Ross node have changed since the 2020 notice was issued, and that the minimum fault level requirement at Ross is met and no shortfall remained. Please refer to AEMO's Notice published on 28 June 2021.

Based on AEMO's most recent assessment, Powerlink's regional System Strength Service Provider obligations have now been fulfilled in relation to the notice issued in April 2020 under the NER.

Through consultation and active collaboration with all parties, the outcome of this EOI has delivered positive outcomes to customers by implementing innovative cost-effective technical solutions which removed the need for long-term investment (network or non-network).

A summary of Powerlink's EOI process is available in the Final Report published in June 2021.

Developing the Northern Queensland Renewable Energy Zone

The Rules describe a REZ as a geographic area proposed for the efficient development of renewable energy sources and associated electricity infrastructure. REZ development may involve expanding the transmission network or augmenting the capacity of an existing transmission line to increase hosting capacity.

Powerlink has been working with the Queensland Government on strategies to identify opportunities to unlock renewable energy potential in Queensland. Development of the strategy included consideration of the existing transmission network topography in Far North Queensland. The identification of the Northern Queensland Renewable Energy Zone (Northern QREZ) included consideration of the existing transmission network topography in North Queensland, particularly the coastal 132kV double circuit transmission line between Ross and Woree substations which, with modification, has the potential to enable more hosting capacity for renewable generation (refer to Figure 6.4) . The development of the Northern QREZ will potentially unlock up to 500MW of renewable capacity.

In May 2021 the Queensland Government announced that it would invest $40 million in transmission line infrastructure to establish a Northern QREZ, with Neoen's 151MW Kaban Wind Farm identified as the foundational proponent. Given the external nature of the majority of the funding, in June 2021 Powerlink commenced a funded augmentation[15] consultation Developing the Northern Queensland Renewable Energy Zone. Powerlink has also committed approximately $5 million of regulated capital investment to the establishment of the QREZ, the benefits of which, including improved reliability of supply to Cairns, exceed Powerlink's commitment.

All submissions received throughout the consultation process were positive and in support of the development of the Northern QREZ. A Final Report published in September 2021 included the determination to enable the development of the Northern QREZ by establishing a third 275kV connection into Woree Substation by November 2023, with all associated works to commence Quarter 4 2021 and to be completed by November 2023. The scope of work includes:

- Conversion of one side of the coastal 132kV double circuit transmission line to permanently operate at 275kV as the third transmission line between Ross Woree
- Construction of a 275kV bay at Ross Substation
- Installation of a 275/132kV transformer at Tully Substation
- Installation of a 275kV busbar at Woree Substation with associated bays and a line reactor.

[15] Refer to Section 5.18 of the NER.

Figure 6.4 Northern Queensland Renewable Energy Zone

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
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2026
Proposed network solution	Maintaining 132kV network topology by replacing the existing double circuit transmission line with a new double circuit transmission line on a new easement from Woree to Kamerunga substations at an estimated cost of $40 million, by December 2026.

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 275kV network.

In 2014, life extension works were performed on certain components of this transmission line that were nearing the end of their technical service 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.

Possible network solutions

- Maintaining the existing 132kV network topography by replacing the existing double circuit transmission line with a new double circuit transmission line from Woree and Kamerunga substations by December 2026[16]
- Network reconfiguration by establishing two single circuit 132kV transmission lines between Woree and Kamerunga substations, or via Cairns North Substation, by December 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 of up to a peak 70MW, and up to a peak 1,200MWh per day on a continuous basis. It should be noted that this transmission line also facilitates the Barron Gorge Hydro Power Station connection in the area.

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

Ross to Chalumbin to Woree 275kV transmission lines

Current consultation	Maintaining reliability of supply in the Cairns region Stage 1 - Addressing the condition risks of the transmission towers between Davies Creek and Bayview Heights
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2023
Proposed network solution	Refurbishment of the 37 towers between Davies Creek and Bayview Heights through the selected replacement of corroded members and components, along with the painting of all 37 towers by October 2023. The indicative capital cost of the preferred option is approximately $38 million.

Potential consultation	Maintaining reliability of supply in the Cairns region Stage 2 - Addressing the condition risks of the transmission towers between Ross and Chalumbin
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2029
Proposed network solution	Refit the double circuit transmission line between Ross and Chalumbin substations, at an estimated cost of $72 million, by December 2029.

The bulk supply of electricity to the Cairns region in Far North Queensland is provided by generators in Central and Northern Queensland, via a 132kV coastal network and a 275kV inland network, as well as a 'run of the river' hydro power station north of Cairns at Barron Gorge, which is connected to the 132kV network. The majority of supply to the Cairns region is delivered through the inland 275kV network to Ross, near Townsville. From Ross it is transferred via a 275kV transmission line to Chalumbin, continuing via a second 275kV transmission line from Chalumbin to the Woree Substation on the outskirts of Cairns. These 275kV transmission lines also provide connections to the Mt Emerald Wind Farm and Kareeya Power Station.

Due to the environmental sensitivities and geographic conditions which occur in the Cairns region, to ensure reliability of supply to customers, the delivery of the required renewal works will be complex and need to be completed outside of summer peak load and the wet season.

Given the non-homogenous condition of sections of the 384km of transmission line, Powerlink has identified an opportunity to optimise potential reinvestments by applying a prudent and staged approach to address higher risk components in the nearer term. This approach is anticipated to deliver the most economic outcome for customers while providing a uniform end of technical service life for all towers on the transmission 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 37 steel lattice 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. Their extended height resulted in increasing exposure to coastal winds and accelerated degradation.

- The deteriorating condition of 16km of the 275kV Chalumbin to Woree transmission line, from Davies Creek to Bayview Heights, in particular the existing 37 steel lattice towers, require priority action to address their more complex and advanced condition risks and have been proposed under the current Stage 1 RIT-T (Maintaining reliability of supply in the Cairns region – Addressing the condition risks of the transmission towers between Davies Creek and Bayview Heights).

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.

- This section of the transmission line is deteriorating at a slightly slower rate than assets addressed under Stage 1 works, due to its location on the western side of the Great Dividing Range. Additional condition assessment and option analysis has been performed and a potential reinvestment for this section is expected around 2029 compared to 2026 as reported in 2020 TAPR. Hence, Powerlink is proposing this reinvestment to be assessed under a subsequent Stage 2 RIT-T (Maintaining reliability of supply in the Cairns region – Addressing the condition risks of the transmission towers between Ross and Chalumbin).

Undertaking a staged approach to address the risks takes into account:

- the condition and network connectivity of both of the 275kV transmission lines
- ongoing network supply needs in the 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.

Possible network solutions

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

- (Stage 1 RIT-T): Chalumbin to Woree 275kV transmission line (section between Davies Creek and Bayview Heights) by 2023
- (Stage 2 RIT-T): Ross to Chalumbin 275kV transmission line by 2029.

In accordance with the requirements of the RIT-T, Powerlink published a PSCR (with PADR exemption) in March 2021 for the Stage 1 RIT-T which identified two network options:

- Replace critical components and members displaying advanced and early onset of corrosion without painting by October 2023, followed by progressive replacement.
- One-off replacement of critical components displaying signs of advanced corrosion, followed by the complete painting of each tower.

Submissions to the PSCR closed on 8 July 2021.

Subject to the outcome of the RIT-T consultation currently underway, the proposed network solution for Stage 2 is to maintain the 275kV network topology through staged line refit projects of the Ross to Chalumbin 275kV transmission line at an estimated cost of $72 million by December 2029.

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

Possible non-network solutions

The Chalumbin to Woree transmission lines provide injection to the Cairns area of up to 270MW at peak and approximately 900MWh per day. A non-network solution must be capable of operating on a continuous basis. Voltage stability governs the maximum supportable power transfer that can be injected into the Cairns and FNQ area.

The Ross to Chalumbin transmission lines provide injection to the north area of close to 400MW at peak and up to 3,000MWh per day.

It should be noted that the network configuration also facilitates generator connections in the area and provides system strength and voltage support for the region.

Substations

Innisfail 132kV Substation

Current consultation	Addressing the secondary systems condition risks at Innisfail
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.
Project timing	December 2024
Proposed network solution	Full replacement of all secondary systems and associated panels in a new building at an estimated cost of $12 million by December 2024.

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 hydro-electricity 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 2024.

Possible network solutions

- Full replacement of all secondary systems within the existing building by December 2024
- Full replacement of all secondary systems in a new building by December 2024.

In accordance with the requirements of the RIT-T, Powerlink published a PSCR (with PADR exemption) in November 2020. Submissions to the PSCR closed on 5 March 2021.

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 27MW, and up to a 550MWh 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.

Chalumbin 275/132kV Substation

Potential consultation	Addressing the secondary systems condition risks at Chalumbin
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 275kV and 132kV secondary systems.
Project timing	December 2025
Proposed network solution	Selected replacement of secondary systems at an estimated cost of $10 million by December 2025.

Chalumbin Substation was established in 1988 and is an essential bulk supply point for 275kV power transfer into FNQ. The substation has undergone feeder and bay extensions and modifications as well as full 132kV and selected 275kV secondary systems replacement since its original construction between 2012 and 2014. The remaining 275kV secondary systems are anticipated to reach end of technical service life around 2025.

Possible network solutions

- Selected replacement of secondary systems components by December 2025
- Full replacement of secondary systems components by December 2025.

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

Possible non-network solutions

Potential non-network solution must be capable of delivering up to 390MW of power at peak and up to 3,000MWh per day on a continuous basis. It should be noted that the Chalumbin 275/132kV Substation is one of the major injection points to the Far North zone. It also facilitates the Kareeya Power Station connection, and provides voltage support for the region.

Edmonton 132/22kV Substation

Potential consultation	Addressing the secondary systems condition risks at Edmonton
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.
Project timing	June 2026
Proposed network solution	Selected replacement of secondary systems at an estimated cost of $6 million by June 2026.

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. The majority of Edmonton secondary systems are anticipated to reach end of technical service life around 2026.

Possible network solutions

- Selected replacement of secondary systems components by June 2026
- Full replacement of secondary systems components 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 range of options to address the identified needs in the Far North zone. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.9 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.9.

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 6.9 Possible network reinvestments in the Far North zone within five years

Potential project	High level scope	Purpose	Earliest 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 December 2023 (1)	New transmission line (2)	$38m (3)
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	Two 132kV single circuit transmission lines (2)	$40m
Substations					
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	Replacement of selected secondary systems equipment (2)	$12m (3)
Chalumbin 275/132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Far North zone	December 2025	Full replacement of 132kV secondary systems (2)	$10m (3)
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
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

Notes:

(1) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(2) The envelope for non-network solutions is defined in Section 6.7.1.

(3) Compared to the 2020 TAPR, the change 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 2027/28 to 2031/32 (refer to Table 6.10).

Table 6.10 Possible network reinvestments in the Far North zone within six to 10 years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative costs
Transmission Lines					
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 North and Ross zones	Staged works by December 2029 (1)	New transmission line (2)	$72m (3)
275/132kV substation establishment to maintain supply to Turkinje substation (4)	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					
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	Full replacement of all 275kV and 132kV primary plant and secondary systems	$7m
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	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 from the 2020 TAPR is based upon updated information on the condition of the assets.

(2) The envelope for non-network solutions is defined in Section 6.7.1.

(3) Compared to the 2020 TAPR, the change 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) Operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

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

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

Planning analysis has shown that, based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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 6.9).

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

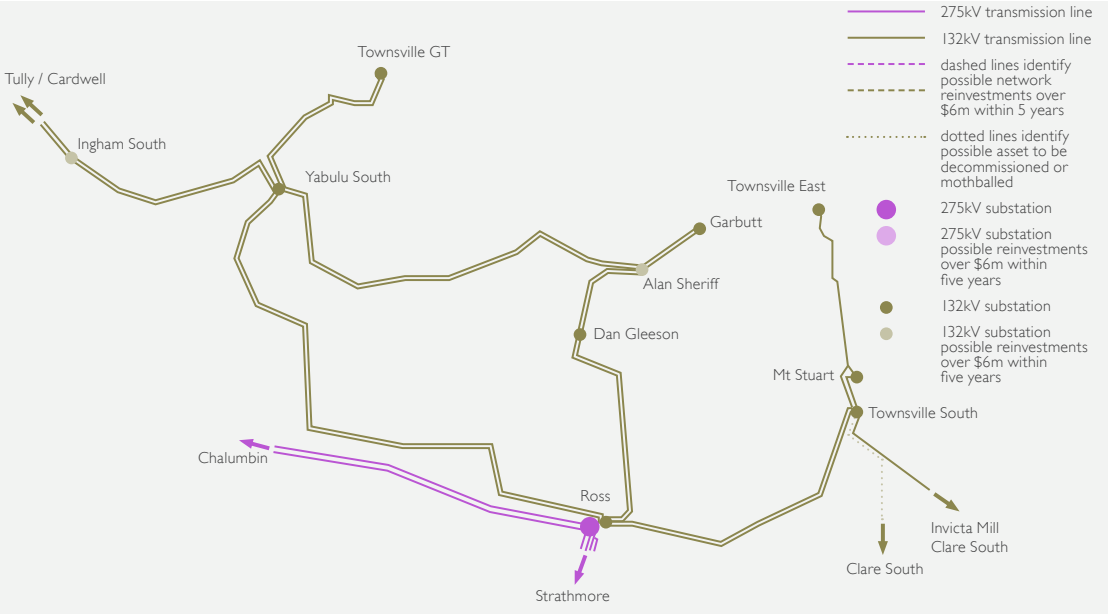
Condition assessment has identified emerging condition risks arising from the condition of the 132kV transmission line between Chalumbin and Turkinje around 2029. At this time, an option would be to establish a 275/132kV switching station near Turkinje to provide 132kV connection and retirement of the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

6.7.2 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 6.5 and 6.6).

Figure 6.5 Northern Ross zone transmission network



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

6 Future network development

Figure 6.6 Southern Ross zone transmission network

Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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 the 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

Alan Sherriff 132kV Substation

Potential consultation	Addressing the secondary systems condition risks at Alan Sherriff
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.
Project timing	June 2025
Proposed network solution	Selected replacement of secondary systems at estimated cost of $11 million by June 2025.

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.

Possible network solutions

- Selected replacement of secondary systems.
- Full replacement of all secondary systems.

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.

Ingham South 132kV Substation

Potential consultation	Addressing the secondary systems condition risks at Ingham South
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 132kV secondary systems.
Project timing	June 2026
Proposed network solution	Full replacement of secondary systems at an estimated cost of $6 million by June 2026.

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 2026.

Possible network solutions

- Selected replacement of the secondary systems components by June 2026.
- Full replacement of all secondary systems and associated panels in a new building 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 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.

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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.10 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.11.

6 Future network development

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 6.11 Possible network reinvestments in the Ross zone within five years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
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
Ingham South 132kV secondary systems replacement	Full replacement of 132kV secondary systems	Maintain supply reliability to the Ross zone	June 2026 (2)	Selected replacement of 132kV secondary systems (1)	$6m

Notes:

(1) The envelope for non-network solutions is defined in this Section 6.7.2.

(2) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

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 2027/28 to 2031/32 (refer to Table 6.12).

Table 6.12 Possible network reinvestments in the Ross zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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 to 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 line between Dan Gleeson and Alan Sheriff substations	Line refit works on steel lattice structures	Maintain supply reliability to the Ross zone	December 2028	New 132kV transmission line	$4m
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	Selected replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2030	Full replacement of secondary systems	$8m
Bowen North 132kV secondary systems replacement	Selected replacement of secondary systems	Maintain supply reliability to the Ross zone	June 2031	Full replacement of 132kV secondary systems	$3m

Possible asset retirements in the 10-year outlook period

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

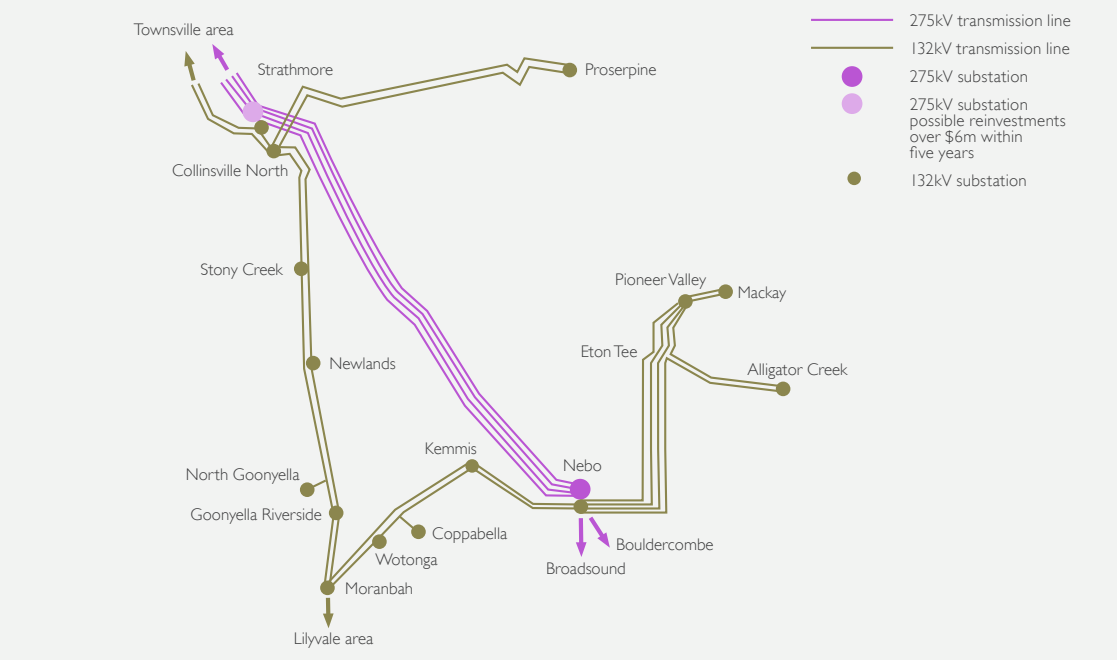
6.7.3 North zone

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 6.7).

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

Figure 6.7 North zone transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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.

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 north Queensland. As a result, voltage control is forecast to become increasingly challenging for longer durations. This is discussed in Section 8.7.3.

Possible network reinvestments within five years

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.

Substations

Strathmore 275/132kV Substation

Potential consultation	Addressing the Static VAr Compensator (SVC) secondary systems condition risks at Strathmore
Project driver	SVC secondary systems condition risks at Strathmore Substation
Project timing	June 2026
Proposed network solution	Full replacement of secondary systems associated with the SVC at Strathmore at an estimated cost of $6 million by June 2026.

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

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 and 132kV switchyard.

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 150MVAr capacitive and 80MVArs inductive.

Nebo 132kV Substation

Anticipated consultation	Maintaining reliability of supply at Nebo
Project driver	Transformer condition risks at Nebo Substation
Project timing	June 2024
Proposed network solution	Replacement of two 132/11kV transformers at an estimated cost of $5 million by June 2026.

Nebo Substation was established in the late 1970s. Nebo was chosen as a location where 275kV marshalling would be required and also as a transformation point to 132kV, to supply local loads in the Moranbah and Mackay area. Two of the transformers have now been in operation for 38 years and are anticipated to reach end of technical service life around 2024.

Possible network solutions

- Replacement of two 132/11kV transformers
- Establish 11kV supply from surrounding network.

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 Nebo up to 3MW at peak and up to 50MWh per day. The non-network solution would be required for a contingency and 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 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 range of options to address the identified needs in the North zone. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.13 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.13.

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 6.13 Possible network reinvestments in the North zone within five years

Potential project	High level scope	Purpose	Earliest 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 2024 (2)	Establish 11kV supply from surrounding network	$5m
Alligator Creek 132kV primary plant replacement	Selected replacement of 132kV primary plant	Maintain supply reliability to the North zone	June 2024 (2)	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	Selected replacement of 132kV secondary systems	$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

Notes:

(1) The envelope for non-network solutions is defined in this Section 6.7.3.

(2) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(3) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to condition and scope of works.

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 2027/28 to 2031/32 (refer to Table 6.14).

Table 6.14 Possible network reinvestments in the North zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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	Selected replacement of 132kV secondary systems equipment	Maintain supply reliability to the North zone	December 2028	Full replacement of 132kV secondary systems	$4m (2)
Strathmore 275kV and 132kV secondary systems	Selected replacement of 275 and 132kV secondary systems in a new prefabricated building	Maintain supply reliability to the North zone	December 2028	Selected replacement of 275kV and 132kV secondary systems in existing panels	$14m
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

Notes:

(1) The revised timing from the 2020 TAPR is based upon the latest condition assessment.

(2) Compared to the 2020 TAPR, the change 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 within the 10-year outlook period

Pioneer Valley to Eton tee 132kV transmission line

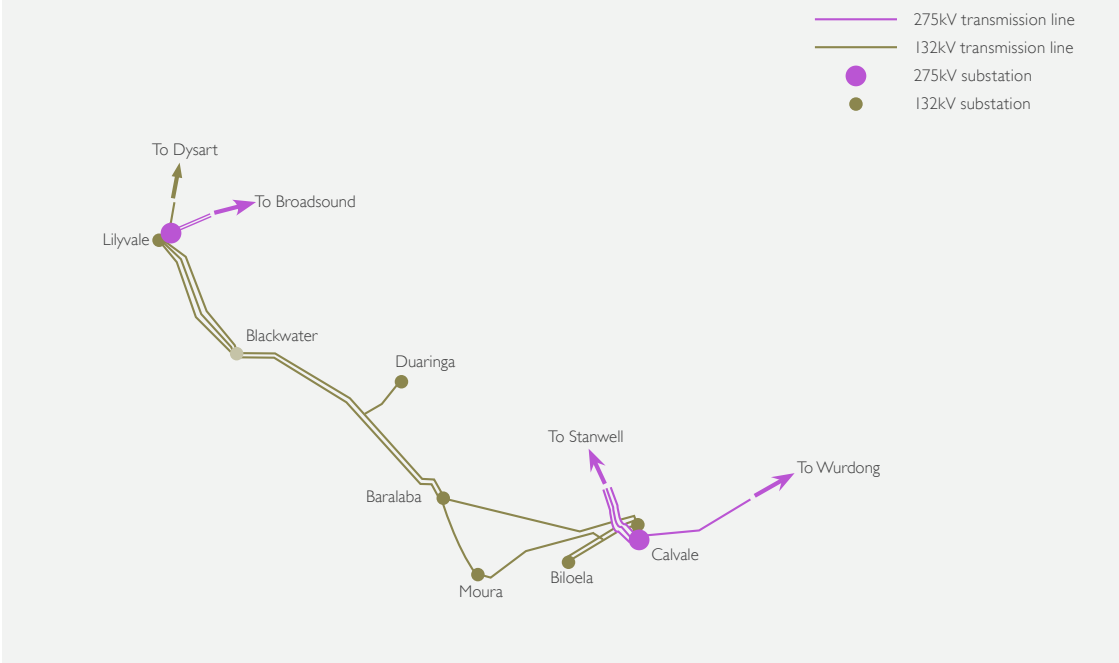
Subject to the outcome of further analysis, Powerlink may retire this inland transmission line at the end of its service life anticipated around 2027, which will also result in the 132kV network reconfiguration from Nebo to Pioneer Valley and Alligator Creek substations, essentially creating a separate double circuit line into each substation.

6.7.4 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 and will require replacement or rebuilding in the near future (refer to Figure 6.8).

Figure 6.8 Central West 132kV transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3 and the committed generation described in tables 8.1 and 8.2, 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 reinvestments within five years

Network reinvestments in the 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

Calvale 275/132kV Substation

Potential consultation	Maintaining reliability of supply at Calvale
Project driver	Addressing the 275kV primary plant condition risks
Project timing	December 2026
Proposed network solution	Selected primary plant replacement at Calvale Substation at an estimated cost of $13 million by December 2026.

Calvale Substation was established in the 1980s and is a critical part of the Central West Queensland transmission network and provides connection to Callide B and C generators. Selected primary plant is anticipated to reach end of technical service life around 2026.

Possible network solutions

- Selected primary plant replacement by December 2026
- Full primary plant replacement by December 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 Moura and Biloela loads of more than 100MW on the 132kV network, and up to 2,000MWh per day on a continuous basis. However Calvale Substation is primarily a major transmission node in Central Queensland connecting power flows between North, Central and Southern Queensland. It also facilitates Callide B and C generation connection, and also provides voltage support for the region.

Broadsound 275kV Substation

Potential consultation	Maintaining reliability of supply at Broadsound
Project driver	Addressing the 275kV primary plant condition risks
Project timing	December 2026
Proposed network solution	Selected primary plant replacement at Broadsound Substation at an estimated cost of $15 million by December 2026.

Broadsound Substation was first established in 1983. Further extensions have been made with additions of 275kV feeders to the West, South and North. Selected primary plant is anticipated to reach end of technical service life around 2026.

Possible network solutions

- Selected primary plant replacement by December 2026
- Full primary plant replacement by December 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 Lilyvale and Blackwater loads of up to 250MW, and up to 6,000MWh per day on a continuous basis. Broadsound Substation is primarily a major transmission node connecting power flows between North and Central Queensland, and also provides voltage support for the region.

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 range of options to address the identified needs in the region. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.15 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.14.

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 6.15 Possible network investments in the Central West zone within five years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
Blackwater 132kV primary plant replacement	Selected replacement of 132kV primary plant	Maintain supply reliability to the Central West zone	June 2025	Full replacement of 132kV primary plant	$3m
Biloela 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply reliability to the Central West zone	June 2025	Full replacement of 132kV secondary systems	$4m
Lilyvale 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain supply to the Central West zone	June 2025	Full replacement of 132kV secondary systems	$3m
Line refit works on the 132kV transmission line between Calvale, Biloela and Moura	Line refit works on the 132kV transmission line and repair selected foundations	Maintain supply reliability to the Central West zone	June 2025 (1)	Rebuild the 132kV transmission lines as a double circuit from Callide A to Moura	$5m
Calvale 275kV primary plant replacement	Selected replacement of 275kV primary plant	Maintain supply reliability to the Central West zone	December 2026	Full replacement of 275kV primary plant	$13m (2)
Broadsound 275kV primary plant replacement	Selected replacement of 275kV primary plant	Maintain supply reliability to the Central West zone	December 2026	Full replacement of 275kV primary plant	$15m
Broadsound 275kV secondary systems replacement	Selected replacement of 275kV secondary systems	Maintain supply reliability to the Central West zone	June 2027	Full replacement of 275kV secondary systems	$4m

Notes:

(1) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(2) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to condition and scope of works.

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 2027/28 to 2031/32 (refer to Table 6.16).

Table 6.16 Possible network reinvestments in the Central West zones within six to 10 years

Potential project	High level scope	Purpose	Earliest 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
Substations					
Blackwater 132kV secondary systems replacement	Selected 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[18]

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 2025, if a new 132kV double circuit transmission line is constructed between Calvale and Moura substations.

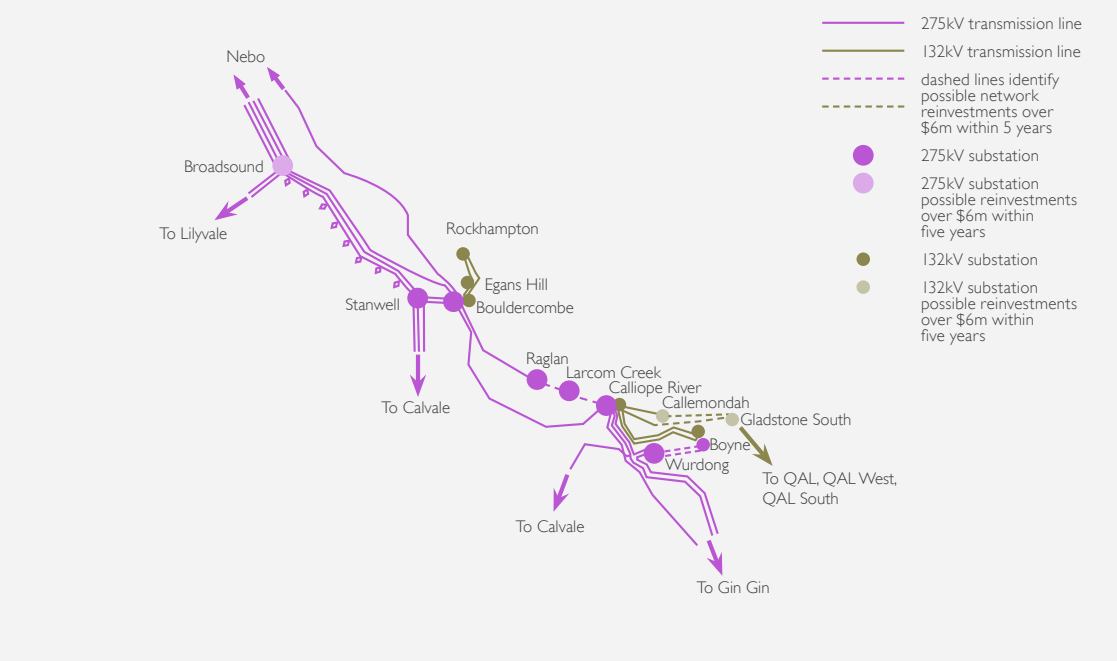
6.7.5 Gladstone zone

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 6.9).

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

Figure 6.9 Gladstone transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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 potentially 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 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
Project driver	Emerging condition risks due to structural corrosion
Project timing	June 2024
Proposed network solution	Line refit works between Larcom Creek and Calliope River (Mt Miller) at an estimated cost of $10 million, by June 2024.

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.

Possible network solutions

- Line refit works on steel lattice structures
- Rebuild the 275kV transmission line between Calliope River and Larcom Creek as single circuit transmission line construction
- Rebuild the 275kV transmission line between Calliope River and Larcom Creek as double circuit transmission line construction.

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 3,200MWh 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

Anticipated consultation	Maintaining reliability of supply in the Gladstone region
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2025
Proposed network solution	Refit the single circuit transmission line between Wurdong and Boyne substations, at an estimated cost of $10 million, by December 2025.

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 of extensive corrosion. The line receives additional maintenance to keep it in a serviceable condition.

Possible network solutions

- Line refit works on steel lattice structures
- Rebuild the 275kV transmission line between Wurdong and Boyne as single circuit transmission line construction
- Rebuild the 275kV transmission line between Wurdong and Boyne as double circuit transmission line construction.

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

Anticipated consultation	Maintaining reliability of supply to Gladstone South
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2023
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.

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).

Possible network solutions

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

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 132kV Substation

Potential consultation	Maintaining reliability of supply at Callemondah
Project driver	Addressing the 132kV primary plant and secondary systems condition risks
Project timing	June 2024
Proposed network solution	Selected primary plant and secondary systems replacement at Callemondah Substation at an estimated cost of $7 million by June 2024.

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.

Possible network solutions

- Full primary plant and secondary systems replacement by June 2024
- Selected primary plant and secondary systems replacement 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 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 range of options to address the identified needs in the Gladstone zone. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

6 Future network development

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.17 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.17.

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 6.17 Possible network reinvestments in the Gladstone zone within five years

Potential project	High level scope	Purpose	Earliest 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	Maintain supply reliability in the Gladstone zone	December 2023	Line refit works on steel lattice structures (1)	$17m
Line refit between Larcom Creek and Mt Miller substation	Line refit works on steel lattice structures	Maintain supply reliability in the Gladstone zone	June 2024 (2)	Rebuild the 275kV transmission line between Mt Miller and Larcom Creek substation (1)	$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 2025 (2)	Rebuild the 275kV transmission line between Wurdong and Boyne Island (1)	$10m (3)
Substations					
Callemondah selected 132kV primary plant and secondary systems replacement	Selected 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 (1)	$7m
Rockhampton 132kV secondary systems replacement	Selected replacement of 132kV secondary systems	Maintain reliability in Rockhampton	December 2026	Full replacement of 132kV secondary systems	$4m

Notes:
(1) The envelope for non-network solutions is defined in Section 6.7.5.
(2) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.
(3) Compared to the 2020 TAPR, the change 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 Gladstone zone from around 2027/28 to 2031/32 (refer to Table 6.18).

Table 6.18 Possible network reinvestments in the Gladstone zone within six to 10 years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Transmission lines					
Line refit works on 275kV transmission line between Mt Miller and Bouldercombe 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 Bouldercombe 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	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	$40m (2)
Line refit works on the 132kV transmission line between Bouldercombe substation and Bouldercombe Tee	Line refit works on steel lattice structures	Maintain supply reliability in the Gladstone zone	December 2030	Rebuild the 275kV transmission line between Bouldercombe and Bouldercombe Tee	$3m
Rebuild the 275kV transmission line between Raglan and Bouldercombe substations	Rebuild the 275kV transmission line between Raglan and Bouldercombe	Maintain supply reliability in the Gladstone zone	June 2032 (1)	Line refit works on steel lattice structures Rebuild the 275kV transmission line between Raglan and Bouldercombe as a single circuit line	$75m
Substations					
Larcom Creek 275kV secondary systems replacement	Selected 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	Selected replacement of 132kV secondary systems	$10m
Pandoin 132kV secondary systems replacement	Full replacement of the 132kV secondary systems	Maintain supply reliability in the Gladstone zone	June 2030	Selected replacement of 132kV secondary systems	$5m

Notes:

(1) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(2) Compared to the 2020 TAPR, the change 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 within the 10-year outlook period[19]

Callide A to Gladstone South 132kV transmission double circuit line

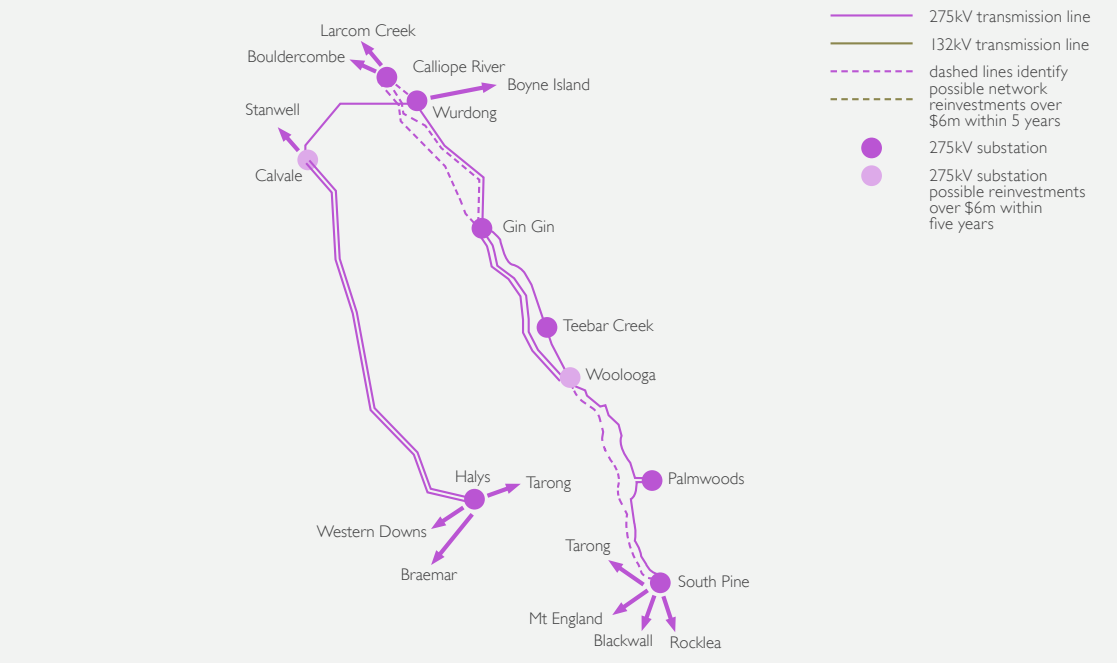
The 132kV transmission line was constructed in the mid-1960s to support the loads in the Gladstone area. Due to reconfiguration in the area, this transmission line will be retired from service at the end of technical service life within the 10-year outlook period.

6.7.6 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 6.10). These transmission lines traverse a variety of environmental conditions and as a result exhibit different corrosion rates and risk profiles.

Figure 6.10 CQ-SQ transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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, plant outages, 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.

[19] 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 may increase when new NQ and CQ VRE generating systems connect to the transmission network. In addition, the incidence of congestion may increase as additional southerly transfer capacity on QNI is released following the completion of the QNI upgrade project currently underway, or decrease with retirement of CQ generation or new NQ/CQ load (refer to Section 6.9.1). The incidence of congestion may increase if further upgrades to QNI are shown to be economically justified (refer to Section 8.6.10).

The 2020 ISP identified a Central to Southern Queensland network project as a Future ISP project with a timing in the mid-2030s. Powerlink provided preparatory activities information to AEMO in June 2021 to better inform the optimal timing in future revisions of the ISP. The 2022 draft ISP is anticipated to be published by AEMO in December 2021 (refer to Section 9.3.1).

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 potentially 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

CQ-SQ transmission lines

Potential consultation	Maintaining reliability of supply between central and southern Queensland
Project driver	Emerging condition and compliance risks related to structural corrosion
Project timing	December 2024 to December 2029
Proposed network solution	Rebuild of 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 2026. 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 $36 million by June 2026.

The coastal CQ-SQ transmission network between Calliope River and South Pine substations was progressively developed in the 1970s and 1980s to 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.

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).

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 economically 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 economically 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.

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.

Possible network reinvestments in the Wide Bay zone within five years[20]

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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as we transform to an energy system underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.19 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.19.

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 6.19 Possible network reinvestments in the Wide Bay zone within five years

Potential project	High level scope	Purpose	Earliest 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 2026 (2)	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	$36m (3)

Notes:

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

(2) The revised timing from the 2020 TAPR is based upon the latest condition assessment.

(3) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

[20] 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 6.7.10).

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 2027/28 to 2031/32 (refer to Table 6.20).

Table 6.20 Possible network reinvestments in the Wide Bay zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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 2032 (1)	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 2032 (1)	Refit the 275kV transmission line between Gin Gin and Woolooga substations	$40m (2)
Substations					
Palmwoods 275kV and 132kV selected primary plant and secondary system replacement	Selected replacement of 275kV and 132kV primary plant and secondary system	Maintain supply to the Wide Bay zone	June 2030 (1)	Full replacement of 275kV and 132kV primary plant and secondary system	$33m (3)
Teebar Creek secondary systems replacement	Full replacement of 132kV and 275kV secondary systems	Maintain supply to the Wide Bay zone	June 2028	Selected replacement of 132kV and 275kV secondary systems	$18m
Woolooga 275kV and 132kV selected primary plant and secondary systems replacement	Selected replacement of 275kV and 132kV primary plant and full replacement of 132kV and 275kV secondary systems (including SVC)	Maintain supply to the Wide Bay zone	June 2029	Selected replacement of 275kV and 132kV secondary systems	$38m
Gin Gin 275kV secondary systems replacement	Selected replacement of 275kV secondary systems	Maintain supply to the Wide Bay zone	June 2031	Full replacement of 275kV secondary systems	$10m

Notes:

(1) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(2) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the construction costs of recently completed projects.

(3) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the condition and scope of works.

Possible asset retirements within the 10-year outlook period

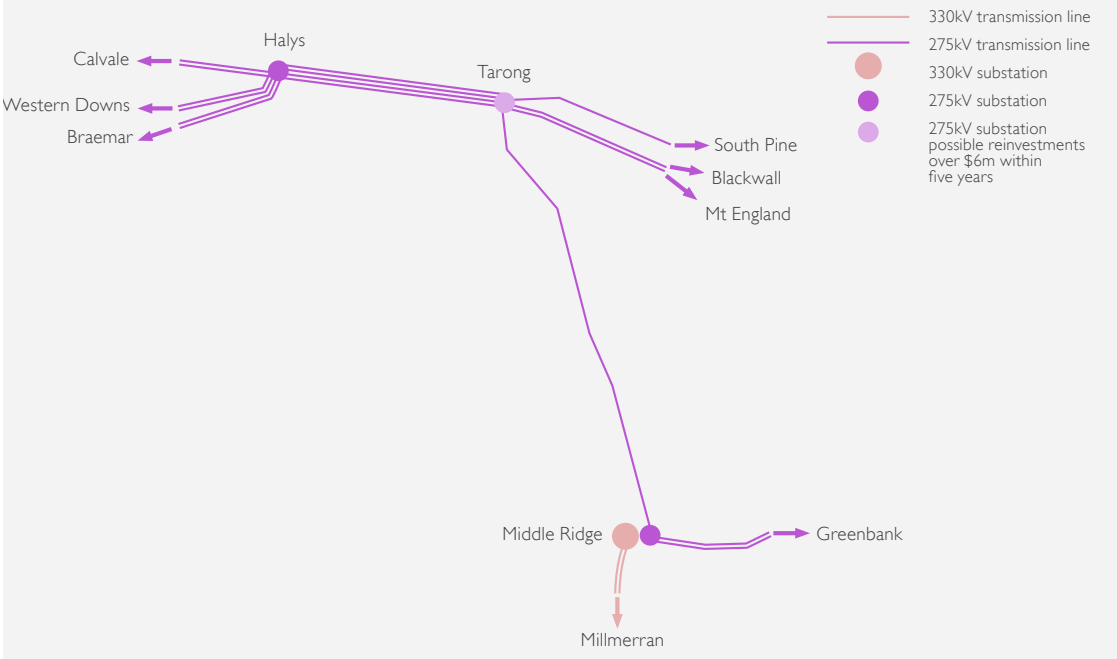
Current planning analysis has not identified any potential asset retirements in the Wide Bay zone within the next 10 years.

6.7.7 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 6.11).

Figure 6.11 South West area 330kV and 275kV network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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 potentially 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[21]

Current consultation	Maintaining reliability of supply in the Tarong and Chinchilla areas
Project driver	Emerging condition and compliance risks
Project timing	December 2025
Proposed network solution	Transformer ending Chinchilla Substation from Columboola Substation at an estimated cost of $11 million by December 2025. Network reconfiguration by replacement of the two 275/66kV transformers at Tarong Substation at an estimated cost of $17 million by December 2025. Decommissioning of the two 275/132kV transformers at Tarong Substation.[22]

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.

Chinchilla's secondary systems and the majority of primary plant 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 manufacturer, with only limited spares available.

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 system 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.

Emerging risks have been identified 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.

Possible network solutions

- Replacement of all at-risk transformers and primary plant at Tarong and Chinchilla substations and secondary systems at Chinchilla Substation
- Reconfigure Chinchilla Substation such that supply is from the Surat Basin network, by replacing selected primary plant and secondary systems, and replacing only two of the four transformers at Tarong. The Chinchilla to Tarong transmission line will be mothballed under this option.

In accordance with the requirements of the RIT-T, Powerlink published a PSCR (with PADR exemption) in August 2021 which identified reconfiguration of the Chinchilla Substation such that supply is from the Surat Basin network, by replacing selected primary plant and secondary systems, and replacing only two of the four transformers at Tarong Substation by 2025 as the preferred option.

Submissions to the PSCR close on 22 November 2021 and Powerlink anticipates publication of the Project Assessment Conclusions Report (PACR) in December 2021.

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

[22] While included in the RIT-T cost benefit analysis, operational works, such as asset retirements, do not form part of Powerlink's capital expenditure budget.

Possible non-network solutions

Non-network solution	Criteria specific to this RIT-T
Replace the functionality of both of the existing 275/66kV transformers	• up to 50MW and up to 850MWh per day on a continuous basis and • auxiliary supply to Tarong Power Station of up to 38MVA
Replace the functionality of one of the existing 275/66kV transformers	• up to 50MW and up to 850MWh per day on a continuous basis following an outage of the remaining transformer • in service within six hours following a contingency • provide supply for planned outages and • auxiliary supply to Tarong Power Station of up to 38MVA

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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as the energy system is transformed, underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.21 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.21.

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.

Table 6.21 Possible network reinvestments in the South West zone within five years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
Chinchilla 132kV Substation replacement	Selected replacement of 132kV secondary systems and primary plant and transformer ending from Columboola (1)	Maintain supply reliability in the South West zone	December 2025 (2)	Replacement of the entire 132kV secondary systems and switchyard (3)	$11m (4)
Tarong 275/66kV transformers replacement	Replacement of 275/66kV transformers and decommissioning the 275/132kV transformers at Tarong Substation (1)	Maintain supply reliability in the South West zone	December 2025 (2)	Life extension of existing transformers (3)	$17m (4)
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	$5m (5)

Notes:

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

(2) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(3) The envelope for non-network solutions is defined in Section 6.7.7.

(4) Compared to the 2020 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.

(5) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to condition and scope of works.

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 2027/28 to 2031/32 (refer to Table 6.22).

Table 6.22 Possible network reinvestments in the South West zone within six to 10 years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
Oakey 110kV secondary systems replacement (1)	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, 132kV and 66kV secondary systems replacement	Selected replacement of 275kV, 132kV and 66kV secondary systems	Maintain supply reliability in the South West zone	June 2030	Full replacement of 275kV, 132kV and 66kV secondary systems	$28m (2)
Middle Ridge 275kV and 110kV secondary systems replacement	Selected replacement of 275kV and 110kV secondary systems	Maintain supply reliability in the South West zone	December 2030 (3)	Full replacement of 275kV and 110kV secondary systems	$38m

Notes:

(1) Currently being evaluated as part of a broader assessment to understand the potential for network optimisation or alternate investment strategies given the potential for VRE generation in south west Queensland.

(2) Compared to the 2020 TAPR, the change in the estimated cost of the proposed network solution is based upon updated information in relation to the scope of works.

(3) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

Possible asset retirements within the 10-year outlook period [23]

Condition assessment has identified emerging condition risks arising from the condition of two 275/132kV transformers at Tarong Substation by 2025 in Table 6.21. Planning studies have confirmed the potential to subsequently retire both transformers based on AEMO's Steady Progress scenario forecast discussed in Chapter 3. 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 2025. 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.

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

6.7.8 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. Utilisation of assets in the area is forecast to continue 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 6.12).

Figure 6.12 Surat Basin North West area transmission network

Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as we transform to an energy system underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.23 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.23.

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.

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 2027/28 to 2031/32 (refer to Table 6.23).

Table 6.23 Possible network reinvestments in the Surat zone within six to 10 years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
Columboola 132kV secondary system replacement	Selected 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

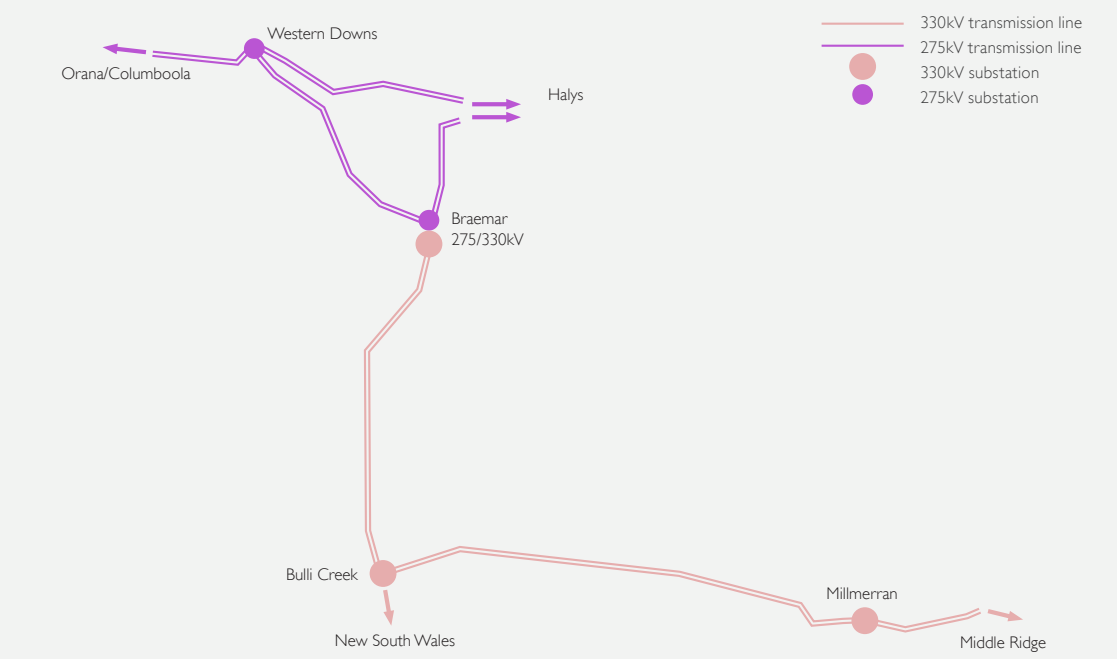
Current planning analysis has not identified any potential asset retirements in the Surat zone within the 10-year outlook period.

6.7.9 Bulli zone

Existing network

The Bulli zone is defined as the area surrounding Goondiwindi and the 330kV and 275kV network south of Kogan Creek and west of Millmerran (refer to Figure 6.13).

Figure 6.13 Bulli area transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as we transform to an energy system underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.24 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.24.

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 potentially 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 Bulli 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 6.24 Possible network reinvestments in the Bulli zone within five years

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
Millmerran 330kV secondary systems replacement	Selected 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 2027/28 to 2031/32 (refer to Table 6.25).

Table 6.25 Possible network reinvestments in the Bulli zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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.

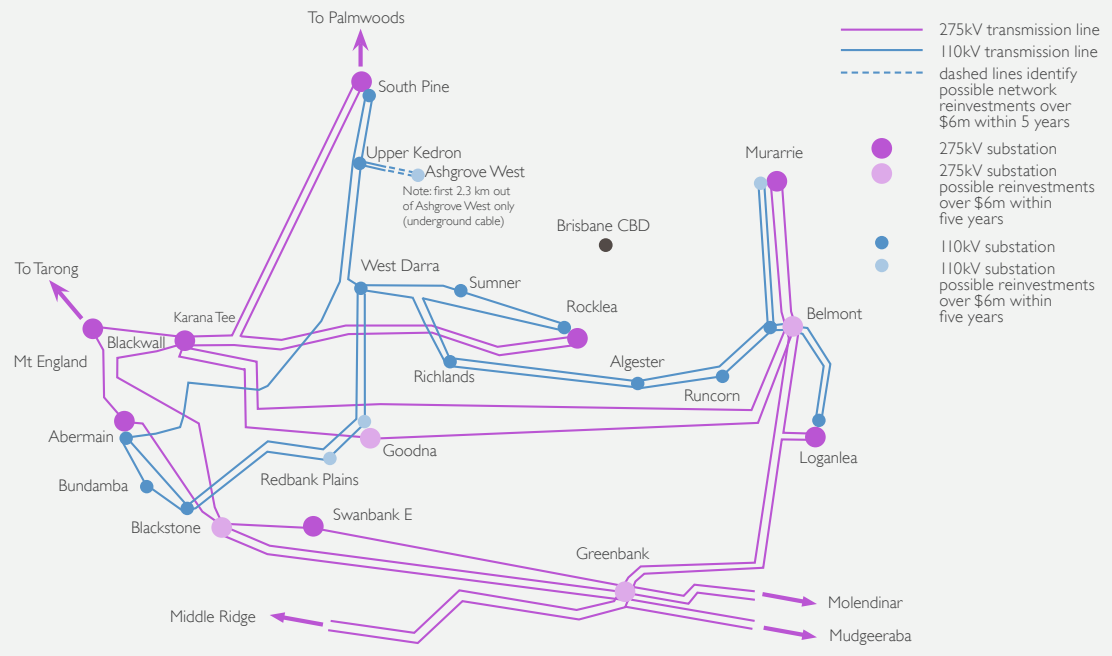
6.7.10 Moreton zone

Existing network

The Moreton zone includes a mix of 275kV and 110kV 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 6.14).

Future investment needs in the Moreton zone are substantially arising from the condition and performance of 275kV and 110kV 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).

Figure 6.14 Greater Brisbane transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3 and the committed generation described in tables 8.1 and 8.2, 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

Current consultation	Managing voltages in South East Queensland
Project driver	Voltage control during light load conditions
Project timing	December 2025
Proposed network solution	Installation of three 120MVAr bus reactors, one each at Woolooga, Blackstone and Belmont substations, at an estimated cost of $30 million by December 2025.

The combination of a declining minimum demand during the day, increasing capacitive nature of the load and the loss of system capacity to absorb reactive power, has created a growing reactive power surplus in both the distribution and transmission networks, during low demand periods. This has resulted in an increased voltage profile and a growing potential for sustained over-voltage events.

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

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.

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
- Installation of 11 reactors on the Energex Network in the Sunshine Coast, Gold Coast and Brisbane areas.

In accordance with the requirements of the RIT-T, Powerlink published a PSCR (with PADR exemption) in July 2021 which identified the installation of 120MVAr bus reactors at Woolooga, Blackstone and Belmont substations by 2025 as the preferred network option. Submissions to the PSCR closed on 29 October 2021 and Powerlink anticipates the publication of the PACR in December 2021.

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

Possible non-network solutions

Under system normal conditions, a complete network support solution would need to provide voltage control equivalent to the proposed three reactors across SEQ, at a nominal 360MVArs. Reactive support would be required to be available on a continuous basis, and not coupled to generation output.

Partial network support solutions designed to address either the declining minimum day time demand or the increasing early morning leading power factor are also encouraged. Where technically and economically feasible, the relevant detailed requirements will be refined with proponents through the submission process to the PSCR and assessed on a case by case basis given the nature of the identified need.

The network support must continue to operate as per system normal for planned and unplanned outages. Outages of the network support must be coordinated to ensure that Powerlink is able to maintain system security at all times.

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
Project driver	Emerging condition, end of technical service life and compliance risks for the Upper Kedron to Ashgrove West underground cables.
Project timing	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.

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

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 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

Anticipated consultation	Maintaining power transfer capability and reliability of supply at Redbank Plains Substation
Project driver	Emerging condition risks of the 110kV primary plant and 110/11kV transformers
Project timing	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.

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.

Redbank Plains 110/11kV 25MVA transformers 1 and 2 were installed 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.

Possible network solutions

- Replacement of selected 110kV primary plant by June 2024
- Full replacement of 110kV primary plant by June 2024
- Life extend both 110/11kV transformers by June 2024
- Replace/life extend one 110/11kV transformer and engage non-network support 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.

Goodna 275/110kV secondary systems replacement

Potential consultation	Addressing the secondary systems condition risks at Goodna
Project driver	Emerging condition and 275kV and 110kV secondary systems compliance risks
Project timing	December 2026
Proposed network solution	Full replacement of the 275kV and 110kV secondary systems at Goodna Substation at an estimated cost of $20 million by December 2026

Goodna Substation was established in 2006 to meet increased demand in the western suburbs of Brisbane, including the emerging Springfield residential and commercial development.

Possible network solutions

- Full replacement of all of the 275kV and 110kV secondary systems by December 2026
- Staged replacement of the 275kV and 110kV secondary systems by December 2026.

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

Possible non-network solutions

Potential non-network solution would need to provide up to 200MW and 3,200MWh of energy each day. The non-network solution would be required to be capable of operating during a contingency or outage on a continuous basis until normal supply can be restored.

Ashgrove West 110kV Substation

Potential consultation	Addressing the secondary systems condition risks at Ashgrove West
Project driver	Emerging condition and 110kV secondary systems compliance risks
Project timing	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.

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.

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.

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.

Murarrie 110kV Substation secondary systems replacements

Potential consultation	Addressing the secondary systems condition risks at Murarrie
Project driver	Emerging condition and 110kV secondary systems compliance risks
Project timing	June 2027
Proposed network solution	Full replacement of the 110kV secondary systems at Murarrie Substation at an estimated cost of $21 million by June 2027.

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.

Possible network solutions

- Full replacement of all of the 110kV secondary systems upfront by June 2027
- Staged replacement on 110kV secondary systems by June 2027.

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.

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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as we transform to an energy system underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.26 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.26.

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 6.26 Possible network reinvestments in the Moreton zone within five years

Potential project	High level scope	Purpose	Earliest 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	In-situ replacement of the 110kV underground cable between Upper Kedron and Ashgrove West substations (1)	$13m
Substations					
Redbank Plains 110kV primary plant and 110/11kV transformers replacement	Selected 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 (1)	$8m
Ashgrove West 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2025	Staged replacement of 110kV secondary systems (1)	$6m
South Pine 275/110kV transformer life extension	Life extension of a single 275kV/110kV transformer	Maintain supply reliability in the Moreton zone	June 2025 (2)	Retirement of a single 275kV/110kV transformer with non-network support	$2m
South-east Queensland bus reactors	Install 275kV bus reactors at Woolooga, Blackstone and Belmont substations	Maintain system voltages within limits	December 2025 (3)	Install 275kV bus reactors at Woolooga, Blackstone and Greenbank substations Non-network solution yielding the same voltage control capacity (1)	$30m (4)
Goodna 275kV and 110kV secondary systems replacement	Full replacement of 275kV and 110kV secondary systems	Maintain supply reliability in the Moreton zone	December 2026	Staged replacement of 275kV and 110kV secondary systems (1)	$20m (3)
Sumner 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the Moreton zone	June 2027	Staged replacement of 110kV secondary systems	$4m
Murarrie 110kV secondary systems replacement	Full replacement of 110kV secondary systems	Maintain supply reliability in the CBD and Moreton zone	June 2027 (1)	Staged replacement of 110kV secondary systems (1)	$21m

Notes:

(1) The envelope for non-network solutions is defined in Section 6.7.10.

(2) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

(3) The change in timing of the network solution from the 2020 TAPR is because on a staged approach in delivery of multiple reactors.

(4) Compared to the 2020 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 2027/28 to 2031/32 (refer to Table 6.27).

Table 6.27 Possible network reinvestments in the Moreton zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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	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	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	Rebuild the 110kV transmission line between Blackstone and Abermain substations	$8m
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	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	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	Rebuild the 110kV transmission lines between Swanbank, Redbank Plains and West Darra substations	$11m
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
Line refit works on the 110kV transmission line between West Darra and Upper Kedron substations	Refit the 110kV transmission line between West Darra and Upper Kedron substations	Maintain supply reliability in Moreton zone	June 2032	Rebuild the 110kV transmission line between West Darra and Upper Kedron substations	$5m

Table 6.27 Possible network reinvestments in the Moreton zone within six to 10 years (*continued*)

Potential project	High level scope	Purpose	Earliest possible commissioning date	Alternatives	Indicative cost
Substations					
South Pine SVC secondary systems replacement	Full replacement of SVC secondary systems	Maintain supply reliability in the Moreton zone	June 2028	Staged replacement of SVC secondary systems	$6m
Goodna 110/332kV 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
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	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	Life extension of one 275/110kV transformer at Rocklea	$6m
Rocklea 110kV primary plant replacement	Full replacement of 110kV primary plant	Maintain supply reliability in the Moreton zone	June 2028	Staged replacement of 110kV primary plant	$5m
Loganlea 275kV primary plant replacement	Full replacement of 275kV primary plant	Maintain supply reliability in the Moreton zone	June 2028	Staged replacement of 275kV primary plant	$5m
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
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 2029 (1)	Staged replacement of 275kV SVC and secondary systems	$31m
South Pine 275kV primary plant replacement	Staged replacement of 275kV primary plant	Maintain supply reliability in the Moreton zone	June 2030	Full replacement of 275kV primary plant	$5m
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
Belmont 33kV and 11kV primary plant replacement	Full replacement of 33kV and 11kV primary plant	Maintain supply reliability in the Moreton zone	December 2029	Staged replacement of 22kV and 11kV primary plant	$5m

Note:

(1) The change in timing of the network solution from the 2020 TAPR is based upon updated information on the condition of the assets.

Possible asset retirements within the 10-year outlook period

Loganlea 110/33kV transformer

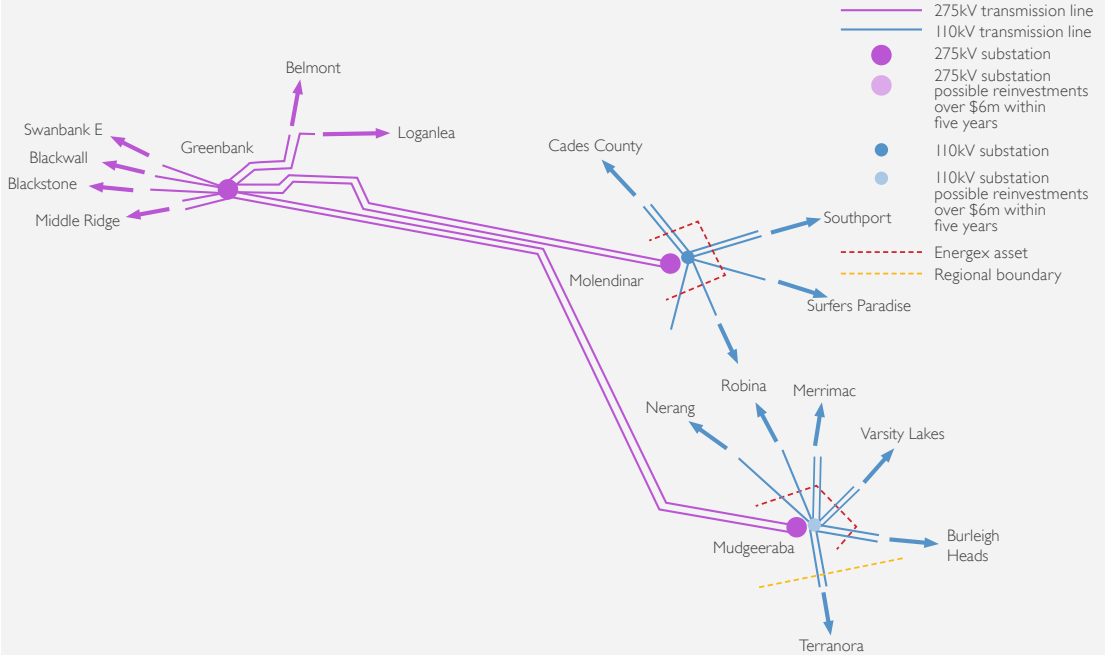
Based on the condition of one of the 110/33kV transformers at Loganlea, it is proposed to retire this transformer at the end of technical service life by June 2023. Powerlink considers that this will not impact on the ability to meet the obligations of Powerlink's reliability criteria. Further joint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

6.7.11 Gold Coast zone

Existing network

The Powerlink transmission system in the Gold Coast zone was originally constructed in the 1970s and 1980s. The Molendinar and Mudgeeraba substations are the two major injection points into the area 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 6.15).

Figure 6.15 Gold Coast transmission network



Possible load driven limitations

Based on AEMO's Steady Progress scenario forecast discussed in Chapter 3, 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	Maintaining reliability of supply to the southern Gold Coast area
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2028
Proposed network solution	Maintain the existing topography by way of a targeted line refit at an estimated cost of $30 to $52 million by December 2028.

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

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.

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 period. 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 to meet 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 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

Anticipated consultation	Addressing the secondary systems condition risks at Mudgeeraba
Project driver	Emerging condition risks arising from the condition of the 110kV secondary systems.
Project timing	December 2025
Proposed network solution	Staged replacement of secondary systems at an estimated cost of $11 million by December 2025.

Possible network solutions

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

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

Potential consultation	Addressing the primary plant condition risks at Mudgeeraba
Project driver	Emerging risks arising from the condition of the 110kV primary plant.
Project timing	December 2025
Proposed network solution	Selected replacement of primary plant at an estimated cost of $20 million by December 2025.

Possible network solutions

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

Molendinar 275kV Substation was established in 2003 and is located in the northern end of Gold Coast zone. The Molendinar Substation is supplied from Greenbank Substation by a 275kV double circuit transmission line. There is currently no 275kV bus at Molendinar, with two 275/110kV transformers supplied transformer ended. There is a long-term enduring need to supply the Gold Coast region through Molendinar Substation.

Molendinar 275/110kV Substation

Potential consultation	Addressing the 275kV secondary systems condition risks at Molendinar
Project driver	Emerging condition risks arising from the condition of the 275kV secondary systems.
Project timing	December 2026
Proposed network solution	Full replacement of secondary systems at an estimated cost of $22 million by December 2026.

Possible network solutions

- Staged replacement of the secondary systems components by December 2026
- Full replacement of all secondary systems by December 2026.

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

Possible non-network solutions

The Molendinar Substation facilitates supply to the Energex loads of Cades County, Molendinar, Southport, Surfers Paradise and Nerang.

To meet the Molendinar demand, the non-network solution must be capable of delivering up to 336MW of power and 3,490MWh of energy each day.

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. In this context, when considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may identify potential network reconfigurations or other options which would be economically assessed under the RIT-T (if applicable). These options may identify opportunities to develop the transmission network in such a way as to realise synergies and efficiencies as we transform to an energy system underpinned by VRE generation, delivering positive outcomes for customers.

As assets approach their anticipated end of technical service life, the potential projects and alternatives (options) listed in Table 6.28 will be subject to detailed analysis to confirm alignment with future reinvestment, optimisation and delivery strategies. This analysis provides Powerlink with an additional opportunity to assess the needs and timing of asset replacement works, further refine options or consider other options, including the associated delivery strategies, from those described in Table 6.28.

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 6.28 Possible network reinvestments in the Gold Coast zone within five years

Potential project	High level scope	Purpose	Earliest 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	Full replacement of 110kV secondary systems (1)	$11m
Mudgeeraba 110kV primary plant replacement	Selected replacement of 110kVequipment	Maintain supply reliability in the Gold Coast zone	December 2025	Staged replacement of 110kV primary plant in existing bays and selected 275kV equipment (1)	$20m
Molendinar 275kV secondary systems replacement	Full replacement of 275kV secondary systems	Maintain supply reliability in the Gold Coast zone	December 2026	Selected replacement of 275kV secondary systems (1)	$22m (2)

Notes:

(1) The envelope for non-network solutions is defined in Section 6.7.11.

(2) Compared to the 2020 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 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 2027/28 to 2031/32 (refer to Table 6.29).

Table 6.29 Possible network reinvestments in the Gold Coast zone within six to 10 years

Potential project	High level scope	Purpose	Earliest 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	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	New double circuit 275kV transmission line	$30m to $52m (1)
Substations					
Mudgeeraba 275/110kV Transformer Replacement	Replacement of the transformer	Maintain supply reliability to the Gold Coast Region	December 2030	Life extension of the existing transformer	$10m

Note:

(1) Compared to the 2020 TAPR, the increase in the estimated cost of the proposed network solution is based upon updated information in relation to required scope of works and the construction costs of recently completed projects.

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.

6.8 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)[24]. Interested parties who require information regarding future supply demand balance should consult this document.

6.9 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 8.6.10).

[24] Published by AEMO in August 2021.

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 8.6.10).

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.

6.9.1 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' 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 market benefits.

The 2020 ISP identified further upgrades to the QNI capacity as part of the optimal development path. These projects are discussed in detail in Section 9.3.

6 Future network development