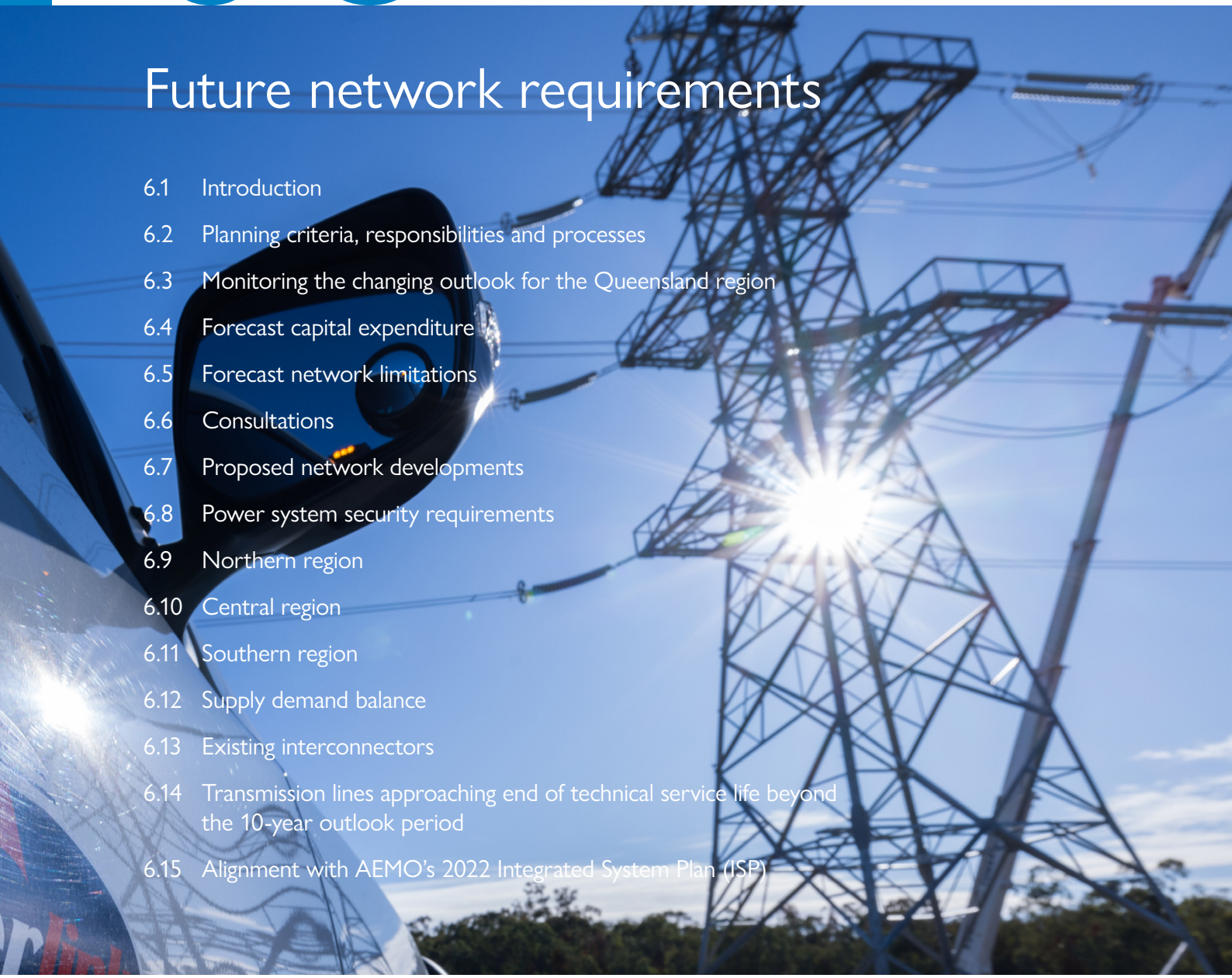
06

Future network requirements



This chapter discusses potential investments required on the transmission network within the 10-year outlook period. It includes information on forecast network limitations, supporting planning criteria and processes, the management of assets and network risks, Regulatory Investment Tests for Transmission (RIT-Ts) and the most recent connection point proposals anticipated to require connection to the transmission network. This chapter also discusses major projects referenced in the 2022 Integrated System Plan (ISP).

Key highlights

- As we move towards 80% renewables by 2035, Powerlink continues to be proactive and adapt to shifts in an increasingly uncertain, technically complex and dynamic operating environment.
- 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, including the potential impacts of the energy transformation
    - the role of emerging technologies and assessing a range of technical factors and dynamic changes in Powerlink's operating environment to ensure network resilience
    - enabling opportunities for the connection of new firming generation and variable renewable energy (VRE) generation where technically and economically feasible to deliver positive benefits to customers
    - actively seeking opportunities to identify and implement more cost effective solutions as demonstrated by Powerlink's Asset Reinvestment Review (ARR), and whenever possible, make use of transmission line and transformer refits or non-network solutions (and services) that avoid or delay the need to establish new transmission network infrastructure.
- The changing generation mix (and associated peak to average production ratios of VRE plant) may lead to increased constraints across critical grid sections. Powerlink considers these potential constraints holistically as part of the planning process and in conjunction with the findings of the most recent Integrated System Plan (ISP) and the Queensland Energy and Jobs Plan (QEJP).
- Powerlink has undertaken the necessary preparatory activities that will inform the analysis for the draft 2024 ISP which will be published by the Australian Market Energy Operator (AEMO) in December 2023.

6.1 Introduction

Powerlink Queensland (Powerlink) 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 transmission system 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))
- inertia and system strength requirements (Clauses 5.20B.4(h) and 5.20C.3(f) and (g)).

This chapter on proposed future network developments contains:

- discussion on Powerlink's planning criteria, processes and integrated planning approach to network development
- information regarding assets reaching the end of their technical 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 AEMO's most recent ISP (Clause 5.12.2.(c)(6)) and 2022 System Strength, Inertia and NSCAS Reports
- a table summarising possible connection point proposals.

Where appropriate, all transmission network, distribution network or non-network alternatives are considered as options for investment. Submissions for non-network alternatives to proposed investments are invited by contacting networkassessments@powerlink.com.au.

6.2 Planning criteria, responsibilities and processes

6.2.1 Powerlink's asset planning criteria

The Queensland Government amended Powerlink's N-1 criterion in 2014 to allow for increased flexibility. The planning standard permits Powerlink to plan and develop the transmission network on the basis that load may be interrupted during a single network contingency event. The following limits are placed on the maximum load and energy that may be at risk of not being supplied during a critical contingency:

- will not exceed 50MW at any one time
- will not be more than 600MWh in aggregate.

The risk limits can be varied by:

- a connection or other agreement made by the transmission entity with a person who receives or wishes to receive transmission services, in relation to those services, or
- agreement with the Queensland Energy Regulator.

Powerlink is required to implement appropriate network or non-network solutions in circumstances where the limits set out above are exceeded or when the probability weighted economic cost of load at risk of not being supplied justifies the cost of the investment. Therefore, the planning standard has the effect of deferring or reducing the extent of investment in network or non-network solutions required. Powerlink will continue to maintain and operate its transmission network to maximise reliability to customers.

Powerlink's transmission network planning and development responsibilities include developing recommendations to address emerging network limitations, or the need to address the risks arising from ageing network assets remaining in-service, through joint planning.

Energex and Ergon Energy (part of the Energy Queensland Group) were issued amended Distribution Authorities from July 2014. The service levels defined in their respective Distribution Authority differ to that of Powerlink's authority. Joint planning accommodates these different planning standards by applying the planning standard consistently with the owner of the asset which places load at risk during a contingency event.

[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.

Powerlink has established policy frameworks and methodologies in place to support its planning standard. These are being applied in various parts of the Powerlink network where possible emerging limitations are being monitored.

6.2.2 Planning processes

Powerlink has obligations that govern how it should address forecast network limitations. These obligations are prescribed by the Act, the NER and Powerlink's Transmission Authority.

The Act requires that Powerlink 'ensure as far as technically and economically practicable, that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid'[2].

It is a condition of Powerlink's Transmission Authority that it meets licence and NER requirements relating to technical performance standards during intact and contingency conditions. The NER sets out minimum performance requirements of the network and connections, and requires that reliability standards at each connection point be included in the relevant connection agreement.

The requirements for initiating solutions to meet forecast network limitations, procurement of system strength or inertia services, or the need to address the risks arising from ageing network assets remaining in-service, including new regulated network developments or non-network solutions, are set down in clauses 5.14.1, 5.16.4, 5.16A, 5.20B, 5.20C and 5.22.14 of the NER. Planning processes require consultation with AEMO, Registered Participants and interested parties, including customers, generators, Distribution Network Service Providers (DNSP) and other TNSPs.

New network developments and reinvestments are proposed to meet these legislative and NER obligations. Each of these clauses prescribes a slightly different consultation process. The RIT-T is the most frequent NER consultation process undertaken by Powerlink and is discussed further in Section 6.6. Powerlink continues to publish information and consult with potential providers of non-network solutions for the provision of network support control and ancillary services (NSCAS)[3] and system strength shortfalls and inertia gaps as notified by AEMO.

6.2.3 Integrated planning of the shared network

Significant inputs to the network planning process are the:

- forecast of customer electricity demand, including demand side management (DSM), and its location
- location, capacity and arrangement of existing, new and retiring generation (including embedded generation)
- condition and performance of assets and an assessment of risks arising from ageing network assets remaining in-service
- assessment of future network capacity to meet the required planning criteria and efficient market outcomes, including limiting transmission losses, system strength and the potential to facilitate future storage requirements to firm intermittent renewable generation and help address minimum demand.

The 10-year forecasts of electrical demand and energy across Queensland are used, together with forecast generation patterns, to determine potential flows on transmission network elements. The location and capacity of existing and committed generation in Queensland is sourced from AEMO, unless modified following advice from relevant participants. Information about existing and committed embedded generation and demand management within distribution networks is provided by DNSPs and AEMO.

Powerlink examines the capability of its existing network and the future capability following any changes resulting from:

- committed network projects (for both augmentation and to address the risks arising from ageing network assets remaining in-service)
- the impact of generation retirements on transmission network power flows, system strength and reactive power capability
- existing and future renewable developments including Renewable Energy Zones (REZ)
- variances in Powerlink's operating environment or changes in technical characteristics such as minimum demand, inertia and system strength as the power system continues to evolve.

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2 Refer to Section 34(2) of the Act.
3 NER Clause 5.20.3(b).

This includes consultation with the relevant DNSP in situations where the performance of the transmission network may impact on, or be impacted by, the distribution network, for example where the two networks operate in parallel.

Where potential flows could exceed network capability, Powerlink notifies market participants of these forecast emerging network limitations. If the capability violation exceeds the required reliability standard, joint planning investigations are carried out with DNSPs (or other TNSPs if relevant) in accordance with Clause 5.14.1 of the NER. The objective of this joint planning is to identify the most cost effective solution, regardless of asset boundaries, including potential non-network solutions.

Powerlink must maintain its current network so that the risks arising from the condition and performance of existing assets are appropriately managed. Powerlink undertakes a program of asset condition assessments to identify emerging asset condition related risks.

As assets approach the end of their technical service life, Powerlink examines a range of options to determine the most appropriate reinvestment strategy, applying a flexible and integrated approach which takes into account multiple factors. Consideration is given to optimising the topography and capacity of the network, taking into account current and future network needs, including future renewable generation and other developments associated with the transforming energy system such as decarbonisation through electrification and emerging industries relating to hydrogen.

In many cases, power system flows and patterns have changed over time. As a result, the ongoing network capacity requirements need to be re-evaluated. Individual asset reinvestment decisions are not made in isolation, and reinvestment in assets is not necessarily undertaken on a like-for-like basis. Rather, asset reinvestment strategies and decisions are made taking into account enduring need, the role that transmission needs to play in the energy transformation and the inter-related connectivity and characteristics of the high voltage (HV) system, and are considered across an area or transmission corridor. The consideration of potential non-network solutions forms an important part of this flexible and integrated planning approach.

The integration of condition, demand based limitations and energy transformation objectives delivers cost effective solutions that address both reliability of supply and risks arising from assets approaching end of technical service life.

Powerlink considers a range of strategies and options to address emerging asset related condition and performance issues. This planning process includes consideration of a broad range of options to address identified needs described in Table 6.1. Each of these options is considered in the context of future capacity.

In accordance with the NER, information regarding proposed transmission reinvestments within the 10-year outlook period must be published in the TAPR and TAPR templates. More broadly, this provides information to the NEM, including AEMO, Registered Participants and interested parties (including non-network providers) on Powerlink's planning processes, anticipated public consultations, and decision making relating to potential future investments and reinvestments.

Table 6.1 Examples of planning options

Option	Description
Non-network alternatives	Non-network solutions are not limited to, but may include network support and system services from existing and/or new generation, 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.
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.
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 a 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, inertia and reactive power 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.
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.
Transformer refit	Powerlink utilises a transformer reinvestment strategy called transformer refit to extend the service life of a transformer to provide cost benefits through the deferral of the timing for a future transformer replacement. Transformer refit may include replacement of components such as high voltage bushings, tap changers and instruments, addressing sources of oil leaks such as replacement of gaskets and main lid sealing, replacement of transformer oil, and addressing radiator corrosion.
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.

6.2.4 Powerlink's reinvestment criteria

Powerlink is committed to ensuring the sustainable long-term performance of its assets to deliver safe, reliable and cost effective transmission services to customers, stakeholders and communities across Queensland. Powerlink demonstrates this by adopting a proactive approach to asset management that optimises whole of life cycle costs, benefits and risks, while ensuring compliance with applicable legislation, regulations, standards, statutory requirements, and other relevant instruments.

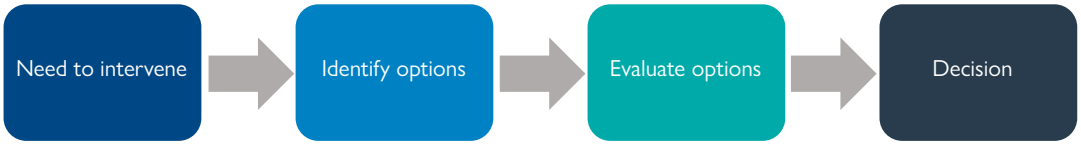
The reinvestment criteria framework

The reinvestment criteria framework defines the methodology that Powerlink uses to assess the need and timing for intervention on network assets to ensure industry compliance obligations are met. The methodology aims to improve transparency and consistency within the asset reinvestment process, enabling Powerlink's customers and stakeholders to better understand the criteria to determine the need and timing for asset intervention. The reinvestment criteria framework is relevant where the asset condition changes so it no longer meets its level of service or complies with a regulatory requirement.

The trigger to intervene needs to be identified early enough to provide an appropriate lead time for the asset reinvestment planning and assessment process. The need and timing for intervention is defined when business as usual activities (including routine inspections, minor condition based and corrective maintenance and operational refurbishment projects) no longer enable the network asset to meet prescribed standards of service due to deteriorated asset condition.

Powerlink's asset reinvestment process (refer to Figure 6.1) enables timely, informed and prudent investment decisions to be made that consider all economic and technically feasible options including non-network alternatives or opportunities to remove assets where they are no longer required. An assessment of the need and timing for intervention is the first stage of this process.

Figure 6.1 Asset Reinvestment Process



Asset reinvestment review

During 2023 Powerlink completed a review of its asset reinvestment approach and criteria to ensure consistency with contemporary asset management and risk-based decision frameworks. The ARR Working Group was established to ensure customers and the Australian Energy Regulator (AER) were actively involved in the review and its recommendations.

The aim of the review was to consider the prudency and efficiency of network reinvestment and the associated risk-based economic assessments[4]. The review considered Powerlink's risk cost modelling approach, the impact of risk on economic decisions, and the role of deterministic criteria in an economic assessment framework. The review focussed on transmission line reinvestments and provided an opportunity to identify improvements which will ultimately benefit customers as the complexities and challenges of maintaining the network continue to grow. While the focus of the review was to further improve Powerlink's approach to asset management practices for transmission line reinvestment, where appropriate Powerlink is applying improvements identified to other areas of asset reinvestment planning to ensure positive outcomes for customers.

The ARR Working Group Report was published on 30 May 2023. A key recommendation included modelling existing and alternative bundling approaches for future transmission line refit investment decisions, and to progress the most cost effective solution based upon detailed condition and cost information, while allowing for the developing network needs to support the energy transformation. It was also recommended that compliance works are only undertaken on structures where condition based work is to be performed, and that Powerlink retain the existing asset definition for transmission lines.

Powerlink has committed to report back to the Customer Panel on progress made in embedding the recommendations from this review into business processes, and any observed outcomes arising, one year after finalisation of the review.

6.3 Monitoring the changing outlook for the Queensland region

Powerlink is actively monitoring the changing outlook for the Queensland region and considering the impact of emerging technologies, withdrawal of coal-fired generation and the integration of VRE and firming generation in future transmission plans. These plans include:

- non-network solutions
- 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 Chapter 2
- replacing existing assets with assets of a different type, configuration or capacity
- investing in assets to maintain planning standards and deliver efficient market outcomes
- investing in assets and/or non-network solutions to meet Powerlink's obligations for inertia, system strength and voltage control (refer to Section 6.8).

[4] Refer to the AER's Industry practice application note for asset replacement planning.

Powerlink anticipates that there will be significant expansion of the transmission network required over the next 10 years to achieve 80% renewables by 2035. Powerlink is committed to early engagement and working in partnership with communities, Local Government and other stakeholders to deliver the new energy future. This includes working together to identify opportunities which deliver positive outcomes and longterm benefits as the energy system evolves, particularly in developing new transmission infrastructure in key parts of the state.

While not included in the 2023 TAPR analysis, this work is well underway and insights are provided in Powerlink's 'Actioning the Queensland Energy and Jobs Plan'.

6.3.1 Possible impacts of the energy transformation

Due to the energy transformation, there is the potential to have significantly changed requirements for transmission infrastructure in the 10-year outlook period. Given Powerlink's integrated planning approach (refer to Section 6.2.3), these requirements may result in the need for new or alternate investments that impact the proposed future network and non-network solutions discussed in this Chapter and possible non-network solutions identified in Chapter 5. Any changes will be updated in subsequent TAPRs.

6.4 Forecast capital expenditure

The external environment in which Powerlink operates continues to be complex. The Reserve Bank of Australia (RBA) recently reported that global inflation had remained high in 2023, despite appearing to have peaked in 2022. The RBA also noted that inflationary pressures are expected to persist for some time, particularly for services, due to labour market tightness, demand exceeding supply in some parts of the economy and rising energy costs[5].

Infrastructure Australia's Market Capacity Report (December 2022) highlighted a number of factors that are challenging infrastructure capacity in Australia, including:

- supply chain disruption caused by COVID-19, volatile demand and geopolitical impacts
- a sharp rise in construction insolvencies leaving fewer companies to deliver work
- the continued rise in complex mega-projects
- severe labour shortages[6].

While recognising these complexities, Powerlink is focussed on identifying supply risks and delivering solutions to ensure customers continue to receive cost effective and efficient services in this uncertain environment.

6.5 Forecast network limitations

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 in its transmission authority (refer to Section 6.2.1).

Emerging limitations may be triggered by thermal plant ratings (including fault current ratings), protection relay load limits, voltage stability and/or transient stability. Appendix H lists the indicative maximum short circuit currents and fault rating of the lowest rated plant at each Powerlink substation and voltage level, accounting for committed projects listed in Chapter 9 and existing and committed generation listed in Chapter 7.

Based on AEMO's Step Change scenario forecast discussed in Chapter 3, the maximum demand for electricity is expected to have mild growth with an average annual increase of 1.8% over the next 10 years.

Notwithstanding network limitations which may result from new loads such as in the Gladstone zone due to electrification of industry, Powerlink does not anticipate undertaking any significant augmentation works during this period based on load growth alone. However, the changing generation mix (and associated peak to average production ratios of VRE plant) 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 and QEJP.

5 Reserve Bank of Australia, Statement on Monetary Policy, August 2023.
6 Infrastructure Australia, Infrastructure Market Capacity: 2022 Report, December 2022.

In Powerlink's Revenue Determination 2023-27[7], 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 8.

6.5.1 Summary of forecast network limitations within the next five years

Powerlink has identified that due to declining minimum demand, changing nature of load 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[8]. Table 6.2 summarises limitations identified in Powerlink's transmission network and noted in AEMO's December 2022 System Strength, Inertia and NSCAS Reports.

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 (2023/24)	3-year outlook (up to 2026/27)	5-year outlook (up to 2028/29)	
System strength shortfall at Gin Gin	Central West	AEMO declared system strength shortfall December 2021	From 31 March 2023 (1)			Section 6.8.1
Reactive power absorption gap in southern Queensland	Moreton	AEMO declared gap December 2021	Immediate gap (2)			Section 6.8.1
Managing voltages in Queensland	Central West		2020/21 project in progress (3)			Table 9.3
	Moreton		2022/23 (1)(2)			Table 9.6

Notes:

(1) Refer to AEMO's December 2021 System Security Reports and Update to 2021 System Security Reports and Powerlink's Expression of Interest (EOI), Request for System Security Services in central, southern and the broader Queensland regions which is currently in progress to address the declared System Strength and NSCAS requirements and discussed Section 6.8.1.

(2) The short-term solution for the reactive power requirement to meet the immediate gap in southern Queensland has been assessed through the Request for System Security Services in central, southern and the broader Queensland EOI process. The immediate gap is being addressed via a Network Support Agreement with CleanCo Queensland (CleanCo) to utilise its asset in southern Queensland and in the rare event this is insufficient, the use of a range of operational measures. The longer term solution has been assessed as part of the RIT-T to manage voltages in south east Queensland which identified the installation of a 120MVAr reactor at Belmont Substation by 2024, and network support services from CleanCo to operate during times of reactive power shortfall as the preferred option.

(3) 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 275kV bus reactor at Broadsound Substation, is commissioned in October 2024.

Based on AEMO's Step Change scenario forecast discussed in Chapter 3 there are no other network limitations forecast to occur in Queensland in the next five years[9].

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 (including electrification of existing industrial processes), 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. However, there were no forecast network limitations identified in Powerlink's transmission network in the 2022 TAPR which fall into this category in 2023.

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

Based on AEMO's Step Change scenario forecast there is approximately 250MW of additional load connected in the Gladstone zone by 2031. This load is associated with electrification of existing customer's processes. The impact of this additional load is discussed in sections 6.10.2 and 8.2.3.

6.6 Consultations

Consultation processes for proposed transmission investments and funded augmentations are conducted under the NER. These processes include:

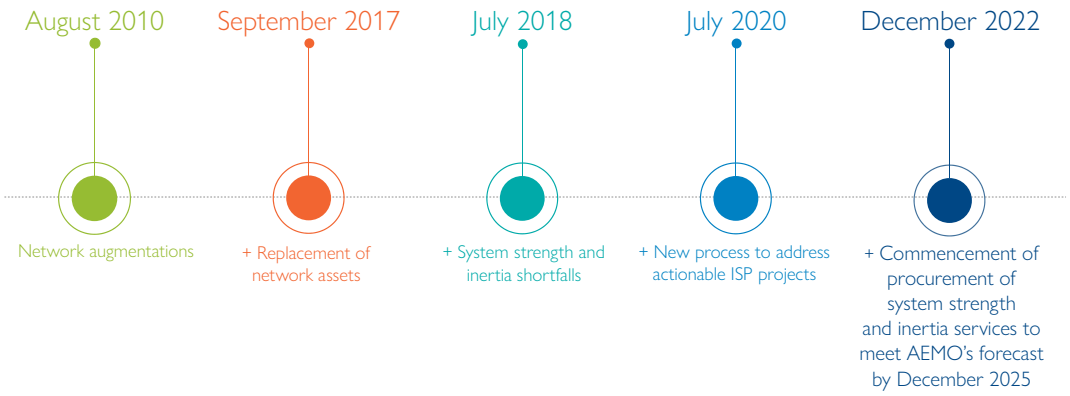
- RIT-Ts
- Expressions of Interest (EOIs) and
- Funded augmentations.

All consultation documents are published and made available on Powerlink's website.

6.6.1 RIT-T consultation process

Since commencement of the RIT-T consultation process in 2010, the requirements to call for proposals for transmission investments over the RIT-T cost threshold (currently $7 million) have been incrementally extended to address a range of transmission investment needs (refer to Figure 6.2) and are progressed under the provisions of clauses 5.16.4 and 5.16A of the NER.

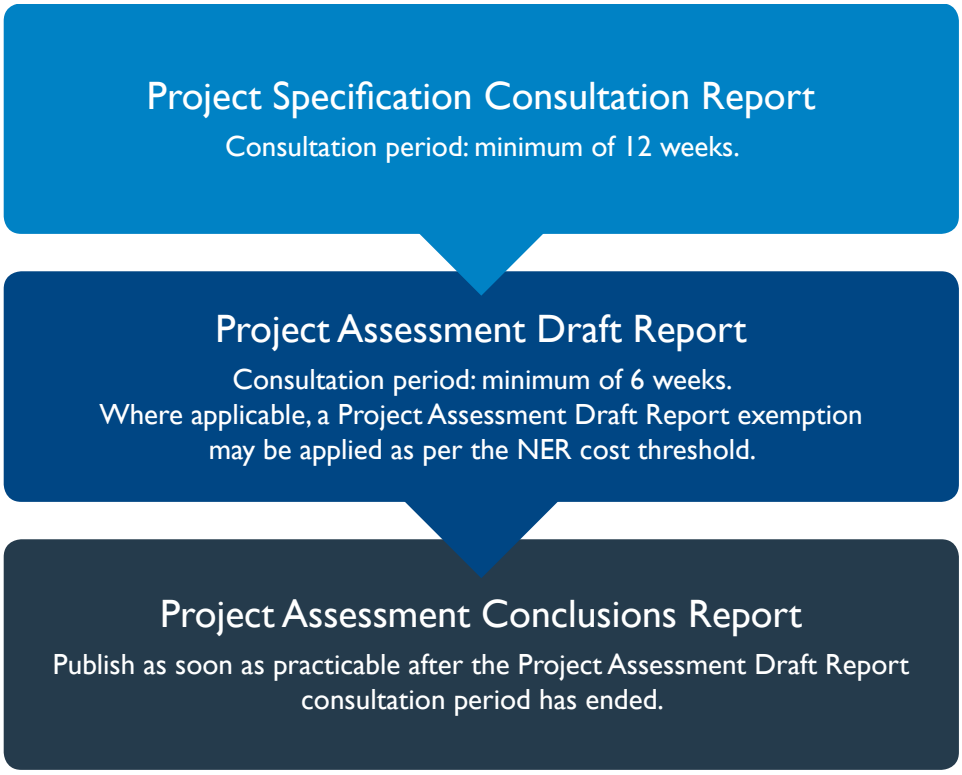
Figure 6.2 Chronological development and expansion of the RIT-T process for proposed transmission network investments



6.6.2 Current consultations – proposed transmission investments

Powerlink carries out separate consultation processes for each proposed new transmission investment over $7 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 6.3).

Figure 6.3 Overview of the RIT-T consultation process for projects which are not actionable ISP projects



The consultations completed since publication of the 2022 TAPR are listed in Table 6.3 (refer to Table 9.6).

Table 6.3 RIT-T consultations completed since publication of the 2022 TAPR

Consultation
Addressing the secondary systems condition risks at Tangkam
Maintaining power transfer capability and reliability of supply at Redbank Plains
Managing voltages in South East Queensland

RIT-T consultations currently underway are listed in Table 6.4

Table 6.4 RIT-T consultations currently underway

Consultation (1)	Reference
Addressing system strength requirements in Queensland from December 2025	Section 6.8.2
Maintaining power transfer capability and reliability of supply at Kemmis	Section 6.9.3
Addressing the reliability of supply to Nebo local area	Section 6.9.3

Note:

(1) The consultations reflect the RIT-T status as at 30 September 2023.

Funded augmentation consultations completed since publication of the 2022 TAPR are listed in Table 6.5.

Table 6.5 Funded augmentation consultations completed since publication of the 2022 TAPR

Consultation	Reference
Augmenting the transmission network to enable renewable hydrogen production at Gibson Island	Gibson Island Project

Expressions of Interest currently underway since publication of the 2022 TAPR are listed in Table 6.6.

Table 6.6 Expressions of Interest currently underway since publication of the 2022 TAPR[10]

Consultation	Reference
Request for power system security services in central, southern and the broader Queensland region	Section 6.8.1

6.6.2 Future consultations – proposed transmission investments

Anticipated consultations

Notwithstanding consideration of the QEJP and power system security requirements, Powerlink's capital expenditure program of work in the 10-year outlook period will focus on investment in the transmission network to manage the risks arising from ageing assets remaining in-service. These emerging risks are discussed in Section 6.9 to 6.11. Table 6.7 summarises consultations Powerlink anticipates undertaking within the next 12 months under the RIT-T to address either the proposed investment in a network asset or limitation.

Table 6.7 Anticipated consultations in the forthcoming 12 months (to October 2024)

Consultation (1)	Reference
Maintaining reliability of supply at Kamerunga	Section 6.9.1
Maintaining reliability of supply and addressing condition risks at Ingham South	Section 6.9.2
Addressing the secondary systems condition risks of the Strathmore SVC	Section 6.9.3
Maintaining reliability of supply to Gladstone South	Section 6.10.1
Maintaining reliability of supply at Callemondah	Section 6.10.1
Maintaining reliability of supply at Ashgrove	Section 6.11.5

Note:

(1) The anticipated consultations listed in Table 6.7 reflect the RIT-T status as at 30 September 2023.

Future ISP projects

The 2022 ISP did not identify any 'actionable' projects within Queensland. However, the 2022 ISP did identify several projects that are part of the optimal development path and may become actionable in future ISPs. Further to the three preparatory activities reports previously provided to AEMO[11], two additional projects were nominated for preparatory activities by 30 June 2023. These include:

- Darling Downs REZ Expansion
- QNI Connect (500kV option).

Preparatory activity reports for these projects were provided to AEMO by 30 June 2023 and are discussed further in Section 6.15. The commencement for consultation for these projects will be triggered by future ISPs and considered in conjunction with the QEJP[12].

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 DNSP[13] or be initiated by generators or customers.

10 Power System Security Consultations.
11 Preparatory Activities reports for Central to Southern Queensland, Gladstone Grid Reinforcement and QNI connect were provided to AEMO by 30 June 2021.
12 Refer to Section 5.16A.3.
13 In Queensland, Energex and Ergon Energy (part of the Energy Queensland Group) and Essential Energy are the DNSPs.

Table 6.8 lists connection works that are anticipated to be required within the 10-year outlook period.

Table 6.8 Connection point commitments (1)

Connection point name (2)	Proposal	Zone
Chinchilla Battery energy storage system (BESS) (3)	New BESS	Bulli
Western Downs BESS	New BESS	Bulli
Greenbank BESS	New BESS	Moreton

Notes:

(1) AEMO's definition of 'committed' from the System Strength Impact Assessment Guidelines Version 2.1 (effective 6 June 2023) has been adopted for connection point proposals identified in the TAPR.

(2) 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.

(3) The listed connection point commitment is in progress (refer to Table 9.2).

It should be noted that while not fully at the stage where the project can be classified as committed under the NER at the time of publication of the 2023 TAPR, Powerlink has signed an agreement for the construction of assets for the connection of the MacIntyre Wind Precinct proposed renewable development to the transmission network in south-west Queensland. More information on this project is available on Powerlink's website.

Table 6.9 summarises connection point activities[14] undertaken by Powerlink since publication of the 2022 TAPR (refer also to figures 6.4 and 6.5). Further details on potential new generation connections are available in the relevant TAPR template located on Powerlink's TAPR portal as noted in Appendix E.

Table 6.9 Connection point activities

Generator Location	Number of Applications	Number of Connection Agreements	Generator Type and Technology
North	4		Load, Wind Farm, Solar Farm and BESS
Central	8		Load, Wind Farm, Solar Farm and BESS
South	12	2	Load, Wind Farm, Solar Farm and BESS
Total	24	2	

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

Figure 6.4 Customer enquiries per month since publication of the 2022 TAPR

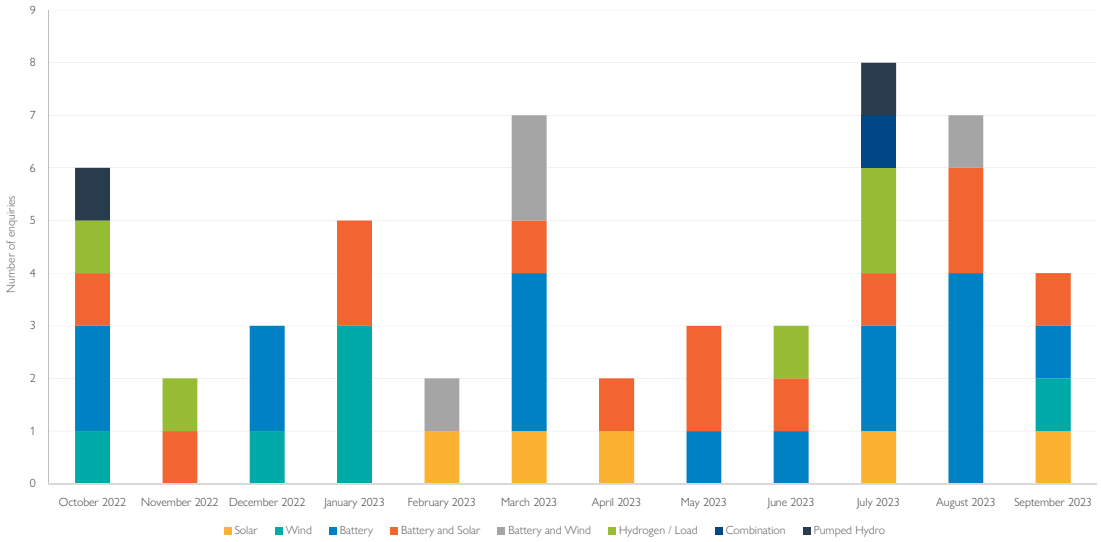
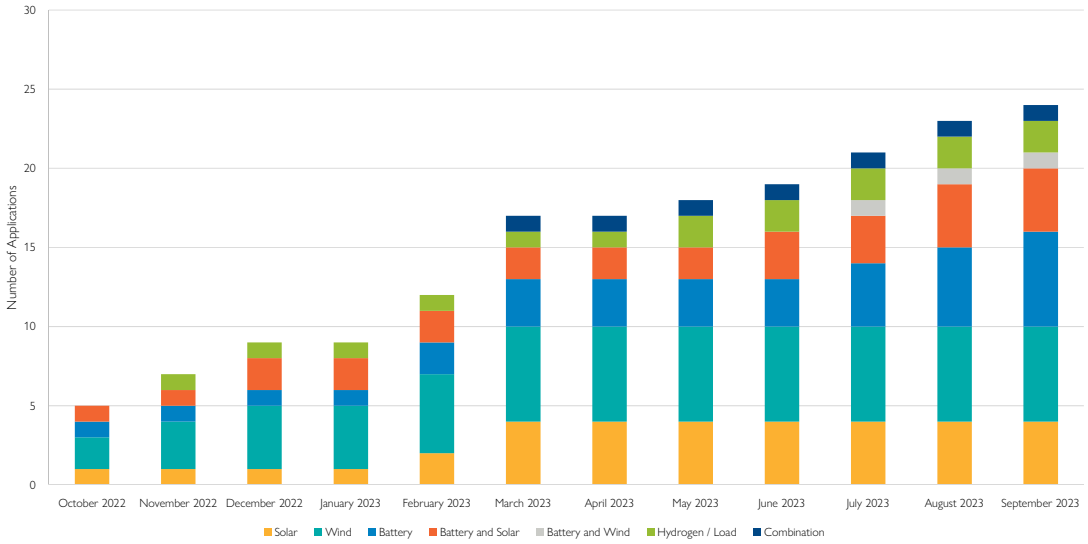


Figure 6.5 Cumulative customer applications per month since publication of the 2022 TAPR



6.7 Proposed network developments

Powerlink's capital expenditure program of work will continue to focus on risks arising from the condition and performance of existing aged assets, as well as emerging limitations in the capability of the network as the external environment shifts to net zero emissions. Proposed future network developments discussed in this chapter do not include the investments in new transmission that is needed under the energy transformation as discussed in the Queensland Energy and Jobs Plan (QEJP) and set out in the Queensland SuperGrid Infrastructure Blueprint (Infrastructure Blueprint) released by the Queensland Government in September 2022.

As the Queensland transmission network experienced considerable growth in the period from 1960 to 1980, there are a large number of transmission assets ranging from 40 to just beyond 60 years old. A number of these assets are approaching the end of their technical service life and investment in some form is required within the 10-year outlook period to manage risks related to safety, reliability and other factors.

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

- improve and further refine options under consideration
- identify other options from those originally specified, including a consideration of the broader energy transformation where appropriate, which may deliver a greater benefit to customers.

Information regarding possible investment alternatives, network limitations and anticipated timing is updated annually in the TAPR and includes discussion on significant changes which have occurred since publication of the previous year's TAPR.

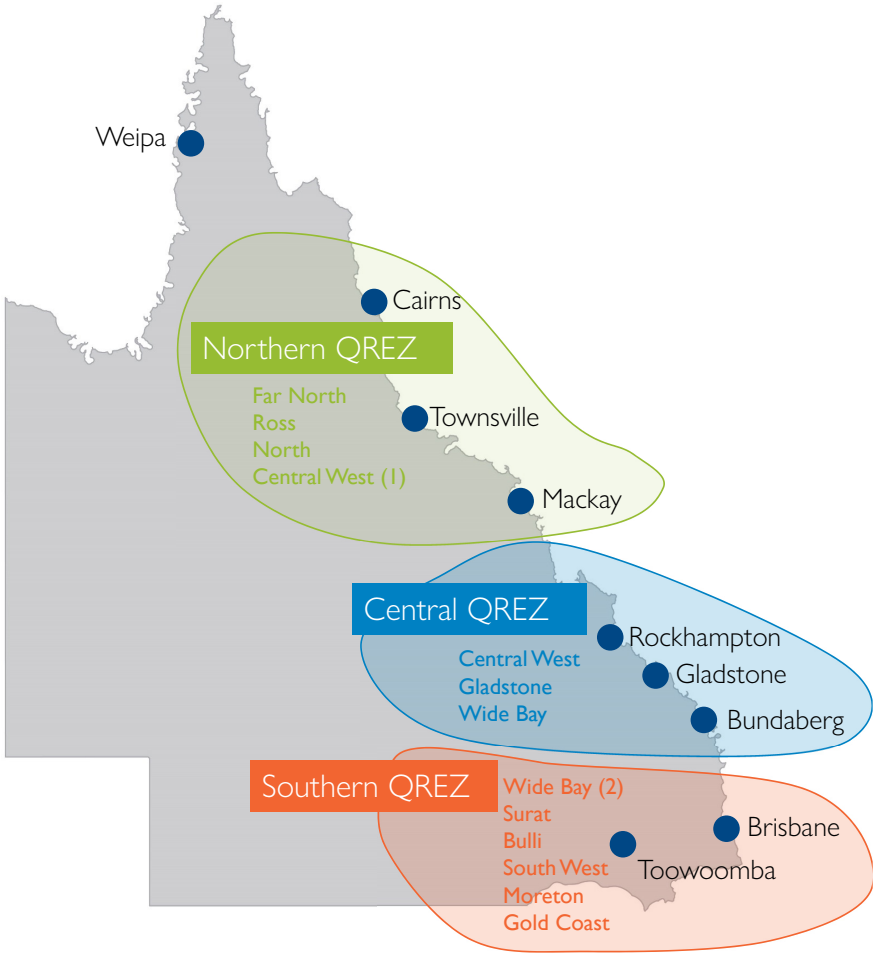
The indicative cost of potential projects identified in this chapter is updated each year to keep pace with external project cost increases that are being experienced broadly across many industries (refer to Section 6.4). Where there may be other factors materially influencing the updated indicative cost, such as a more granular view of condition and project scope, these factors are noted in the summary table in Appendix D which summarises all proposed network investments for the 10-year outlook period. It should be noted that the indicative cost of potential projects also excludes known and unknown contingencies.

Other than the outcomes set out in the 2022 System Security and Inertia Reports (refer to Section 6.8), and based on the current information available, the possible network developments discussed in this chapter are outside of the scope of the AEMO's most recent ISP and General Power System Risk Review[15]. 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 2023 annual planning review.

6.7.1 Geographical context

Powerlink has analysed investment needs and potential limitations across Powerlink's standard geographic zones (refer to sections 6.9 to 6.11). To provide geographical context, the reinvestment needs and network limitations are broadly aligned with Queensland's renewable energy resource regions in Queensland, as shown in Figure 6.6.

Figure 6.6 Queensland's renewable energy resource regions



(1) The Central West zone traverses the Northern and Central regions
(2) The Wide Bay zone traverses the Central and Southern regions

[15] AEMO, General Power System Risk Review, July 2023. In its 2023 review, AEMO recommended Powerlink and Transgrid investigate, design and implement a Special Protection Scheme to mitigate the risk of Queensland to New South Wales Interconnector instability and synchronous separation of Queensland following a range of non-credible contingencies.

6.7.2 Investment context, timeframes and description

Against the backdrop of a rapidly changing external environment, Powerlink's planning overview (10-year outlook period of the TAPR) considers a range of options to address identified needs. When considering the replacement of existing assets in conjunction with the broader network topography, Powerlink may also identify potential network reconfigurations or other options to realise synergies and efficiencies in developing the transmission network which would be economically assessed under the RIT-T (if applicable).

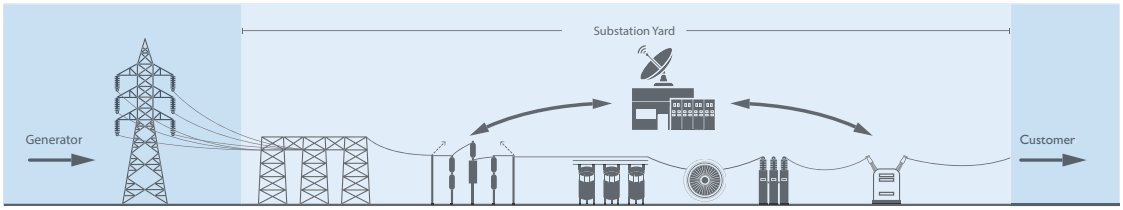
Information in relation to potential projects, alternatives and possible commissioning needs is revised annually based on the latest information available at the time of publication. Refer to Appendix D for the complete list of proposed network investments within the 10-year outlook period. Significant timing and cost differences are noted in the analysis of this program of work.

Possible network investments needs (which includes reinvestment, augmentations and/or the procurement of power system security services) likely to require RIT-T consultation within the five-year outlook period, from July 2023 to June 2029 are discussed in this Chapter.

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 2022 TAPR and 2023 TAPR and TAPR Templates.

The functions performed by the major transmission network assets discussed in this chapter are illustrated in Figure 6.7.

Figure 6.7 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.

- **Synchronous condenser**

  A synchronous condenser is a large rotating machine connected to the transmission network with no driving force (spins freely). It is similar to a synchronous generator but does not produce energy. It helps the power system with voltage control, system strength, and inertia.

- **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.

6.8 Power system security requirements

6.8.1 Power system security services in central, southern and broader Queensland regions

In May 2022 Powerlink published an EOI to Request for Power System Security Services in central, southern and broader Queensland regions. The EOI requested submissions from potential solution providers to ascertain and evaluate non-network and network options to meet the power system security requirements identified in the AEMO's System Security Reports published in December 2021 and May 2022 respectively[16].

The EOI requested potential non-network solutions to address AEMO's declared shortfalls of:

- an immediate system strength shortfall of up to 90MVA at the Gin Gin 275kV fault level node, located in the Wide Bay zone, to be addressed from 31 March 2023
- an NSCAS gap of 120MVAr of reactive power absorption, more specifically a Reliability and Security Ancillary Service (RSAS) gap, in southern Queensland to be addressed immediately and rising to 250MVAr by 2026.

Submissions to the EOI closed in June 2022.

Powerlink has concluded the engagement activities and assessment in relation to the immediate NSCAS gap, and published the findings in the Final Report - Part 1 in December 2022. Since publication of the report, Powerlink has entered into a Network Support Agreement with CleanCo Queensland to address the immediate gap. Longer term NSCAS requirements have been considered in conjunction with the Managing voltages in South East Queensland RIT-T which recommended installation of a 120MVAr bus reactor at Belmont Substation in 2024 and network support services from CleanCo Queensland to operate during times of reactive power shortfall as the preferred option for implementation (refer to Powerlink's website).

Powerlink expects to publish the Final Report - Part 2 focussing on the outcome of the assessment to fill the system strength shortfall at the Gin Gin fault level node in late 2023. The findings of the EOI process will also be discussed in the 2024 TAPR.

6.8.2 Addressing system strength requirements in Queensland from December 2025

In October 2021, the Australian Energy Market Commission (AEMC) introduced the Efficient Management of System Strength on the Power System Rule (System Strength Rule)[17]. The System Strength Rule established a new framework for the supply and demand of system strength in the NEM.

As of 2 December 2022, Powerlink, as the System Strength Service Provider (SSSP) in Queensland, is required to take action to plan, procure and make available system strength services as set out in the 10-year forecast provided in AEMO's annual System Strength Reports[18].

AEMO published the first System Strength Report under the new framework in December 2022. The report set minimum three phase fault level requirements, and provided a 10-year forecast of utility-scale inverter-based resource (IBR) generation, for each of Queensland's five system strength nodes[19]. Powerlink must meet minimum fault level requirements by December 2025, and procure system strength to meet the efficient level of IBR in the 10-year forecast. In March 2023, Powerlink commenced the RIT-T process, publishing a Project Specification Consultation Report (PSCR), Addressing System Strength Requirements in Queensland from December 2025. The PSCR sought to identify solutions to meet the minimum and efficient fault levels of system strength.

To replicate dispatch that has historically met minimum fault level requirements, and deliver sufficient system strength to meet the minimum system strength requirements identified by AEMO, the PSCR indicated Powerlink sought:

- Seven synchronous machines or equivalent plant online in Central Queensland, in the order of 350MVA each
- Two hydro-electric machines or equivalent plant in North Queensland, in the order of 20MVA each
- Four synchronous machines or equivalent plant online in Southern Queensland, in the order of 400MVA each.

16 AEMO, System Security Planning.
17 AEMC, Efficient Management of System Strength on the Power System, October 2021.
18 Refer to Schedule 5.1.14 of the NER.
19 AEMO, 2022 System Strength Report, December 2022.

To meet efficient system strength requirements, Powerlink estimated that up to a further eight synchronous machines or equivalent plant are required within the 10-year outlook period, comprising four by 2030 (but potentially as early as 2025) and four by 2033 (but potentially as early as 2030).

Given the need to meet minimum requirements from December 2025, the challenging external environment, and potential network project delivery delays in the immediate term, Powerlink did not consider there was a credible network option to install a synchronous condenser by 2025.

The PSCR proposed two credible options to address the minimum and efficient levels of system strength:

- Seek to procure system strength services to meet the identified need in its entirety for both the minimum and efficient levels of system strength
- Hybrid solution to procure system strength services together with the installation and commissioning of up to eight 200MVA synchronous condensers (network component) for both the minimum and efficient levels of system strength required by December 2030. The number of synchronous condensers actually required would depend on Powerlink's assessment of submissions received to the PSCR. The PSCR provided an indicative capital cost of the network component of this option of up to $752 million (2023/24 prices). Annual operating and maintenance costs were anticipated to be up to approximately $15 million (2023/24 prices).

For both options, Powerlink indicated system strength services would need to be able to commence availability in the period between December 2025 and December 2030.

The PSCR also noted the potential for the credible options to have a material inter-network[20] impact by increasing the fault level by at least 10MVA on the Queensland to New South Wales Interconnector.

Submissions to the PSCR closed in July 2023 and Powerlink is progressing the technical and economic analysis for the optimal portfolio of solutions anticipated to be required. Powerlink expects publication of the Project Assessment Draft Report (PADR) in the second quarter of 2024 which will identify the proposed preferred option to provide minimum and efficient levels of system strength.

6.9 Northern region

The Northern region includes proposed network investments located within the Far North, Ross and North zones and broadly aligns with the Northern renewable energy resource region stretching between Mackay and Cairns, encompassing the northern most extent of Powerlink's transmission network (refer to Figure 6.6). The Northern region also includes a number of candidate REZ areas in north Queensland identified in the 2022 ISP optimal development pathway (refer to Figure 7.2).

6.9.1 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, Mt Emerald Wind Farm near Walkamin and Kaban Wind Farm near Tumoulin (refer to Figure 6.8).

[20] Refer to NER rule 5.21.

Figure 6.8 Far North zone transmission network

Possible load driven limitations

Based on AEMO's Step Change 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.

Possible network investments within five years

Network investments (which include reinvestments and augmentations) in the Far North zone are related to addressing the risks arising from the condition of the existing network assets which, without corrective action, could result in Powerlink being exposed to breaching a number of its jurisdictional network, safety, environmental and NER obligations.

By addressing the condition of these assets, Powerlink is seeking to ensure it can deliver a safe, cost effective and reliable supply of electricity to 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
Asset details	Constructed in 1963 Life extension in 2014 on certain components nearing end of technical service life
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2028
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 $70 million[21]
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. This transmission line also facilitates the Barron Gorge Hydro Power Station connection in the area

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

The Woree to Kamerunga 132kV double circuit transmission lines, originally connected to Cairns, provide critical supply to the Cairns northern beaches region, as well as connecting the Barron Gorge Hydro Power Station to the 275kV network. A significant proportion of the transmission line traverses built-up residential, encroached development and there are a number of major and minor road crossings causing access and construction work challenges. Replacement on a new easement is a possible end of technical service life strategy and investigations for easement alternatives are currently underway.

Possible network solutions may include

- 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 2028
- Network reconfiguration by establishing two single circuit 132kV transmission lines between Woree and Kamerunga substations, or via Cairns North Substation, by December 2028.

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

Ross to Chalumbin to Woree 275kV transmission lines

Potential consultation	Maintaining reliability of supply in the Cairns region Stage 2 - Addressing the condition risks of the transmission towers between Ross and Chalumbin
Asset details	Constructed in 1989
Project driver	Emerging condition risks due to structural corrosion
Project timing	June 2029
Proposed network solution	Refit the double circuit transmission line between Ross and Chalumbin substations, at an estimated cost of $37 million, by June 2029
Possible non-network solutions	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. The network configuration also facilitates generator connections in the area and provides system strength and voltage support for the region.

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, the Kaban Wind Farm and Kareeya Power Station. As a result of the funded augmentation consultation undertaken by Powerlink to facilitate the development of Stage 1 of the Far North Queensland REZ, establishment of a third 275kV connection into Woree Substation is under construction and expected to be completed by April 2024.

Due to environmental sensitivities and geographic conditions 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.

In June 2022 Powerlink completed the RIT-T, Maintaining Reliability of Supply in the Cairns region Stage 1 to address the more complex and advanced condition risks of the transmission towers between Davies Creek and Bayview Heights, part of the Chalumbin to Woree section of the transmission line. The Project Assessment Conclusions Report (PACR) identified extending the life of the transmission line through the selective replacement of corroded members and components, along with painting selected towers as the preferred option (refer to Table 9.5).

The double circuit 275kV transmission line between Ross and Chalumbin substations is 244km in length and comprises 528 steel lattice towers. The line traverses the rugged terrain of the northern Queensland tropical rainforest, passing through environmentally sensitive, protected areas and crossing numerous regional roads and rivers. This section of the transmission line is deteriorating at a slower rate than assets assessed under Stage 1 works due to its location on the western side of the Great Dividing Range.

Substations

Kamerunga 132/22kV Substation

132kV Primary plant and 132kV secondary systems replacement

Anticipated consultation	Maintaining reliability of supply at Kamerunga
Asset details	Established in 1976
Project driver	Emerging condition risks due to structural corrosion
Project timing	December 2028
Proposed network solution	Upfront replacement of all 132kV primary plant and secondary systems with GIS technology at an estimated cost of $75 million
Possible non-network solutions	Potential non-network options would need to provide supply to the 22kV network of up to a peak 60MW, and up to a peak 900MWh per day on a continuous basis. This would allow for the decommissioning of Kamerunga Substation and bridging of the Woree to Kamerunga transmission lines to the Kamerunga to Barron Gorge transmission line.

Kamerunga Substation is located in western Cairns and provides bulk electricity supply to Ergon Energy's distribution network in the northern Cairns region which includes Kamerunga, Smithfield and the northern beach areas, and also provides connection to the Barron Gorge Power Station, which was upgraded by Stanwell Corporation in 2011. The area surrounding the substation is residential and located along the flood plain of the Barron River.

In August 2019, Powerlink published a PACR to address the emerging condition risks at Kamerunga Substation. Based on information received subsequent to the conclusion of the consultation process, Powerlink has identified a material change in circumstances[22] which has resulted in the identification of an additional credible option not assessed under the RIT-T and significant cost increases across all options. This has resulted in a change to the preferred option recommended in the PACR. Powerlink expects to reapply the RIT-T process to address the identified need at Kamerunga within the next 12 months.

Possible network solutions

- Replacement of primary plant including additional switching functionality and secondary systems upfront with Gas Insulated Switchgear (GIS) technology by December 2028
- Replacement of primary plant including additional switching functionality and secondary systems upfront with AIS technology on an adjacent substation site by December 2028.

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

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

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 2030. At this time, an option would be to establish a 275kV Substation and cut into an existing 275kV Chalumbin to Woree circuit. Should this option eventuate, there will be an opportunity to retire the existing 132kV transmission line from Chalumbin to Turkinje.

Refer to Table 9.8 for confirmed asset retirements in the Far North zone and Table 6.10 for possible asset retirements beyond the 10-year outlook period.

22 Refer to NER clause 5.16.4(z3).

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

6.9.2 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 6.9 and 6.10).

Figure 6.9 Northern Ross zone transmission network

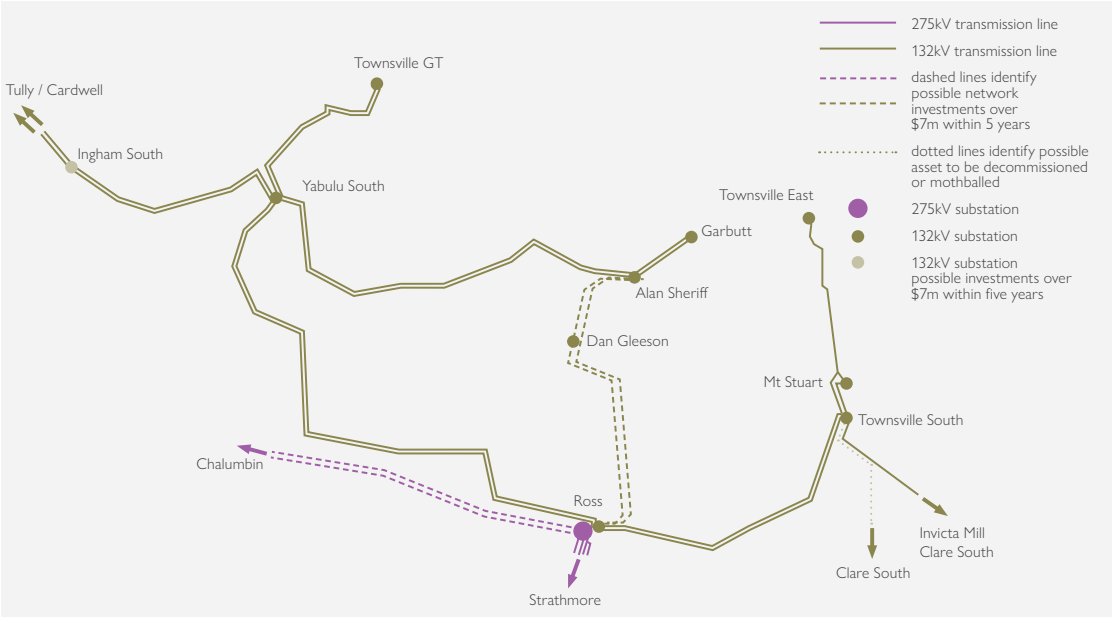


Figure 6.10 Southern Ross zone transmission network

Possible load driven limitations

Based on AEMO's Step Change 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 investments within five years

Network investments (which includes reinvestment and augmentations) 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 NER obligations.

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

Substations

Ingham South 132kV Substation

132kV Primary plant and 132kV secondary systems replacement

Anticipated consultation	Maintaining reliability of supply and addressing condition risks at Ingham South
Asset details	Established in 2005
Project driver	Condition driven replacement to address emerging obsolescence and compliance risks on 132kV primary plant and secondary systems
Project timing	December 2027
Proposed network solution	Full replacement of primary plant and secondary systems at an estimated cost of $10 million by December 2027
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.

Ingham South Substation is a major injection point into Ergon Energy's 66kV distribution network providing supply to the Ingham area.

Possible network solutions may include:

- In-situ replacement of primary plant and secondary systems by December 2027
- Minimum extension of the substation platform to replace primary plant and secondary systems by December 2027.

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

Possible asset retirements within 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.

Refer to Table 6.10 for possible asset retirements beyond the 10-year outlook period.

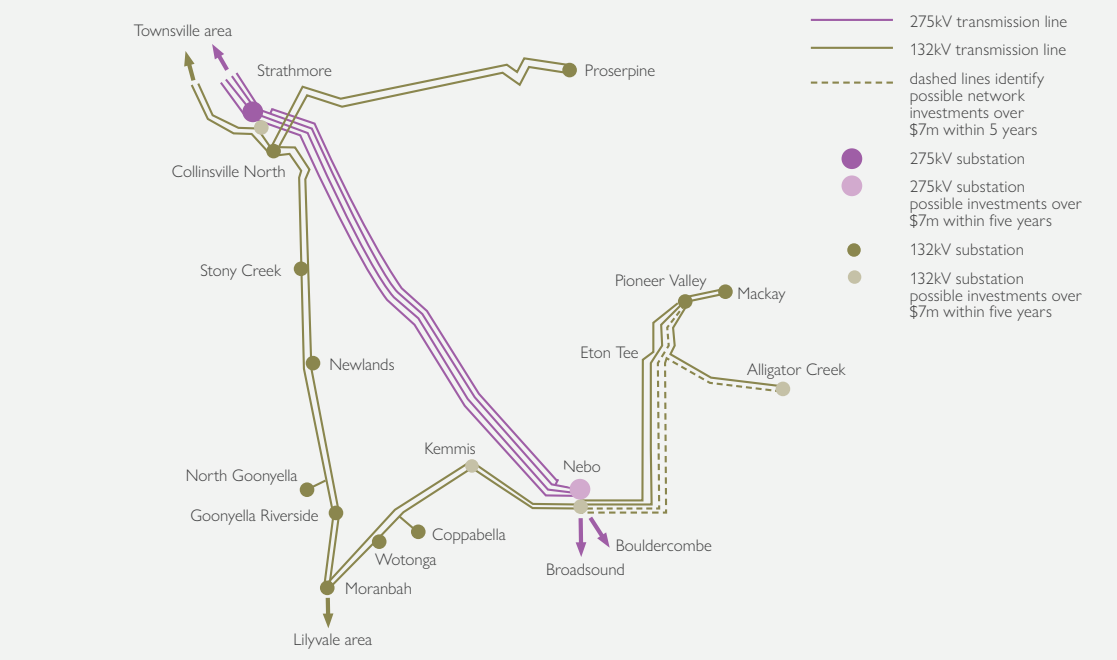
6.9.3 North zone

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 6.11).

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

Figure 6.11 North zone transmission network



Possible load driven limitations

Based on AEMO's Step Change 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 and low power transfer 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 7.6.2.

Possible network investments within five years

Network investments (which includes reinvestment and augmentations) 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 NER 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

Anticipated consultation	Addressing the Static VAr Compensator (SVC) secondary systems condition risks at Strathmore
Asset details	Established in 2007
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 $8 million by June 2026
Proposed non-network solutions	Potential non-network solutions would need to provide dynamic voltage support of up to 260MVAr capacitive and 80MVArs inductive.

Strathmore Substation is a major injection point to supply Ergon Energy's distribution network and Powerlink's direct connected customers in the Northern Bowen Basin.

Possible network solutions may include:

- Secondary systems replacement while retaining the existing thyristor valves and SVC cooling system
- Secondary systems replacement and replacing the thyristor valves including associated cooling system.

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

Nebo 275/132kV Substation

Current consultation	Addressing the reliability of supply to Nebo local area
Asset details	Established circa 1977
Project driver	Transformer condition risks at Nebo Substation
Project timing	December 2025
Proposed network solution	Replacement of transformers 3 and 4 and associated 11kV primary plant at Nebo Substation at an estimated cost of $11.5 million (2022/23 prices) by December 2025
Possible non-network solutions	A non-network option that avoids replacement of the ageing transformers and primary plant would need to provide injection or demand response at Nebo of up to 3MW during peak demand and up to 50MWh per day.

Nebo Substation was established in conjunction with the development of the interconnected 275kV network between Gladstone and North Queensland. Nebo was chosen as a location to establish a marshalling point for the 275kV network and as a transformation point to 132kV, to allow supply to local mining and domestic loads in the northern and central Queensland area.

Possible network solutions may include:

- Replacement of transformers 3 and 4 and associated 11kV primary plant by 2025.

Powerlink has identified that the options to refurbish and later replace the transformers are not credible, as it is not technically feasible due to the poor condition and age of the transformers.

Powerlink published a PSCR claiming PADR exemption, Addressing the reliability of supply to Nebo local area, in September 2023 which identified the replacement of transformers 3 and 4 and associated 11kV primary plant as the preferred network option. Submissions to the PSCR close on 22 December 2023 and Powerlink anticipates the publication of the PACR in early 2024.

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

Alligator Creek 132kV Substation

Potential consultation	Maintaining reliability of supply at Alligator Creek
Asset details	Established in 1982
Project driver	Primary plant condition risks at Alligator Creek Substation
Project timing	June 2025
Proposed network solution	Replacement of primary plant at Alligator Creek at an estimated cost of $7 million by June 2025
Possible non-network solutions	Potential non-network solutions would need to provide up to a peak 80MW, and up to a peak 1,400MWh per day on a continuous basis.

Alligator Creek Substation is a bulk supply point from mines in the Bowen Basin to the coal loading terminals of Hay Point and Dalrymple Bay and provides supply to Ergon Energy's distribution network for the surrounding communities to the south of Mackay.

Possible network solutions may include:

- Selected replacement of 132kV primary plant
- Full replacement of 132kV primary plant.

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

Potential consultation	Addressing the SVC secondary systems condition risks at Alligator Creek
Asset details	Established in 1982
Project driver	SVC Secondary systems condition risks at Alligator Creek
Project timing	June 2028
Proposed network solution	Replacement of secondary systems at Alligator Creek at an estimated cost of $7 million by June 2028
Possible non-network solutions	Potential non-network solutions would need to provide voltage imbalance support for the 132kV network.

Possible network solutions may include:

- Selected secondary systems replacement for the Alligator Creek SVC
- Full secondary systems replacement for the Alligator Creek SVC.

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

Kemmis 132kV Substation

Current consultation	Maintaining power transfer capability and reliability of supply at Kemmis
Asset details	Transformer 1 originally commissioned in 1984 and relocated to Kemmis in 2005
Project driver	Replace transformer 1 at Kemmis
Project timing	December 2026
Proposed network solution	Replacement of transformer 1 at Kemmis Substation at an estimated cost of $6.78 million (2022/23 prices) by December 2026
Possible non-network solutions	A non-network option that avoids replacement of the ageing transformer would need to provide injection or demand response at Kemmis of up to 60MW during peak demand and up to 650MWh per day.

Kemmis Substation, located approximately 32km north west of Nebo, was established to support the load growth arising from the expansion of mining in the northern Bowen Basin and to provide a bulk-supply injection point to the Ergon Energy distribution network.

Possible network solutions may include:

- Replacement of the 132kV transformer 1 at Kemmis.

Powerlink has identified that the option to refurbish and later replace the transformer is not credible, as it is not technically feasible due to the poor condition of the transformer. This is primarily due to the poor insulation strength of the transformer with condition assessments indicating significant deterioration of both oil and insulating paper condition. Based on this assessment, transformer 1 is not a candidate for refurbishment.

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

Powerlink published a PSCR claiming PADR exemption, Maintaining power transfer capability and reliability of supply at Kemmis, in September 2023 which identified the replacement of transformer 1 as the preferred network option. Submissions to the PSCR close on 22 December 2023 and Powerlink anticipates the publication of the PADR in early 2024.

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 2028. Should it proceed, the retirement 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.

Refer to Table 6.10 for possible asset retirements beyond the 10-year outlook period and Table 9.8 for confirmed asset retirements in the North zone.

6.10 Central region

The Central region includes proposed network investments located within the Central West and Gladstone zones that broadly align with the Central renewable energy resource region (referto Figure 6.6). This region:

- hosts some of Powerlink's largest industrial customers together with significant coal-fired generation
- offers considerable opportunities for the development of new industries
- is pivotal to supply power to northern and southern Queensland
- plays a major role in supporting industry, rail systems and mines, and
- includes several potential future REZs to be developed in the next 10 years as outlined in the 2023 Queensland Renewable Energy Zone Roadmap (epw.qld.gov.au) (refer to Section 2.4.2).

The Central renewable energy resource region has high quality solar and wind resources and long-term industrial and hydrogen potential, as well as existing energy-intensive industries that are seeking to decarbonise through either electrification of existing processing facilities and/or conversion to loads powered by VRE generation. These factors, in combination with the anticipated reduced operation of existing coal-fired power stations, will significantly impact the transmission capacity required to maintain reliability of supply in the Gladstone zone and power system security. Powerlink anticipates that power transfers will reach the secure limits and result in network congestion (refer to Section 8.2.3).

The utilisation of the transmission network in the Central region depends on both the generation dispatch and supply and demand balance within the Central West and Gladstone zones, and northern and southern Queensland. In addition, the significant increase in VRE generation is changing the generation mix and impacting the operation of existing coal-fired generators within the region, which in turn, is further effecting the utilisation of existing transmission infrastructure. This has been most evident across the Central to North Queensland and Central to South Queensland grid sections (refer to sections 7.6.2 and 7.6.5 respectively) and the Queensland to NSW interconnector (QNI). A shift in utilisation and material change in supply demand balance within the Gladstone zone has implications for significant investment in the transmission network, including the Central to South Queensland transmission link, and the Gladstone area 275kV transmission network between the generation rich nodes of Calvale, Stanwell and Calliope River substations. Potential investments for the Central region are outlined in Section 8.2.3.

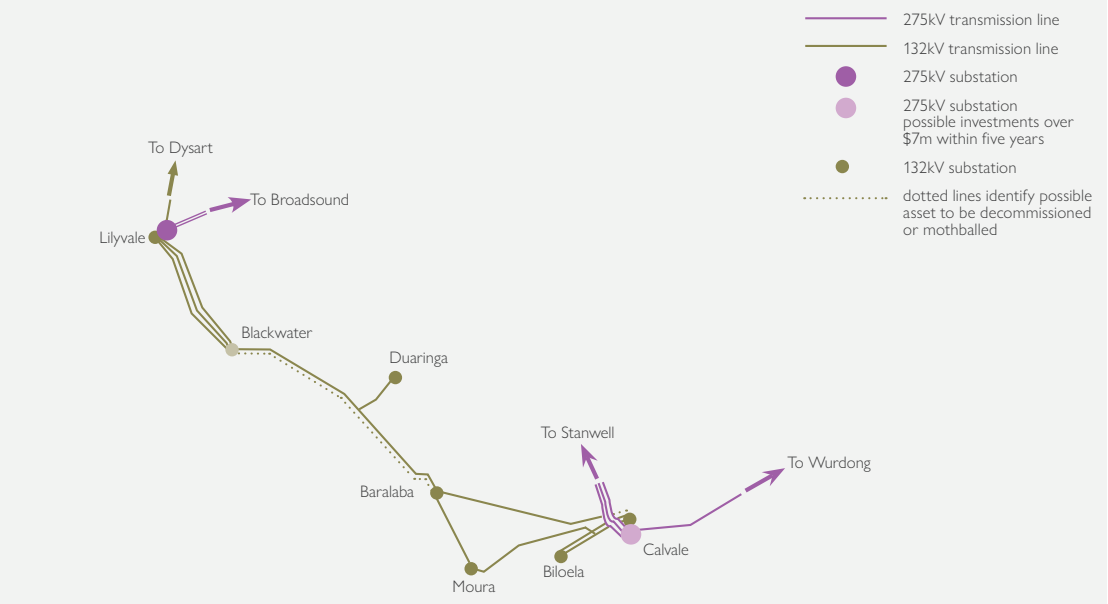
The investments outlined in Section 6.10 are based on AEMO's 2023 Electricity Statement of Opportunity (ESOO) Step Change scenario forecast in the 10-year outlook period. However, as mentioned, the Central region has the potential for significantly changed requirements in supply demand balance above this forecast. Given Powerlink's integrated planning approach and the rapidly evolving environment of the energy transformation, these requirements may result in the need for new investments that impact the proposed future network and non-network solutions identified in the geographical zones located within this region (refer to sections 6.10.1 to 6.11.1) and the Queensland SuperGrid Infrastructure Blueprint and will be updated in subsequent reviews.

6.10.1 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 (refer to Figure 6.12). The network is located more than 150km from the coast in a dry environment making infrastructure less susceptible to corrosion. As a result transmission lines and substations in this region have met (and in many instances exceeded) their anticipated service life but will still require replacement or rebuilding in the near future.

Figure 6.12 Central West 132kV transmission network



Possible load driven limitations

Based on AEMO's Step Change scenario forecast discussed in Chapter 3 and the committed generation described in tables 7.1 and 7.2, there is no additional capacity forecast to be required in the Central West zone within the next five years to meet reliability obligations.

Possible network investments within five years

Any forecast network investments 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
Asset details	Established in the mid-1980s
Project driver	Addressing the 275kV primary plant condition risks
Project timing	December 2028
Proposed network solution	Selected primary plant replacement at Calvale Substation at an estimated cost of $18 million by December 2028
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. Calvale Substation is also a major transmission node in Central Queensland connecting power flows between northern, central and southern Queensland. It also facilitates Callide B and Callide C generation connection, and also provides voltage support for the region.

Calvale Substation is a critical part of the Central West Queensland transmission network and provides connection to Callide B and Callide C generators.

Possible network solutions may include:

- Selected primary plant replacement by December 2028
- Full primary plant replacement by December 2028.

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

Broadsound 275kV Substation

Potential consultation	Maintaining reliability of supply at Broadsound
Asset details	Established in 1983. Further extensions have been made with additions of 275kV feeders to the West, South and North.
Project driver	Addressing the 275kV primary plant condition risks
Project timing	December 2027
Proposed network solution	Selected primary plant replacement at Broadsound Substation at an estimated cost of $19 million by December 2027
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.

Possible network solutions may include:

- Selected primary plant replacement by December 2027
- Full primary plant replacement by December 2027.

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

Possible asset retirements within the 10-year outlook period[24]

Calvale to Moura to Baralaba 132kV transmission lines

Subject to the outcome of further analysis and RIT-T consultation, a new 132kV double circuit transmission line may be constructed between Calvale and Moura substations due to a step change in load growth at Moura Substation or end of technical service life of the existing single circuit transmission lines within the 10-year outlook period. The reconfiguration allows Powerlink to mothball the existing single circuit transmission lines between Calvale and Baralaba, and Baralaba and Moura substations, and the Baralaba Substation, at the end of their technical service lives and be retired from service.

Baralaba to Blackwater 132kV transmission line

The 132kV inland transmission line was constructed in the mid-1960s to support the loads in the Central West area and due to network reconfiguration has no enduring need. This transmission line is mothballed as part of the economic end of technical service life strategy, and is energised from Blackwater Substation (and disconnected at the Baralaba Substation) for maintenance purposes. The transmission line may be repurposed or rebuilt in part to facilitate new connections to Blackwater Substation in the future.

Refer to Table 6.10 for possible asset retirements beyond the 10-year outlook period.

6.10.2 Gladstone zone

Existing network

The Gladstone 275kV network was initially developed in the 1970s with the Gladstone Power Station (GPS) and has evolved over time with the addition of the Wurdong Substation and supply into Boyne Smelters Limited in the early 1990s (refer to Figure 6.13).

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

Figure 6.13 Gladstone transmission network

Possible load driven limitations

AEMO's Step Change scenario forecast discussed in Chapter 3 has approximately 250MW of additional load connected in the Gladstone zone by 2031. This load is associated with electrification of a component of the existing industrial processes within the area. While Powerlink has no commitment from any direct connect customers to electrify existing industrial process, Powerlink is in discussions with corporations that have committed to decarbonisation of their existing fossil fuelled operations. Therefore, for this TAPR, any additional capacity forecast to be required to meet this increase of 250MW load will only be considered in the context of the main 275kV network supplying the Gladstone zone. Network limitations downstream of the main transmission system cannot be assessed without specific customer identification.

In addition, the new electrification loads and any other new loads have the potential to impose significant limitations impacting market outcomes as well as reliability of supply obligations. Possible network solutions to address these issues are outlined in Section 8.2.3.

Notwithstanding this additional electrification load and any future new loads and taking into account the committed generation described in tables 7.1 and 7.2, there is no additional capacity forecast to be required in the Central West zone within the next five years to meet reliability obligations.

Possible network investments within five years

Network investments (which includes reinvestment and augmentations) 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 NER 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 line

Potential consultation	Maintaining reliability of supply in the Gladstone region
Asset details	Constructed in 1977
Project driver	Emerging condition risks due to structural corrosion
Project timing	June 2029
Proposed network solution	Rebuild the 275kV transmission line between Calliope River and Larcom Creek substations as double circuit high capacity transmission line and turn in one or both circuits to Larcom Creek Substation at an estimated cost of $107 million, by June 2029
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. The line is also critical for delivering power to the Calliope River Substation, Calliope River Substation supplies the existing loads at Gladstone South, Queensland Alumina Limited (QAL) and part of Boyne Smelters Limited. Any non-network solution would also need to address this supply requirement.

The transmission line between Calliope River and Larcom Creek is located in Central Queensland immediately adjacent to the Gladstone industrial area. This built section covers the distance between Calliope River and Larcom Creek via Yarwun Substation. 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 may include:

- Line refit works on steel lattice structures between Mt Miller near Calliope River and Larcom Creek
- 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 and turn-in one circuit to Larcom Creek substation
- Rebuild the 275kV transmission line between Calliope River and Larcom Creek as double circuit transmission line construction and turn-in both circuits to Larcom Creek substation.

The proposed network solution is heavily influenced by the energy transformation. There are several drivers, yet to be committed, that can have a material impact on the transmission capability required into the Gladstone zone. A number of corporations have committed to the decarbonisation of existing fossil fuelled operations and processes either through electrification or clean fuel substitution. This will have the impact of materially changing the supply and demand balance of the Gladstone zone necessitating greater transmission capability. Refitting this low capacity 275kV line or constructing a new higher capacity single circuit 275kV line is not aligned with this broader strategy (refer to Section 8.2.3).

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

Possible future development

This transmission line forms part of the existing two 275kV single transmission lines between Bouldercombe and Calliope River substations. Due to the potential for significant change in future supply demand balance within the Central Queensland region, and the potential for growing power transfer requirements from North Queensland and South Queensland, Powerlink is preserving the option to retain both 275kV transmission lines to ensure shared network needs can be met across a range of plausible development scenarios. It is expected the scale and configuration of the optimal network investment will require one single circuit transmission line to be rebuilt as a high capacity double circuit, with the other single circuit to be maintained through line refit works in the 10-year outlook period and subject to a future RIT-T consultation (refer to Appendix D, Table D.5).

The current strategy for these two 275kV single circuit lines is to construct a new high capacity 275kV double circuit transmission line between Bouldercombe and Larcom Creek Substation (refer to Section 8.2.3). This new build is adjacent (on an existing double width easement) to the existing more western single circuit 275kV line between Bouldercombe and Calliope River substations (feeder 812). This line traverses valuable wind resources in the area and will divert to Larcom Creek Substation at a suitable location where the future 500/275kV substation west of Gladstone under the QEJP will be located.

Calliope River to Gladstone South 132kV transmission lines

Anticipated consultation	Maintaining reliability of supply to Gladstone South
Asset details	Constructed in 1977
Project driver	Emerging condition risks due to structural corrosion
Project timing	June 2026
Proposed network solution	Rebuild the double circuit transmission line between Calliope River and Gladstone South substations, at an estimated cost of $53 million, by June 2026
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.

The Calliope River to Gladstone South 132kV double circuit transmission line facilitates supply to Gladstone South Substation which is an Ergon Energy bulk supply point and the connection point for QAL.

Possible network solutions may include

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

In making this investment decision Powerlink will also take into account the possible decarbonisation of existing fossil fuelled operations and processes that are currently supplied from this network. This may impact the scale and configuration of the optimal network investment. These development plans will be reported in subsequent TAPRs as more certainty and commitment of these additional loads emerge.

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

Substations

Callemondah 132kV Substation

Anticipated consultation	Maintaining reliability of supply at Callemondah
Asset details	Established in 1985 and provides supply to the Aurizon network
Project driver	Addressing the 132kV primary plant and secondary systems condition risks
Project timing	June 2025
Proposed network solution	Selected primary plant and secondary systems replacement at Callemondah Substation at an estimated cost of $10 million by June 2025
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 solutions may include:

- Full primary plant and secondary systems replacement by June 2025
- Selected primary plant and secondary systems replacement by June 2025.

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

Possible asset retirements within the 10-year outlook period[25]

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.

Refer to Table 6.10 for possible asset retirements beyond the 10-year outlook period.

6.11 Southern region

The Southern region includes proposed network investments located within the Wide Bay, South West, Surat, Bulli, Moreton and Gold Coast zones. The region broadly aligns with the Southern Queensland REZ proposed development area (refer to Figure 6.6). The Southern region includes a diverse range of industries and large load centres with considerable opportunity to connect renewable energy resources such as wind and solar to the transmission network. It is also located close to QNI. The Southern region also includes a number of candidate REZ areas in southern Queensland identified in the draft Queensland Renewable Energy Zone Roadmap and 2022 ISP (refer to Section 2.4.1).

The investments outlined in Section 6.11 are based on AEMO's 2023 ESOO Step Change scenario forecast in the 10-year outlook period. Given Powerlink's integrated planning approach, and the rapidly evolving environment of the energy transformation, these requirements may result in the need for new investments that impact the proposed future network and non-network solutions identified in the geographical zones located within this region (refer to sections 6.15 and 8.2.4), including the Queensland SuperGrid Infrastructure Blueprint and will be updated in subsequent reviews.

6.11.1 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 6.14). These transmission lines traverse a variety of environmental conditions and as a result exhibit different corrosion rates and risk profiles.

Figure 6.14 CQ-SQ transmission network

Possible load driven limitations

Based on AEMO's Step Change 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.

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

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 bid 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.

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. In order for power from new and existing NQ and CQ VRE generating systems to make its way to southern Queensland and the southern states, it must be transferred through the CQ-SQ grid section. The utilisation may increase following the commissioning of the QNI Minor project (refer to Section 6.13).

The 2022 ISP identified a potential Central to Southern Queensland network project as a Future ISP project. Powerlink and AEMO (through the ISP process) will continue to investigate the impact of large-scale VRE generation investment in the Queensland region.

Possible network solutions to facilitate efficient market operation are outlined in Section 8.3.2.

Possible network investments within five years

Network reinvestments (which includes reinvestment and augmentations) in the 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
Asset details	Progressively developed during 1970s and 1980s
Project driver	Emerging condition and compliance risks related to structural corrosion
Project timing	December 2028 to June 2029
Proposed network solution	Rebuild two of the three single circuit transmission lines between Calliope River and Wurdong Tee as a double circuit at an estimated cost of $40 million by December 2028. Line refit works on the remaining single circuit 275kV transmission line between Calliope River Substation and Wurdong Substation at an estimated cost of $14 million by June 2029. 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 June 2030. Line refit works on the 275kV transmission single circuit transmission line between Woolooga and South Pine substations at an estimated cost of $16 million by June 2029.
Possible non-network solutions	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.

The coastal CQ-SQ transmission network between Calliope River and South Pine substations provides essential supply between the generation in central and north Queensland and the loads in 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 in targeted sections.

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).

Powerlink, through the ISP process, will continue to investigate the impact of investment in large-scale VRE generation and firming generation in the Queensland region on the utilisation and economic performance of the CQ-SQ grid section. Powerlink also considers the emerging condition based drivers as part of the integrated planning process to ensure that overall the most cost effective solutions are delivered for customers.

The current long-term network strategy based on existing network topology is to rebuild two of the 275kV single circuit transmission lines from Calliope River to South Pine as a double circuit at end of technical service life. The third circuit between Calliope and Woolooga substations is expected to be economic to maintain in the medium term through targeted refit. When this circuit is dismantled, Wurdong Substation would be supplied from Calliope River via a dedicated 275kV double circuit transmission line and single circuit 275kV transmission line from Calvale Substation.

Strategies to address the transmission line sections with advanced corrosion in the five-year outlook will be economically assessed in consideration of longer term network needs based on future generation and network requirements. Given Powerlink's integrated planning approach and the fast evolving environment of the energy transition, these requirements may result in the need for new investments that impact the proposed future network and non-network solutions identified and will be updated in subsequent reviews of the Infrastructure Blueprint and TAPR. Such decisions will be undertaken using the RIT-T consultation process, where the benefits of non-network options will also be assessed.

The longer term network solution options to address the condition based drivers 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 staged rebuild and line refit projects
- 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.

Closer to the timing of the investment decision and as part of the option analysis under the RIT-T, Powerlink will consider whether the proposed preferred option will have a material inter-network impact.

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.

Refer to Table 6.10 for possible asset retirements beyond the 10-year outlook period.

6.11.2 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 upstream processing facilities by multiple proponents, together with the supporting infrastructure and services (refer to Figure 6.15).

Figure 6.15 Surat Basin North West area transmission network

Possible load driven limitations

Based on AEMO's Step Change 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 investments within the five year outlook period

Current planning analysis has not identified any assets requiring investment in the Surat zone within the next five years.

Possible asset retirements within the 10-year outlook period

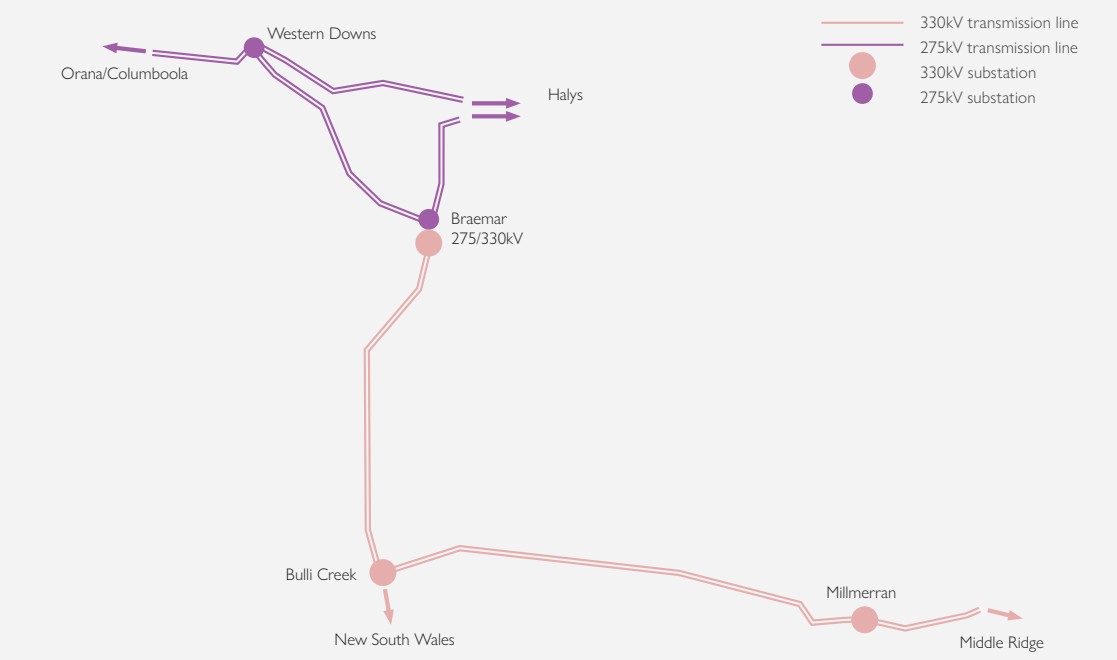
Current planning analysis has not identified any potential asset retirements in the Surat zone within the 10-year outlook period.

6.11.3 Bulli zone

Existing network

The Bulli zone is defined as the area surrounding Goondiwindi and the 330kV and 275kV network south of Kogan Creek Power Station and west of Millmerran Power Station (refer to Figure 6.16).

Figure 6.16 Bulli area transmission network



Possible load driven limitations

Based on AEMO's Step Change 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 investments within the five year outlook period

Current planning analysis has not identified any assets requiring investment above the RIT-T cost threshold in the Surat zone within the next five years.

Possible asset retirements within the 10-year outlook period

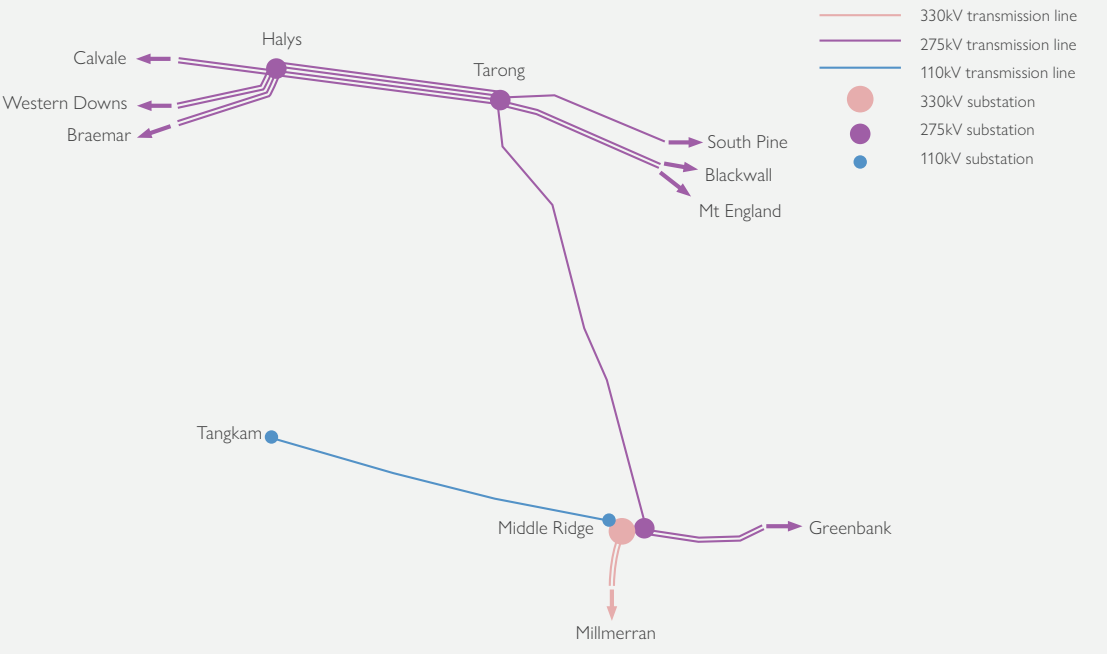
Current planning analysis has not identified any potential asset retirements in the Bulli zone within the 10-year outlook period.

6.11.4 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 6.17).

Figure 6.17 South West area 330kV and 275kV network



Possible load driven limitations

Based on AEMO's Step Change 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 investments within the five year outlook period

Current planning analysis has not identified any assets requiring investment in the South West zone within the next five years.

Possible asset retirements within the 10-year outlook period[26]

Refer to Table 11.7 for confirmed asset retirements in the South West zone and Table 6.10 for possible asset retirements beyond the 10-year outlook period.

6.11.5 Moreton zone

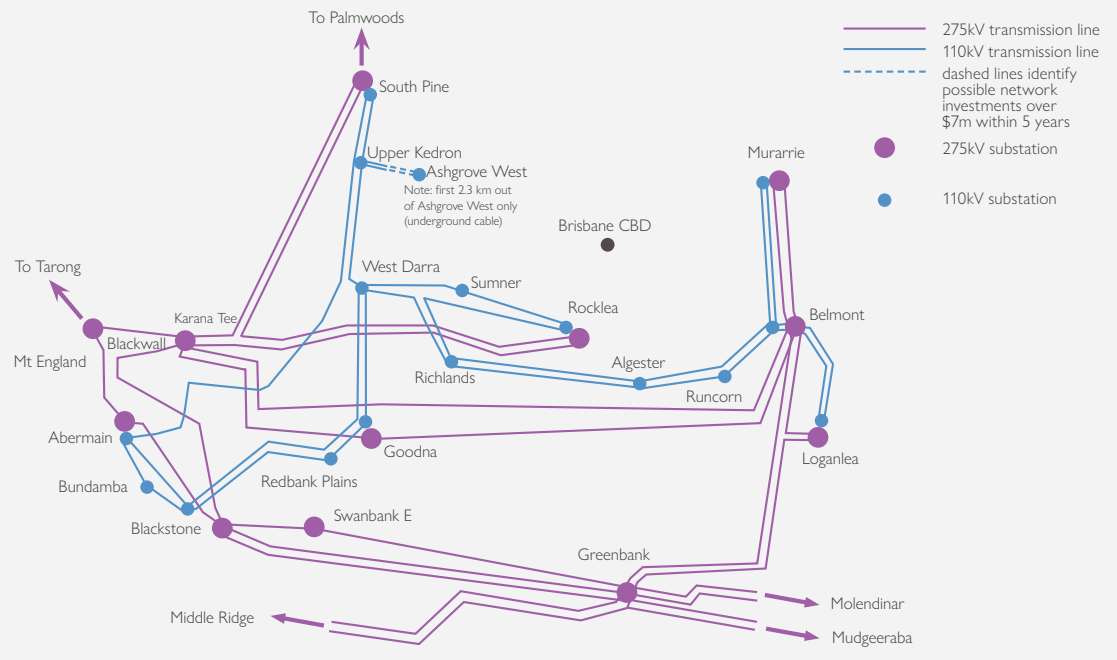
Existing network

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 6.18).

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).

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

Figure 6.18 Greater Brisbane transmission network



Possible load driven limitations

Based on AEMO's Step Change scenario forecast discussed in Chapter 3 and the committed generation described in tables 7.1 and 7.2, 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 within five years

Network investments (which includes reinvestment and augmentations) in the 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 the end of the 2020s and into the early 2030s.

With maximum demand expected to maintain low growth over the next 10 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

Anticipated consultation	Maintain reliability of supply at Ashgrove
Asset details	Constructed in 1978
Project driver	Emerging condition, end of technical service life and compliance risks for the Upper Kedron to Ashgrove West underground cables.
Project timing	June 2028
Proposed network solution	Replacement of the oil-filled cables with new cables in a new easement at an estimated cost of $18 million by June 2028
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.

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

Possible network solutions may include:

- Replacement of existing cables with new cables in a new easement by June 2028
- Replacement of existing cables with new cables in the existing easement by June 2028.

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

Substations

Current planning analysis has not identified any substation assets requiring investment in the Moreton zone within the next five years.

Possible asset retirements within the 10-year outlook period

Loganlea 110/33kV transformer

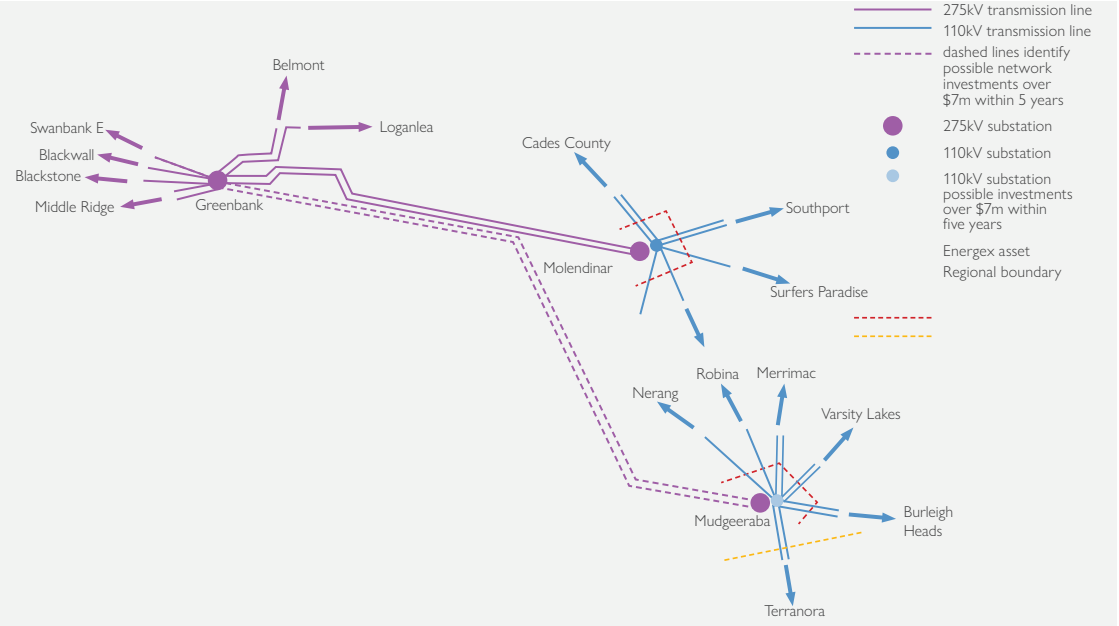
Based on the condition of one of the 110/33kV transformers at Loganlea, it is proposed to retire this transformer at the end of technical service life by June 2026. Powerlink considers that this will not impact on the ability to meet the obligations of Powerlink's reliability criteria. Since publication of the 2022 TAPR, joint planning with Energex has confirmed that based on the most recent load forecast, there is no enduring requirement for the transformer.

6.11.6 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 6.19).

Figure 6.19 Gold Coast transmission network



Possible load driven limitations

Based on AEMO's Step Change 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 investments within five years

Network investments (which includes reinvestment and augmentations) in the 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
Asset details	Constructed in the mid-1970s
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 million to $53 million by December 2028
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.

The two 275kV single circuit transmission lines between Greenbank and Mudgeeraba substations support the supply to Gold Coast and northern NSW.

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.

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.

Substations

Mudgeeraba 275/110kV Substation

Mudgeeraba 275/110kV Substation, located within the southern end of the Gold Coast zone, 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 primary plant and secondary systems

Anticipated consultation	Maintaining reliability of supply at Mudgeeraba
Asset details	Established in 1972 and expanded progressively from 1980s to 2000s
Project driver	Emerging condition risks arising from the condition of the 110kV primary plant and secondary systems
Project timing	June 2029
Proposed network solution	Selected replacement of primary plant and staged replacement of secondary systems at an estimated cost of $33 million
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.

Possible network solutions may include:

- Selected replacement of primary plant and staged replacement of the secondary systems components by June 2029
- Full replacement of all primary plant and secondary systems by June 2029.

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

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.

6.12 Supply demand balance

The outlook for the supply demand balance for the Queensland region was published in the AEMO ESOO[27]. Interested parties who require information regarding future supply demand balance should consult this document.

6.13 Existing interconnectors

Powerlink and Transgrid completed a RIT-T in December 2019 on 'Expanding NSW-Queensland transmission transfer capacity'. The recommended QNI Minor Project included uprating the 330kV Liddell to Tamworth 330kV lines, and installing SVCs at Tamworth and Dumaresq substations and static capacitor banks at Tamworth, Armidale and Dumaresq substations. Transgrid completed the commissioning of these works by May 2022.

[27] Published by AEMO in August 2023.

After consultation and in accordance with Clause 5.7.7(p) of the NER, Transgrid, Powerlink and AEMO published a final inter-network test program in May 2022 and commenced looking for test opportunities from June 2022. The Test Plan requires the flows on the interconnector to reach specific levels (hold points) for a period of approximately three hours to allow switching tests and monitoring of damping levels using the on-line Oscillatory Stability Monitoring with comparative small signal stability assessment using system snapshots to occur. Normal market dispatch is being relied on to deliver these required transfer levels.

AEMO, Transgrid and Powerlink aimed to achieve full commercial service of the QNI upgrade by mid-2023. However, due to non-availability of favourable market and test conditions, only a modest increase to the QNI transfer capability has been released. The northerly hold point has now been increased from 600MW to 700MW and the southerly hold point from 1,200MW to 1,300MW.

In response to this lack of available market and test conditions, the test plan was revised to remove the requirement for extended periods at a given transfer level hold-point. This will allow testing to proceed in the event of availability of favourable test conditions for shorter periods availing more testing opportunities. These tests are expected to continue until mid-2024.

6.14 Transmission lines approaching end of technical service life beyond the 10-year outlook period

As transmission lines approach their anticipated end of technical service life, detailed planning studies are undertaken to confirm the asset's enduring need taking into consideration asset condition and risk as well as alignment with future investment or possible network optimisation strategies. Options considered may include line refit, targeted and/or staged refit or replacement, upfront replacement or rebuild, network reconfiguration, non-network alternatives, asset de-rating or retirement.

The information contained in Table 6.10 which goes five years beyond the 10-year outlook period of the 2023 TAPR, is provided in good faith[28] and is the best information available at the time of TAPR publication. Transmission equipment ratings information is available on AEMO's website and can also be accessed via the link in the TAPR Portal.

Given the rapid speed of the energy transformation, proponents who wish to connect to Powerlink's transmission network are strongly encouraged to contact BusinessDevelopment@powerlink.com.au in the first instance.

[28] For completeness, please refer to Powerlink's Disclaimer on **page 2**.

Table 6.10 Transmission Lines approaching end of technical service: 10-15 years (July 2034 – June 2039)

Region	Zone	Feeder	Voltage	General location
Northern	Far North	7165	132kV	Between Chalumbin and Turkinje substations
Northern	Far North	7227	132kV	Between Cairns and Woree substations
Northern	Far North	7191	132kV	Kareeya to Chalumbin substations
Northern	Ross	879	275kV	Between Strathmore and Ross Substation
Northern	Ross	7131	132kV	Between Clare South and Townsville South substations
Northern	North	7152	132kV	Between Eton and Alligator Creek substation
Northern	North	7119	132kV	Between Pioneer Valley and Alligator Creek substations
Northern	North	7238	132kV	Between Pioneer Valley and Mackay substations
Northern	North	820	275kV	Between Bouldercombe and Broadsound substations
Central	Central West	7150	132kV	Between Lilyvale and Dysart substations
Central	Central West	7109	132kV	Between Baralaba and Calvale substations
Central	Central West	7110	132kV	Between Calvale and Moura substations
Central	Central West	7112	132kV	Between Baralaba and Moura substations
Central	Central West	833	275kV	Between Broadsound and Lilyvale substations
Central	Central West	7124	132kV	Between Moranbah and Dysart substations
Central	Gladstone	7145	132kV	Between Calliope River and Boyne Island substations
Central	Gladstone	7221	132kV	Between Bouldercombe and Egans Hill substations
Central	Gladstone	871	275kV	Between Calvale and Wurdong substations
Central	Gladstone	848	275kV	Between Stanwell and Bouldercombe substations
Southern	Wide Bay	8850	275kV	Between Woolooga and Teebar Creek substations
Southern	Wide Bay	813	275kV	Between Woolooga and Gin Gin substations
Southern	Wide Bay	814	275kV	Between Woolooga and Gin Gin substations
Southern	Wide Bay	819	275kV	Between Teebar Creek and Gin Gin substations
Southern	Wide Bay	807	275kV	Between South Pine and Woolooga substations
Southern	Wide Bay	810	275kV	Between Woolooga and Palmwoods substations
Southern	Wide Bay	808	275kV	Between South Pine and Palmwoods substations
Southern	South West	831	275kV	Between Tarong and Middle Ridge substations
Southern	South West	827	275kV	Between Tarong and Blackwall substations
Southern	Moreton	8819	275kV	Between Blackwall and Greenbank substations
Southern	Moreton	829	275kV	Between Loganlea and Belmont substations
Southern	Moreton	8822	275kV	Between Greenbank and Belmont substations
Southern	Moreton	825	275kV	Between Mt England and South Pine substations
Southern	Moreton	832	275kV	Between Tarong and South Pine substations

6.15 Alignment with AEMO's 2022 Integrated System Plan

The 2022 ISP published by AEMO in June 2022 provides a strategic view of the efficient development of the NEM transmission network to 2050.

The installation of large-scale VRE generation is changing the mix of generation and impacting the utilisation of existing transmission infrastructure. This has been most evident across the Central to North Queensland and Central to South Queensland grid sections (refer sections 7.6.2 and 7.6.5 respectively) and QNI. This has implications for investment in the transmission network both inter-regional and within Queensland.

These impacts have been investigated in the 2022 ISP. The 2022 ISP identified that to deliver low-cost, secure and reliable energy, investments in transmission are needed. Although no 'actionable' projects were identified for Queensland, several Queensland projects were identified as part of the optimal development path that may become 'actionable' in future ISPs. These projects will be vital to achieving lower cost solutions that meet energy security and reliability, affordability and reduced emissions.

Two projects were nominated for preparatory activities. These include:

- AEMO's Darling Downs REZ Expansion (Stage 1)
- QNI Connect (500kV option).

Powerlink completed the preparatory activities for each project as required by 30 June 2023. These reports are available on AEMO's website[29]. Each Preparatory Report provides the following information:

- Project scope and single line diagrams
- Electrical network parameters
- Ratings of network equipment
- Power transfer limits for the existing network and following the augmentation project
- High level cost estimate.

Three additional projects were identified as requiring no action as AEMO will leverage the estimated project costs from previous preparatory activities. These include:

- Central to Southern Queensland reinforcement
- Gladstone Grid reinforcement
- QNI Connect (330kV option).

For Gladstone Grid reinforcement and QNI Connect (330kV option) Powerlink has provided AEMO with updates to the project scopes to enable AEMO to reflect these changes into their updated project estimates.

This information will be used by AEMO to better inform the optimal development path for the 2024 ISP.

6.15.1 Expanding NSW-Queensland transmission transfer capacity

Increasing the capacity of interconnection between NEM regions is essential in order to take advantage of the geographic diversity of renewable resources so regions can export power when there is local generation surplus, and import power when needed to meet demand. Appropriate intra-regional transmission capacity is required to support these objectives.

The 2022 ISP identified that further upgrade of the transmission capacity between Queensland and NSW (coined 'QNI Connect') is an integral part of the optimal development plan with a timing as early as 2029-30 in the Hydrogen Export scenario forecast and 2032/33 in the Step Change scenario forecast.

As the likely timing (2032/33) is beyond a practical delivery timing, AEMO did not declare QNI Connect as an actionable project. Rather it recommended that Powerlink and Transgrid carry out further preparatory activities to better inform options for the 2024 ISP. AEMO required preparatory activities to be undertaken for a 500kV option for both NSW and Queensland scope.

Powerlink consulted with Transgrid on a number of options to increase the capacity of QNI. These options also align with long-term development plans in both states to host more VRE generation. The preparatory activities, as outlined in this section, were completed by 30 June 2023 so that estimated costs and capacity improvements could be included in the 2024 Draft ISP.

[29] AEMO | 2023 Transmission Expansion Options Report Consultation (Reference materials) etc.

Possible network solutions

Options to upgrade QNI capacity include both 330kV and 500kV options:

- Construct a 330kV single circuit between Powerlink's Bulli Creek Substation and follow the existing 330kV line except traversing to the west and then south-west of Armidale to connect to the New South Wales (NSW) planned New England Central Hub Substation. The single circuit line would be switched at Transgrid's Dumaresq and the New England Central Hub Substation connecting to Transgrid's existing Armidale and Tamworth substations. The proposed route traverses the New England REZ (within AEMO's North West NSW) and Darling Downs REZs.
- A variation to the option above is to connect the 330kV single circuit line from Powerlink's Braemar Substation and then to the NSW border (via Bulli Creek Substation) and beyond as per the option above.
- Construct a 330kV double circuit between Powerlink's Bulli Creek Substation and follow the existing 330kV line except traversing to the west and then south-west of Armidale to connect to the New England Central Hub Substation, as per the single circuit options above.
- Construct a double circuit 500kV line between Powerlink's Halys Substation and Transgrid's New England Hub Substation and connecting at 330kV to Transgrid's Dumaresq Substation with associated supporting plant.

6.15.2 CQ-SQ grid section reinforcement

The utilisation of the CQ-SQ grid section is highly dependent on generation and load in Central and North Queensland. As new generation connects in Central and North Queensland, congestion along this corridor may increase and generation may be curtailed. Upgrading the capacity of QNI may also add to the congestion of this grid section. The 2022 ISP has identified a further upgrade of QNI capacity.

In the 2020 ISP, AEMO recommended Powerlink complete preparatory activities to increase transfer capability from CQ-SQ grid section. For the 2022 ISP, two options were selected. One option makes use of the existing transmission line with a mid-point switching station between Calvale and Halys substations. The other option includes a new double-circuit transmission line. For the 2024 ISP, since no changes are anticipated for this project, AEMO will escalate the estimated cost of the preparatory activities delivered for the 2022 ISP.

The 2022 ISP identified a staged approach to upgrade CQ-SQ as part of the optimal development path. The upgrade is critical for unlocking VRE resources in the North, Isaac, and Fitzroy REZs to deliver efficient market outcomes.

Under the Step Change scenario forecast an incremental upgrade was identified as economic by 2028/29. This involves establishing a mid-point switching station on the Calvale to Halys 275kV transmission line. By 2038/39 a more material upgrade has been identified as economic, involving the construction of a new 275kV double circuit transmission line between Calvale and Wandoan South substations.

Following the release of the QEJP in September 2022, Powerlink and Queensland Government have discussed the pathway for consideration for direct inclusion of elements of the Infrastructure Blueprint in the 2024 ISP. Section 2.3 outlines the components of the Queensland SuperGrid transmission backbone. AEMO will consider the Borumba PHES as an anticipated project and therefore may be selected as part of the optimal development path in all scenarios. If AEMO's ISP model selects Borumba PHES then it will be connected to the transmission system via a 500kV network between Halys, Borumba, Woolooga West and Gladstone West 500kV substations. This is described as Stages 1 and 2 in Section 2.3 and shown diagrammatically in Figure 2.3.

Stage 2, a 500kV double circuit line between Woolooga West and Gladstone West Substation, will therefore also be available as a network option to increase the power transfer capacity between Central and Southern Queensland.

Possible network solutions

Feasible network solutions to facilitate efficient market operation may differ in scale. These include:

- establishment of a mid-point switching substation on the 275kV double circuit between Calvale and Halys substations
- construction of a 275kV double circuit transmission line between Calvale and Wandoan South Substation
- construction of a 500kV double circuit transmission line between Central Queensland and Halys Substation

- a grid-scale battery system. A Virtual Transmission Line (VTL) option could comprise of grid-scale batteries on both sides of CQ-SQ, or a grid-scale battery on the south side and a braking resistor or generator tripping scheme on the northern side
- A 1,500MW high voltage direct current (HVDC) bi-pole overhead transmission line from Calvale and South West Queensland.

Powerlink, through the ISP process and modelling associated with the QEJP, will continue to investigate the impact of investment in large-scale VRE generation and firming generation in the Queensland region on the utilisation and economic performance of the CQ-SQ grid section. Powerlink also considers the emerging condition based drivers (refer to Section 6.11.1) as part of the integrated planning process to ensure that overall the most cost effective solutions are delivered for customers. Such decisions will be undertaken using the RIT-T consultation process, where the benefits of non-network options will also be considered.

6.15.3 Gladstone grid section reinforcement

The 2022 ISP identified significant increases in VRE generation for the North, Isaac, and Fitzroy REZs. With this additional generation and the retirement or reduced generation from Gladstone Power Station, the transmission network which supplies the Gladstone area will not be adequate to maintain the required reliability of supply to customers in the Gladstone zone. If major industrial loads are electrified, or if large hydrogen projects progress, there is a further material shift in the supply-demand balance in the Gladstone area. These scenarios and the consequences for network development have been addressed in Section 8.2.3.

In the 2020 ISP, AEMO recommended Powerlink complete preparatory activities for reinforcement of Gladstone grid section. New 275kV transmission lines are proposed to increase the network transfer capability between Central West and Gladstone zones. For the 2024 ISP, AEMO has aligned the scope and cost of the project to match the higher capacity conductor proposed to be used (refer to Section 8.2.3).

Under the Step Change scenario forecast, the 2022 ISP identified a need to materially upgrade the transmission capacity from Calvale and Bouldercombe substations into the Gladstone zone and also increase the 275/132kV transformation capacity in the Gladstone zone.

Possible network solutions

Feasible network solutions to facilitate efficient market operation and also deliver reliability of supply obligations in the Gladstone zone have been outlined in Section 8.2.3. In addition to these options, a new high capacity 275kV double circuit transmission line between Bouldercombe, Raglan, Larcom Creek and Calliope River substations would also increase capacity.

Powerlink, through the ISP process and modelling associated with the QEJP, will continue to investigate the impact that investment in large-scale VRE generation and firming generation, reduced operation of the Gladstone Power Station, electrification of existing industrial processes and/or development of new industry load will have on the utilisation and economic performance of the Gladstone grid section. Powerlink will also consider the emerging condition based drivers as part of the integrated planning process to ensure that overall the most cost effective solutions are delivered for customers.

6.15.4 AEMO's Darling Downs REZ Expansion

AEMO's Darling Downs REZ extends from the border of NSW near Dumaresq to Columboola within the Surat zone of Queensland. The Darling Downs REZ has high network capacity and is near QNI and Brisbane. The area has abundant high quality solar and wind resources. A number of large-scale solar and wind projects are already connected or committed within the zone (refer to tables 7.1 and 7.2). Furthermore, the ultimate retirement of thermal generation within this REZ will also release network capacity to allow for additional VRE connections. However, given the abundant high quality solar and wind resources in this REZ and that the energy transformation will require significantly more renewable generation to connect in the REZ, expansion of the Darling Downs REZ will be required.

The Darling Downs REZ connects to South East Queensland (SEQ) across two transmission corridors; a northern corridor that consists of five 275kV transmission circuits from the Tarong Substation to SEQ and a southern corridor that consists of two 330kV transformer ended (330/275kV) circuits between Millmerran and Middle Ridge substations.

The 2022 ISP analysis found that under high demand conditions, this southern corridor can only facilitate 1,300MW into SEQ from generation connected around the Bulli Creek area. This is due to a 300/275kV transformer limitation at the Middle Ridge Substation. Therefore, VRE generation will need to connect around the Halys area to increase the overall VRE hosting capacity of the Darling Downs REZ.

Notwithstanding connection of VRE generation to the more northern regions of the REZ, the 2022 ISP identified that the Middle Ridge transformer rating is a limitation to the development of the Darling Downs REZ. It identified the earliest timing for this expansion as 2025/26 in the Hydrogen Export scenario forecast and 2028/29 in the Step Change scenario forecast. The timing of these upgrades will also be influenced by generation retirements and any QNI upgrades.

AEMO identified expansion of the Darling Downs REZ for preparatory activities. The Darling Downs REZ Expansion report was finalised for AEMO in June 2023.

Possible network solutions

Feasible network solutions to expand the capacity of the Darling Downs REZ include:

- Replacement of the existing 1,300MVA 330/275kV transformer at Middle Ridge with a 1,500MVA 330/275kV transformer
- Implementation of a Special Protection schemes (SPS), including pairing a large-scale BESS in SEQ and generation runback.

Powerlink, through the ISP process and modelling associated with the QEJP, will continue to investigate the impact that investment in large-scale VRE generation and reduced operation of the thermal generation in the Darling Downs REZ area has on the utilisation and economic performance of the transmission between the Darling Downs REZ and SEQ. Powerlink will also consider the emerging condition based drivers as part of the integrated planning process to ensure that overall the most cost effective solutions are delivered for customers.