Chapter 6:
Strategic planning

6 Strategic planning

Key highlights

- This chapter identifies possible network limitations which may arise between the five and 10-year outlook period and provides potential network solutions.
- Long-term planning takes into account:
  - the role network is to play in enabling the transition to a lower carbon future while continuing to balance the economic and efficient development of the network; and
  - uncertainties in load growth and sources of generation, and the condition and performance of existing assets to optimise the network that is best configured to meet current and a range of plausible future capacity needs.
- Plausible new loads within the resource rich areas of Queensland or at the associated coastal port facilities may cause network limitations to emerge within the 10-year outlook period. Possible network options are provided for Bowen Basin coal mining area, Bowen Industrial Estate, Galilee Basin coal mining area, CQ-NQ grid section, Central West to Gladstone and the Surat Basin north west area.
- Assets where reinvestment will need to be made in the next five to 10-year period where there may be opportunities for reconfiguration include Ross, Central West and Gladstone zones and CQ-SQ grid section.

6.1 Background

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

A key step in this process is the development of long-term strategic plans for both the main transmission network and supply connections within the zones. These long-term plans take into consideration uncertainties in the future. This can impact potential sources of generation and load growth. Uncertain load growth can occur due to different economic outlooks, emergence of new technology and the commitment and/or retirement of large industrial and mining loads.

There is also considerable uncertainty in generation. Queensland is experiencing a high level of growth in variable renewable electricity (VRE) generation, in particular small and large-scale solar photovoltaic (PV) and wind farm generation, either being connected or proposing to connect to the transmission and distribution networks. This new generation, together with generation that may be displaced in or outside Queensland, has the potential to significantly impact the utilisation and flow patterns of the transmission network including major grid sections. Long-term plans need to take into account the role network is to play in enabling the transition to a lower carbon future while continuing to balance the economic and efficient development of the network.

Long-term plans also take into consideration the condition and performance of existing assets. As assets reach the end of technical or economic life, reinvestment decisions are required. These decisions are made in the context of the required reliability standards, load forecast and generation outlook. Reinvestment decisions also need to be cognisant of the uncertainties that exist in the generation and load growth outlooks.

As assets reach the end of technical or economic life, opportunities may emerge to retire without replacement, initiate non-network alternatives, extend technical life or replace with assets of a different type, configuration or capacity. Powerlink considers options to integrate demand based limitations and condition based risks of assets to ensure an optimised network that is best configured to meet current and a range of plausible future capacity needs.

Information in this chapter is organised in two parts. Section 6.2 discusses the possible impact uncertain load growth may have on the performance and adequacy of the transmission system. This discussion is limited to the impact possible new large loads may have on the network (refer to Table 2.1). Section 6.3 provides a high-level outline of the possible network development plan for investments required to manage risks related to the condition and performance of existing assets. This high-level outline is discussed for parts of the main transmission system and within regional areas where the risks based on the condition and performance of assets may initiate investment decisions in the five to 10-year outlook period of this Transmission Annual Planning Report (TAPR). Information on reinvestment decisions within the current five-year outlook period of this TAPR is detailed in Chapter 4.

Powerlink considers it important to identify these long-term development options so that analyses using a scenario based approach, such as the Australian Energy Market Operator's (AEMO) National Transmission Network Development Plan (NTNDP), are consistent. In this context the longer-term plans only consider possible network solutions. However, this does not exclude the possibility of non-network solutions or a combination of both. As detailed planning studies are undertaken around the future network need and possible reinvestment options, Powerlink will identify the requirements a non-network solution would need to offer in order for it to be a genuine alternative to network investment. Subject to the cost threshold of $6 million, these non-network options will be fully evaluated as part of the Regulatory Investment Test for Transmission (RIT-T) process.

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

Chapter 2 provides details of several proposals for large mining, metal processing and other industrial loads whose development status is not yet at the stage that they can be included (either wholly or in part) in the medium economic forecast. These load developments are listed in Table 2.1.

The new large loads in Table 2.1 are within the resource rich areas of Queensland or at the associated coastal port facilities. The relevant resource rich areas include the Bowen Basin, Galilee Basin and Surat Basin. These loads have the potential to significantly impact the performance of the transmission network supplying, and within, these areas. The degree of impact is also dependent on the location and capacity of new or withdrawn generation in the Queensland region.

The commitment of some or all of these loads may cause limitations to emerge on the transmission network. These limitations could be due to plant ratings, voltage stability and/or transient stability. Options to address these limitations include network solutions, demand side management (DSM) and generation non-network solutions. Feasible network projects can range from incremental developments to large-scale projects capable of delivering significant increases in power transfer capability.

As the strategic outlook for non-network options is not able to be clearly determined, this section focuses on strategic network developments only. This should not be interpreted as predicting the preferred outcome of the RIT-T process. The recommended option for development is the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the market.

The emergence and magnitude of network limitations resulting from the commitment of these loads will also depend on the location, type and capacity of new or withdrawn generation. For the purpose of this assessment the existing and committed generation in Table 5.1 has been taken into account when discussing the possible network limitations and options. However, where current interest in connecting further VRE generation has occurred, that has the potential to materially impact the magnitude of the emerging limitation, this is also discussed in the following sections.

For the transmission grid sections potentially impacted by the possible new large loads in Table 2.1, details of feasible network options are provided in sections 6.2.1 to 6.2.6. Formal consultation via the RIT-T process on the network and non-network options associated with emerging limitations will be subject to commitment of additional demand.

6.2.1 Bowen Basin coal mining area

Based on the medium economic forecast defined in Chapter 2, the committed network described in Table 3.1, and the committed generation described in Table 5.1 network limitations exceeding the limits established under Powerlink's planning standard may occur following the possible retirement of assets described in Section 4.2.2. A possible solution to the voltage limitation could be the installation of a transformer at Strathmore Substation, network reconfiguration works, or a non-network solution.

In addition, there has been a proposal for the development of coal seam gas (CSG) processing load of up to 80MW (refer to Table 2.1) in the Bowen Basin. These loads have not reached the required development status to be included in the medium economic forecast for this TAPR.

The new loads within the Bowen Basin area would result in voltage and thermal limitations on the 132kV transmission system upstream of their connection points. Critical contingencies include an outage of the Strathmore 275/132kV transformer, a 132kV circuit between Nebo and Moranbah substations, the 132kV circuit between Strathmore and Collinsville North substations, or the 132kV circuit between Lilyvale and Dysart substations (refer to Figure 4.3).

The impact these loads may have on the Central Queensland to North Queensland (CQ-NQ) grid section and possible network solutions to address these is discussed in Section 6.2.4.

Possible network solutions

Feasible network solutions to address the limitations are dependent on the magnitude and location of load. The location, type and capacity of future VRE generation connections in North Queensland may also impact on the emergence and severity of network limitations. The type of VRE generation interest in this area is predominately large-scale solar PV. Given that the Bowen Basin coal mining area has a predominately flat profile it is unlikely that the daytime PV generation profile will be able to successfully address all emerging limitations.

Possible network options may include one or more of the following:

- second 275/132kV transformer at Strathmore Substation
- turn-in to Strathmore Substation the second 132kV circuit between Collinsville North and Clare South substations
- 132kV phase shifting transformers to improve the sharing of power flow in the Bowen Basin within the capability of the existing transmission assets.

6.2.2 Bowen Industrial Estate

Based on the medium economic forecast defined in Chapter 2, no additional capacity is forecast to be required as a result of network limitations within the five-year outlook period of this TAPR.

However, electricity demand in the Abbot Point State Development Area (SDA) is associated with infrastructure for new and expanded mining export and value adding facilities. Located approximately 20km west of Bowen, Abbot Point forms a key part of the infrastructure that will be necessary to support the development of coal exports from the northern part of the Galilee Basin. The loads in the SDA could be up to 100MW (refer to Table 2.1) but have not reached the required development status to be included in the medium economic forecast for this TAPR.

The Abbot Point area is supplied at 66kV from Bowen North Substation. Bowen North Substation was established in 2010 with a single 132/66kV transformer and supplied from a double circuit 132kV line from Strathmore Substation but with only a single circuit connected. During outages of the single supply to Bowen North the load is supplied via the Ergon Energy 66kV network from Proserpine, some 60km to the south. An outage of this single connection will cause voltage and thermal limitations impacting network reliability.

Possible network solutions

A feasible network solution to address the limitations comprises:

- installation of a second 132/66kV transformer at Bowen North Substation
- connection of the second Strathmore to Bowen North 132kV circuit
- second 275/132kV transformer at Strathmore Substation
- turn-in to Strathmore Substation the second 132kV circuit between Collinsville North and Clare South substations.

6.2.3 Galilee Basin coal mining area

There have been proposals for new coal mining projects in the Galilee Basin. Although these loads could be up to 400MW (refer to Table 2.1) none have reached the required development status to be included in the medium economic forecast for this TAPR. If new coal mining projects eventuate, voltage and thermal limitations on the transmission system upstream of their connection points may occur.

Depending on the number, location and size of coal mines that develop in the Galilee Basin it may not be technically or economically feasible to supply this entire load from a single point of connection to the Powerlink network. New coal mines that develop in the southern part of the Galilee Basin may connect to Lilyvale Substation via an approximate 200km transmission line. Whereas coal mines that develop in the northern part of the Galilee Basin may connect via a similar length transmission line to the Strathmore Substation.

Whether these new coal mines connect at Lilyvale and/or Strathmore Substation, the new load will impact the performance and adequacy of the CQ-NQ grid section. Possible network solutions to the resultant CQ-NQ limitations are discussed in Section 6.2.4.

In addition to these limitations on the CQ-NQ transmission system, new coal mine loads that connect to the Lilyvale Substation may cause thermal and voltage limitations to emerge during an outage of a 275kV circuit between Broadsound and Lilyvale substations.

Possible network solutions

For supply to the Galilee Basin from Lilyvale Substation, feasible network solutions to address the limitations are dependent on the magnitude of load and may include one or both of the following options:

- installation of capacitor bank/s at Lilyvale Substation
- third 275kV circuit between Broadsound and Lilyvale substations.

The location, type and capacity of future VRE generation connections in Lilyvale, Blackwater and Bowen Basin areas may also impact on the emergence and severity of this network limitation. The type of VRE generation interest in this area is predominately large-scale solar PV. Given that the coal mining load in the area has a predominately flat profile it is unlikely that the daytime PV generation profile will be able to successfully address all emerging limitations.

6.2.4 Central Queensland to North Queensland grid section transfer limit

Based on the medium economic forecast outlined in Chapter 2 and the committed generation described in Table 5.1, network limitations impacting reliability or the efficient economic operation of the NEM are not forecast to occur within the five-year outlook of this TAPR.

However, as discussed in sections 6.2.1, 6.2.2 and 6.2.3 there have been proposals for large coal mine developments in the Galilee Basin, and development of CSG processing load in the Bowen Basin and associated port expansions. The loads could be up to 580MW (refer to Table 2.1) but have not reached the required development status to be included in the medium economic forecast of this TAPR.

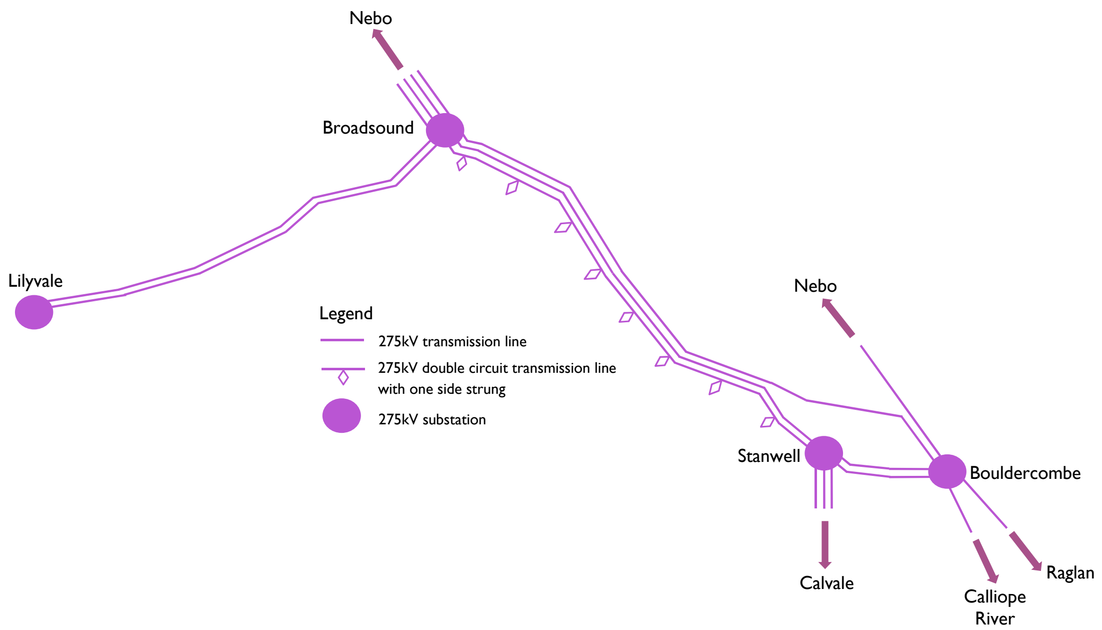
Network limitations on the CQ-NQ grid section may occur if a portion of these new loads commit. Power transfer capability into northern Queensland is limited by thermal ratings or voltage stability limitations. Thermal limitations may occur on the Bouldercombe to Broadsound 275kV line during a critical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

Currently generation costs are higher in northern Queensland due to reliance on liquid fuels, and there may be positive net market benefits in augmenting the transmission network. The recent uptake of VRE generation connections in North Queensland would be taken into account in any market benefit assessment, including consideration of the location, type and capacity of these future connections.

Possible network solutions

In 2002, Powerlink constructed a 275kV double circuit transmission line from Stanwell to Broadsound with one circuit strung (refer to Figure 6.1). A feasible network solution to increase the power transfer capability to northern Queensland is to string the second side of this transmission line.

Figure 6.1 Stanwell/Broadsound area transmission network



6.2.5 Central West to Gladstone area reinforcement

The 275kV network forms a triangle between the generation rich nodes of Calvale, Stanwell and Calliope River substations. This triangle delivers power to the major 275/132kV injection points of Calvale, Bouldercombe (Rockhampton), Calliope River (Gladstone) and Boyne Island substations.

Since there is a surplus of generation within this area, this network is also pivotal to supply power to northern and southern Queensland. As such, the utilisation of this 275kV network depends not only on the generation dispatch and supply and demand balance within the Central West and Gladstone zones, but also in northern and southern Queensland.

Based on the medium economic forecast defined in Chapter 2 and the existing and committed generation in Table 5.1, network limitations impacting reliability are not forecast to occur within the five-year outlook period of this TAPR. This assessment also takes into consideration the possible retirement of the Callide A to Gladstone South 132kV double circuit transmission line within the next five years (refer to Section 4.2.4).

The committed generation in Table 5.1 in North Queensland has the potential to increase the utilisation of this transmission network. As detailed in Section 4.2.4, based on the expected operation of the committed VRE generators, the north and central west generators should continue to operate mostly unconstrained.

Notwithstanding the connection of this committed VRE generation, Powerlink recognised the vulnerability of this grid section to congestion and proposed a network project under the Network Capability Incentive Parameter Action Plan (NCIPAP) for the 2018-22 Revenue Reset period. This project involves increasing the ground clearance of 11 spans on Bouldercombe to Raglan 275kV and three on Larcom Creek to Calliope River 275kV transmission lines to increase the thermal rating of these lines. This project was accepted by the Australian Energy Regulator (AER) and Powerlink will seek final approval, as per the NER, before implementing these improvements.

In addition, there are several developments in the Queensland region that would change not only the power transfer requirements between the Central West and Gladstone zones but also on the intra-connectors to northern and southern Queensland. These developments include new loads in the resource rich areas of the Bowen Basin, Galilee Basin and Surat Basin and also the connection of VRE energy generation, in particular large-scale solar PV and wind farm generation. Such generation, together with what it displaces, has the potential to further significantly increase the utilisation of this grid section. This may lead to significant limitations within this 275kV triangle impacting efficient market outcomes despite the uprating from the NCIPAP project. Network limitations would need to be addressed by dispatching out-of-merit generation and the technical and economic viability of increasing the power transfer capacity would need to be assessed under the requirements of the RIT-T.

Possible network solutions

Depending on the emergence of network limitations within the 275kV network it may become economically viable to increase its power transfer capacity to alleviate constraints. A feasible network solution to facilitate efficient market operation may include transmission line augmentation between:

- Calvale and Larcom Creek substations
- Larcom Creek and Calliope River substations.

6.2.6 Surat Basin north west area

Based on the medium economic forecast defined in Chapter 2, network limitations impacting reliability are not forecast to occur within the five-year outlook period of this TAPR.

However, there have been several proposals for additional CSG upstream processing facilities and new coal mining load in the Surat Basin north west area. These loads have not reached the required development status to be included in the medium economic forecast for this TAPR. The loads could be up to 300MW (refer to Table 2.1) and cause voltage limitations impacting network reliability on the transmission system upstream of their connection points.

Depending on the location and size of additional load, voltage stability limitations may occur following outages of the 275kV circuits between Western Downs and Columboola, and between Columboola and Wandoan South substations (refer to Figure 6.2).

Possible network solutions

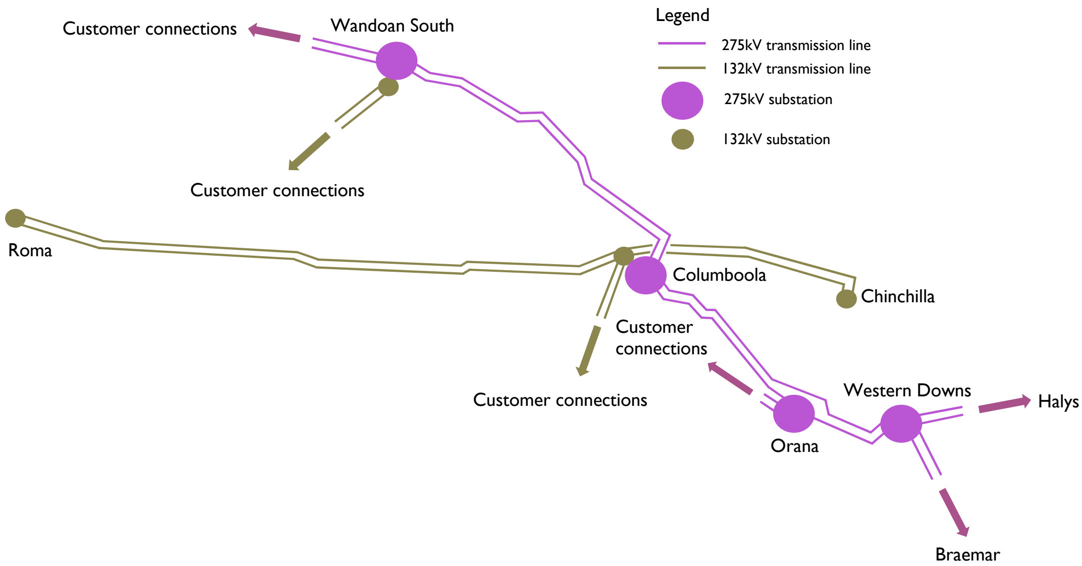
Due to the nature of the voltage stability limitation, the size and location of load and the range of contingencies over which the instability may occur, it may not be possible to address this issue by installing a single SVC at one location.

The location, type and capacity of future VRE generation connections in the Surat Basin north west area may also impact on the emergence and severity of these voltage limitations. The type of VRE generation interest in this area is large-scale solar PV. Given that the CSG upstream processing facilities and new coal mining load has a predominately flat profile it is unlikely that the daytime PV generation profile will be able to successfully address all emerging voltage limitations. However, voltage limitations may be ameliorated by these renewable plants, particularly if they are designed to provide voltage support 24 hours a day.

To address the voltage stability limitation the following network options are viable:

- SVCs, STATCOMs or SynCons at both Columboola and Wandoan South substations
- additional circuits between Western Downs, Columboola and Wandoan South substations to increase fault level and transmission strength, or
- a combination of the above options.

Figure 6.2 Surat Basin north west area transmission network



6.3 Possible reinvestment options initiated within the five to 10-year outlook period

In addition to meeting the forecast demand, Powerlink must maintain existing assets to ensure the risks associated with condition and performance are appropriately managed. To achieve this Powerlink routinely undertakes an assessment of the condition of assets and identifies potential emerging risks related to such factors as reliability, physical condition, safety, performance and functionality, statutory compliance and obsolescence.

Based on these assessments a number of assets have been identified as approaching the end of technical or economic life. This section focuses on those assets where reinvestment will need to be made in the next five to 10-year period of this TAPR and where there may be opportunities for network reconfiguration. Information on reinvestment decisions within the current five-year outlook period is detailed in Chapter 4.

The parts of the main transmission system and regional areas for which Powerlink has identified opportunities for reconfiguration in the five to 10-year outlook period of this TAPR include:

- Ross zone
- Central West and Gladstone zones
- Central Queensland to South Queensland grid section
- Gold Coast zone.

Powerlink will also continue to investigate opportunities for reconfiguration in other parts of the network where assets are approaching the end of technical or economic life and demand and generation developments evolve.

Reinvestment decisions in these areas aim to optimise the network topology to ensure the network is best configured to meet current and a range of plausible future capacity needs. As assets reach the end of technical or economic life, consideration is given to a range of options to manage the associated risks. These options include asset retirement, network reconfiguration, partial or full replacement (possibly with assets of a different type, configuration or capacity), extend technical life, and/or non-network alternatives.

Individual asset investment decisions are not determined in isolation. An integrated planning process is applied to take account of both future load and generation, and the condition based risks of related assets in the network. The integration of condition and demand based limitations delivers cost effective solutions that manage both reliability of supply obligations, efficient market operation and the risks associated in allowing assets to remain in-service.

A high-level outline of the possible network development plan for these identified areas that manage risks related to the condition and performance of the existing assets is given in sections 6.3.1 to 6.3.4.

6.3.1 Ross zone

The network from the Strathmore area to Townsville South and Ross substations in North Queensland has developed over many years. It comprises a 132kV network and a 275kV network which operate in parallel. As detailed in Section 4.2.2, the 132kV lines are forecast to approach end of technical or economic life in the five to 10-year outlook period.

The establishment of the 275kV network has reduced the reliance on these 132kV transmission lines for intra-network transfers. However, two single circuit 275kV transmission lines, that form part of this network which are paralleled and operate as one circuit, are also reaching the end of technical or economic life in the 10 to 20-year horizon.

The end of technical or economic life decisions for these 275kV single circuit transmission lines may present an opportunity to reshape the transmission footprint to better support the evolving requirements of the transmission system in North Queensland. In particular, by aligning the reinvestment needs on the 275kV and 132kV network, the long-term network strategy may help to address issues originating from:

- the potential for a number of large VRE generators to connect
- the relatively low thermal capacity of the existing 132kV transmission system; and
- the connection large industrial block load increases above forecast levels (refer to sections 6.2.1 to 6.2.4).

The first stage of this strategy will require taking the lowest cost approach to maintain the required network reliability and connectivity of the 132kV transmission lines between Collinsville North and Townsville South substations until the 275kV transmission network requires major investment. It is expected that in most cases targeted maintenance or an extension of life by a 'fit for purpose' refit will be the most economic network option.

Beyond this, there are a number of technically feasible options for the end of technical or economic life strategies for the 132kV transmission line assets within this area. Planning studies have indicated the potential to reconfigure the 132kV network whilst still maintaining the required reliability and connectivity, including an option to retire the inland 132kV transmission line from Townsville South to Clare South substations. If this retirement were to eventuate, and based on the medium economic forecast defined in Chapter 2, network limitations exceeding the limits under Powerlink's planning standard are forecast to occur. Possible solutions to the limitation include the installation of the second 275/132kV transformer at Strathmore (refer to Section 4.2.2) or network support.

If 132kV network reconfiguration is the most technical and economic end of life option in the 10-year outlook period, it is still aligned with the longer term strategy to maintain flexibility to reshape the transmission footprint at a later date, whilst:

- maintaining geographic diversity of transmission supply into North Queensland
- meeting existing network requirements, including connectivity to Clare South, King Creek and Invicta Mill and for potential new loads and/or generation
- providing flexibility to adapt to meet various scenarios for network requirements in the future, including rationalisation of the number of transmission lines in this corridor
- allowing rationalisation of the 132kV switchyards at Collinsville North and Strathmore substations in 15 to 20 years when the primary plant at Strathmore is predicted to reach end of technical or economical life and

- installation of a second 275/132kV injection at Strathmore will provide higher headroom to allow 132kV optimisation to one higher capacity circuit in the future and potential connection of more renewable generation.

6.3.2 Central West and Gladstone zones

The 275kV network in the Gladstone area was constructed in the 1970s with the exception of the transmission line to Boyne Island via Wurdong which was constructed in the 1990s. All the 1970s lines are expected to require reinvestment within the next 10 years.

The 132kV lines from Calliope River to Boyne Island, Calliope River to Gladstone Power Station, Calliope River to Gladstone North and Calliope River to Gladstone South were built prior to 1982. The 132kV lines from Gladstone South to QAL were built prior to 1970 and Gladstone South to Callide in the mid 1960s. As outlined in Section 4.2.4 it is likely this line will be retired from service at the end of its technical or economic life within the next five to 10 years.

The two single 275kV circuits between Calliope River Substation and Bouldercombe Substation (one via Larcom Creek and Raglan) are showing signs of deteriorated galvanising of structures, nuts and bolts and hardware. These lines will exceed an acceptable risk profile and require some reinvestment in the next five to 10 years.

Planning assessments confirm the need to retain two 275kV circuits between Calliope River and Bouldercombe substations. The long-term strategy is to perform targeted maintenance or an extension of life by a 'fit for purpose' refit to align the end of technical and economic life of these two 275kV lines. High-level assessments indicate it may be of more benefit to replace these circuits in the late 2020s with a new high capacity double circuit line between Calliope River and Bouldercombe that would also supply Larcom Creek and Raglan substations.

6.3.3 Central Queensland to South Queensland grid section

Three single circuit 275kV transmission lines operate between Calliope River and South Pine substations and form the coastal corridor of the Central Queensland to South Queensland (CQ-SQ) grid section. These transmission lines were constructed in the 1970s and 1980s. The lines traverse a variety of environmental conditions that have resulted in different rates of corrosion. The risk levels therefore vary across the transmission lines. More detailed condition assessments have been completed for those sections of the lines where the environmental conditions are more onerous.

Based on these detailed assessments the 275kV single circuit lines in the most northern and southern end will reach end of technical or economic life in the five to 10-year outlook of this TAPR. Powerlink expects to require some form of investment in the remainder of the transmission lines over the next 10 to 20 years.

The 275kV lines at the northern end of this coastal corridor are currently experiencing an accelerated rate of corrosion. It is expected that the risks, primarily driven by the 275kV single circuit transmission lines between Calliope River and Wurdong substations, will exceed acceptable corrosion levels by approximately 2021. The higher rate of corrosion is due to the proximity to the coast and exposure to salt laden coastal winds. The Calliope River to Wurdong line also traverses two tidal crossings and operates in a heavy industrial area.

Risks on the section between Calliope River and Wurdong may be managed through maintenance works, with minimal work required over the next five years. This strategy is economic and will allow the technical end of life of the 275kV single circuits between Calliope River to Wurdong to be aligned with those from Wurdong to Gin Gin.

The 275kV transmission lines between South Pine and Woolooga substations are also experiencing a higher rate of corrosion and will exceed acceptable risk levels in the next five years. The higher rate of corrosion is due to a localised wet weather environment in the hinterland regions of Mapleton and Maleny.

Similar to the strategy in the northern section, it is considered economic to align the technical and economic end of life of the South Pine to Woolooga and Palmwoods to Woolooga transmission lines. This will require a moderate amount of maintenance or refurbishment on the South Pine to Woolooga 275kV transmission line in the next five to 10 years. A transmission line refit project is underway for completion in the next five years to manage the risks of the 275kV single circuit transmission line between Palmwoods and Woolooga substations.

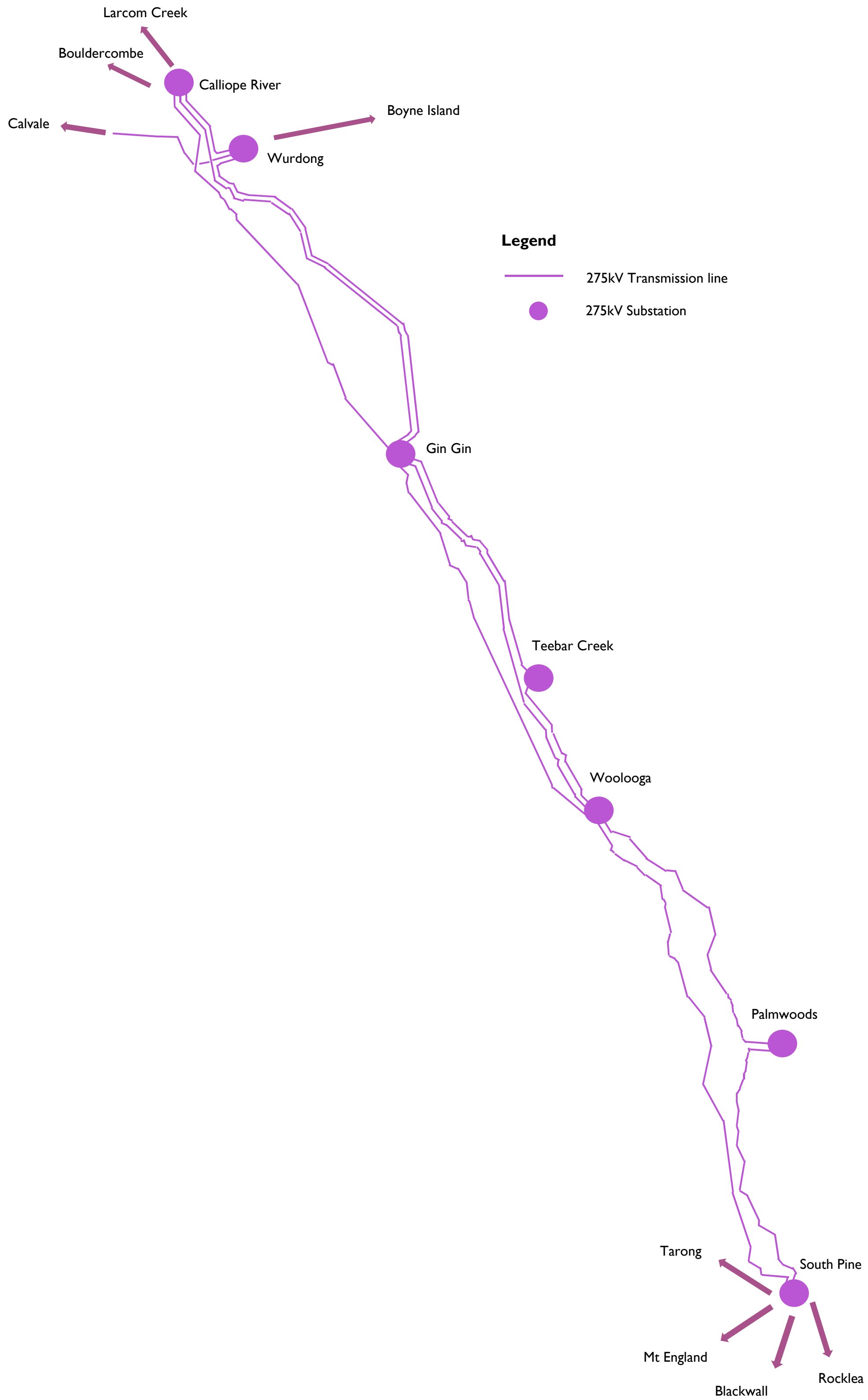
These strategies have the benefit of maintaining the existing topology, transfer capability and operability of the network. The strategies provide for an incremental development approach and defer large capital investment.

The incremental approach to reinvesting in the existing assets is both economic over the 10-year outlook period of this TAPR and is fully aligned with providing time to better understand the impact that a lower carbon (higher renewable) electricity generation future may have on the required transfer capability of this grid section.

The CQ-SQ grid section is an important intra-connector for the efficient operation of the NEM. Based on the medium economic forecast defined in Chapter 2 and the existing and committed generation in Table 5.1, network limitations impacting reliability or efficient market outcomes are not forecast to occur within the 10-year outlook period of this TAPR. However, potential investment in VRE generation in central and north Queensland, coupled with the possible displacement and/or retirement of existing thermal plant, may significantly increase the utilisation of the grid section and potentially cause congestion.

Powerlink will take these developments into account when formulating the strategies to meet the future emerging market requirements.

Figure 6.3 Coastal Central Queensland to South Queensland area transmission network



6.3.4 Gold Coast zone

The main transmission system into the Gold Coast area is via the Greenbank to Molendinar double circuit 275kV transmission line and the two Greenbank to Mudgeeraba 275kV single circuit transmission lines.

The Greenbank and Mudgeeraba substations are located approximately 40km and 8km respectively from the coast. Given this, the south eastern end of the single circuit 275kV lines are subjected to higher rates of corrosion due to the prevailing salt laden coastal winds.

The single circuit 275kV lines consist of around 160 galvanized steel lattice towers that have been subject to above ground corrosion. A condition assessment concludes that these lines are currently tracking to a standard rate of corrosion. It is expected that these lines will exceed an acceptable risk profile within 10 to 20 years. To defer a major rebuild these lines will need targeted maintenance or refit in the five to 10-year outlook period.

The reinvestment options that would be considered include refit of one or both single circuit transmission lines, a new double circuit transmission line, decommissioning with consideration to any non-network alternatives. Due to potentially complex staging and deliverability requirements, the end of technical or economic life strategy should be reviewed within the next five years (refer to Section 4.2.8).

Any major reinvestment in the Greenbank to Mudgeeraba single circuit 275kV transmission lines will require extensive joint planning with Energex, Essential Energy, TransGrid and Directlink. Following more detailed analysis, Powerlink will undertake a RIT-T at the appropriate time when impacts on power transfer limits, power quality and efficient market outcomes will be assessed.

The Tweed region in Northern NSW is supplied by the double circuit 110kV Mudgeeraba to Terranora transmission line and the Directlink HVDC link to Lismore. A condition assessment of the double circuit line concludes that this line will exceed an acceptable risk profile within 10 to 20 years. To defer a major rebuild of this line targeted maintenance or refit in the five to 10-year outlook period will be required.

The capacity on the 132kV network supplying northern NSW is limited, and operation of Directlink must be taken into account when considering reinvestment in this area. Outages on or removal of any of these circuits will have market impacts. As such, it is expected that any major reinvestment in the 10 to 20-year horizon for the Mudgeeraba to Terranora double circuit transmission line would require extensive joint planning and consultation with Energex, Essential Energy, TransGrid and Directlink. Following more detailed analysis, Powerlink will undertake a RIT-T at the appropriate time when impacts on power transfer limits, power quality and efficient market outcomes will be assessed.

6.4 Supply demand balance

The outlook for the supply demand balance for the Queensland region was published in the AEMO 2016 Electricity Statement of Opportunities (ESOO)[1]. Interested parties who require information regarding future supply demand balance should consult this document.

6.5 Interconnectors

6.5.1 Existing interconnectors

The Queensland transmission network is interconnected to the New South Wales (NSW) transmission system through the Queensland/New South Wales Interconnector (QNI) transmission line and Terranora Interconnector transmission line.

The QNI maximum southerly capability is limited by thermal ratings, transient stability and oscillatory stability (as detailed in Section 5.5.9).

The combined QNI plus Terranora Interconnector maximum northerly capability is limited by thermal ratings, voltage stability, transient stability and oscillatory stability (as detailed in Section 5.5.9).

[1] Published by AEMO in July 2016.

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

6.5.2 Interconnector upgrades

Powerlink and TransGrid have assessed whether an upgrade of QNI could be technically and economically justified on several occasions since the interconnector was commissioned in 2001. Each assessment and consultation was carried out in accordance with the relevant version of the AER's Regulatory Investment Test in place at the time.

The most recent assessment was carried out as part of the joint Powerlink and TransGrid regulatory consultation process which concluded in December 2014. At that time, in light of uncertainties, Powerlink and TransGrid considered it prudent not to recommend a preferred upgrade option, however continue to monitor market developments to determine if any material changes could warrant reassessment of an upgrade to QNI. Relevant changes may include:

- changes in generation and large-scale load developments in Queensland and the NEM (including CSG, coal developments, VRE generation, retirement of generation) and
- NEM-wide reductions in forecast load and energy consumption.

There is considerable uncertainty in both load and generation development/retirement in the Queensland region. This uncertainty also extends to the southern States, perhaps not to the same extent for new large-scale load developments, but certainly for new generation development and/or retirements. The impact this may have on the congestion and incidence of constraints on QNI is complex and varied. Depending on the emergence of these changes, QNI congestion may increase in the northerly or southerly direction. The different investments in load and investments and retirements in generation across the NEM may also impact on the location and scope of viable network upgrade options.

Augmentation to QNI was also considered in AEMO's 2016 National Transmission Network Development Plan (NTNDP)[2]. The merits of increasing QNI capacity were assessed across a number of scenarios. For each of the scenarios the generation outlooks were co-optimised with interconnector augmentation, as increased interconnection has the potential to provide a range of benefits, including increased efficiency in generation production costs, greater reliability and security outcomes, and reduction in capital investment related to new generation. AEMO's modelling indicated that bi-directionally increasing the capability of QNI may deliver net positive market benefits from 2026–27 depending on the scenario. AEMO modelled controllable series compensation on QNI to achieve this bi-directional increase in QNI power transfer capability. To manage the voltage profile a part of this series compensation could be installed in the Queensland region. The AER accepted this as a contingent project in Powerlink's 2018-22 Revenue Reset period.

Possible network solutions

The National Electricity Market (NEM) is moving into a new era with transformation of the generation mix to meet climate change policy objectives. There is a shift from large-scale, synchronous, centrally dispatched generation towards distributed and VRE generators, connected to the power system through inverter-based technology as the electricity industry transitions to a low carbon future.

The Electricity Network Transformation Roadmap[3] and AEMO's 2016 NTNDP both suggest that transmission interconnections will play a stronger role in the future. Greater levels of interconnection allows the diversity of VRE generation, particularly wind generation, across regions during summer and winter peaking conditions, to deliver fuel cost savings by improving utilisation of renewable generation and reducing reliance on higher-cost gas generation.

[2] 2016 National Transmission Network Development Plan
[3] Electricity Network Transformation Roadmap – Final Report, April 2017 (page 99)

Transmission networks, including interconnection, will also be increasingly needed for system support services, such as frequency and voltage support, to maintain a reliable and secure supply. For example, a more interconnected NEM can improve system resilience to high impact, low probability events such as interconnector failures.

Powerlink will proactively monitor this changing outlook for the Queensland region and take into consideration the impact of emerging technologies, withdrawal of gas and coal-fired generation and the integration of VRE in future transmission plans. Options that increase interconnector capacity will not be constrained to upgrades to the existing QNI, but will look holistically at the potential market benefits of solutions required to maintain reliable, secure energy supply over the next 20 years and beyond.

This may involve consideration of the technical and economic benefits of establishing diversity in the interconnection paths. Options include developing additional circuits between Queensland and New South Wales or establishing an alternative inter-state connection. Powerlink is contributing to the South Australian Energy Transformation RIT-T. One of the network options being assessed in this RIT-T is the development of a High Voltage Direct Current-Voltage Source Converter (HVDC–VSC) ~1,500km connection between South West Queensland and South Australia. This option also has the potential benefit of increasing the QNI limit, and other interstate limits, by implementing special control schemes with the HVDC-VSC link. Increases in the QNI limit of approximately 300MW may be possible by quickly changing the dispatched power on the HVDC-VSC link following the initial critical contingency.

Powerlink will monitor the progress of this RIT-T, and AEMO's 2017 NTNDP, and use these results to further inform the prudent timing and form of further interconnector studies.

Powerlink will also consider smaller-scale network or non-network alternatives that in combination may deliver a more cost-effective range of future reliability, security, and efficiency benefits for consumers. With respect to this, Powerlink continues to encourage expressions of interest for potential non-network solutions which may be capable of increasing the transfer capability across the interconnector and hence deliver market benefits[4]. This is part of a broader strategy Powerlink is implementing to further develop, expand and capture economically and technically feasible non-network solutions. This strategy is based on enhanced collaboration with stakeholders (refer to Section 1.8.2).

[4] Information on non-network solutions may be found at QNI Upgrade consultation.

6 Strategic planning