CHAPTER 7

Strategic planning

7 Strategic planning

Key highlights

- Long-term planning takes into account:
  - the role the transmission network is to play in enabling the transition to a lower carbon future while continuing to deliver a secure, safe, reliable and cost effective service
  - dynamic changes in the external environment, including load growth and the growth in variable renewable energy (VRE) developments in Queensland
  - 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.
- The high uptake of large-scale VRE generation and rooftop photovoltaic (PV) is significantly changing the daily load profile and presenting challenges to the planning and operability of the transmission system and generation systems required to maintain reliable and efficient market outcomes.
- 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, Central Queensland to North Queensland (CQ-NQ) grid section and the Surat Basin north west area.
- The changing generation mix also has implications for investment in the transmission network, both inter-regionally and within Queensland, across critical grid sections. The 2020 Integrated System Plan (ISP) and recent Queensland Government announcements identify the development of Renewable Energy Zones (REZs) that could impact the utilisation and adequacy of the Gladstone and Central Queensland to South Queensland (CQ-SQ) grid sections and Queensland to New South Wales (NSW) Interconnector (QNI).

7.1 Introduction

Australia is in the midst of an energy transformation driven by advances in renewable energy technologies, displacement and retirement of existing fossil fuelled generation, changing customer expectations and emission policies.

The future customer load will be supplied by a mix of large-scale generation and distributed energy resources (DER). Queensland is experiencing a high level of growth in VRE generation, in particular solar PV and wind farm generation. During 2019/20, commitments have added 1,498MW to Queensland's semi-scheduled VRE generation capacity (refer to Section 6.2), taking the total to 3,960MW connected, or committed to connect to the Queensland transmission and distribution networks.

Customer behaviour is central to the energy transformation. Customers are demanding choice and the ability to exercise greater control over their energy needs, with consistent expectations of reliability and greater affordability. The future load is also uncertain due to different scenario outlooks, the emergence of new technology, orchestration of significant DER, and the commitment and/or retirement of large industrial and mining loads. These uncertainties have now increased further due to the COVID-19 pandemic and the impact this may have on economic recovery and demand for existing energy-intensive industries.

This energy transformation is creating opportunities and challenges for the power system. The high uptake of large-scale VRE generation, especially PV solar farms, coupled with continued uptake of rooftop PV is having a significant impact on the net daily load profile that is met by conventional fossil-fuelled generators. This will have an impact on the technical operation of these power plants. These emerging power system issues are discussed in Section 7.2.

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 have been included (either wholly or in part) in the AEMO's ISP Central scenario forecast. These load developments are listed in Table 2.1. Section 7.3 discusses the possible impact these uncertain loads may have on the performance and adequacy of the transmission system.

Australian Energy Market Operator (AEMO)'s ISP identifies the optimal development path over a planning horizon of at least 20 years for the strategic and long-term development of the national transmission system. The ISP establishes a whole of system plan that integrates generation and transmission network developments. The ISP identifies actionable and future projects, and informs market participants, investors, policy decision makers and consumers on a range of development opportunities.

The 2020 ISP has not identified any 'actionable' projects within Queensland. However, the 2020 ISP has identified several projects that may become actionable in future ISPs. Projects identified as part of the optimal development path nominated in the 2020 ISP which relate to Powerlink's transmission network, include:

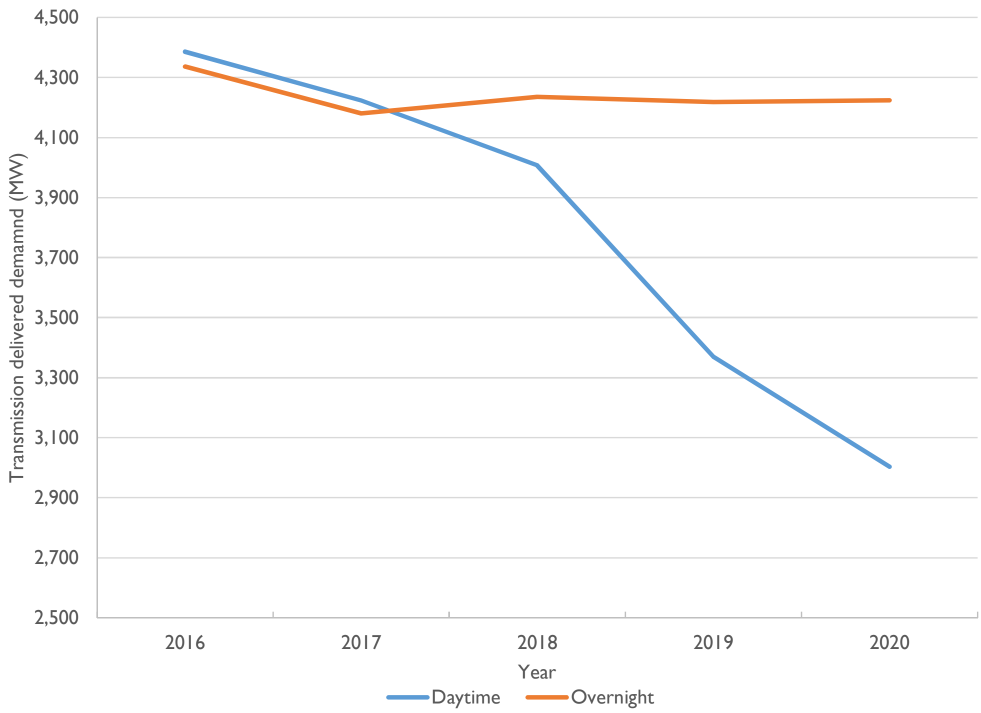
- QNI Medium and Large interconnector upgrades
- Central to Southern Queensland reinforcement
- Gladstone Grid reinforcement.

Preparatory activities for these projects will be provided by 30 June 2021 to inform the development of the 2022 ISP.

7.2 Challenges of falling minimum demand

The high uptake of large-scale VRE generation within the distribution networks together with the significant uptake of rooftop PV is changing the transmission delivered daily load profile to a characteristic 'duck curve' shape (refer Section 2.3.1). These large quantities of solar generation are all highly correlated in output. A noticeable change has been the transition of minimum demand from the very early morning historically to the middle of the day. As embedded and rooftop PV capacity increases, the minimum daytime demand will continue to decrease. Figure 7.1 shows the transition to daytime minimum demands.

Figure 7.1 Decline of minimum day time transmission delivered demand



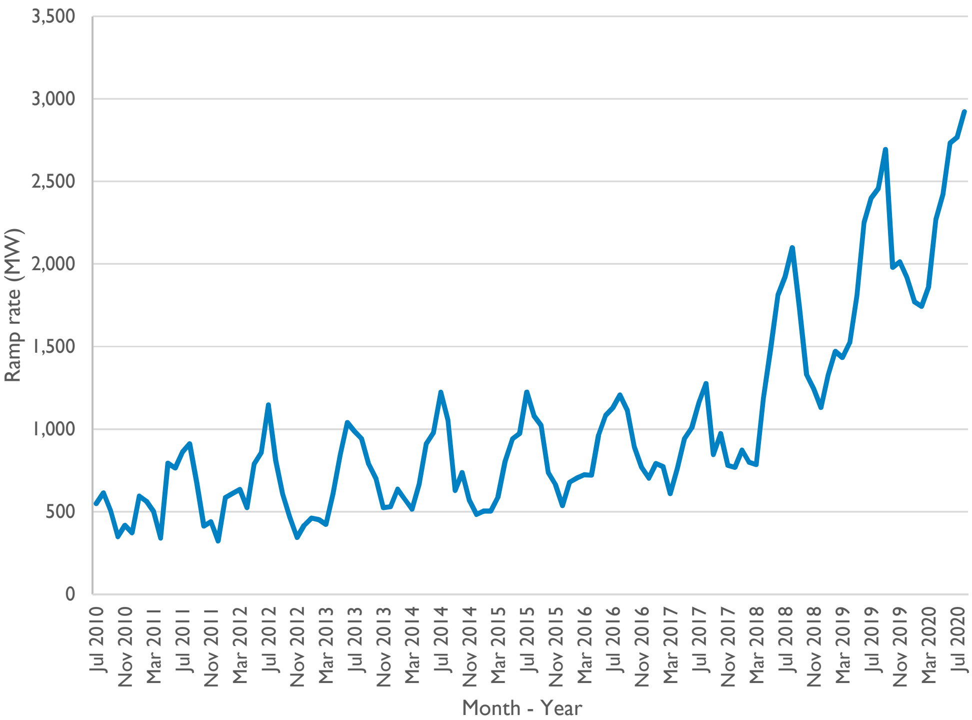
The transmission delivered demand in Figure 7.1 is also partially supplied from transmission connected large-scale solar VRE. Therefore, the load available for supply by the traditional synchronous generation or 'residual demand' is reducing.

As the supply side capacity increases with more VRE, evidence has emerged that scheduled synchronous generators are having to reduce their output at times of low electricity demand and high solar generation output. Zero or negative daytime wholesale electricity prices are now regularly observed in response to this increased competition to meet the falling daytime residual demands.

In the absence of energy storage devices (such as household battery systems) or significant levels of demand time of day shifting, minimum demand is expected to further decrease as the uptake of rooftop PV systems continues within residential and commercial premises. However, the maximum daily demand continues to increase in line with underlying load growth since the contribution of rooftop PV tapers off towards the evening. As a result, there is continued widening between maximum and minimum demand.

This trend is likely to present challenges to the power system. Synchronous generators will be required to ramp up and down more frequently in response to daily demand variations. For example, as the rooftop PV ramps down from 4pm in the afternoon, scheduled synchronous generation (and interconnection) need to ramp up to meet the daily peak demand. Figure 7.2 shows the historical average ramp rate that has occurred at the scheduled synchronous generators in the Queensland region. This indicates that the rate of change of synchronous generation required to meet evening peak demand is increasing.

Figure 7.2 Average ramp rate for evening peak demand



However, generation capacity to meet the evening peaks may become scarce if synchronous generators are being displaced in the middle of the day due to minimum demand or do not have adequate flexibility to ramp up for the evening peak periods. This is likely to progressively increase the reliance on gas-fired generation over peak demand periods.

There may also be opportunities for new technologies and non-network solutions to assist with managing the daily peaks and troughs. Demand shifting and storage solutions have the potential to smooth the daily load profile. These services could offer a number of benefits to the electricity system including reducing the need for additional transmission investment. Additional interconnection capacity may also play a role in meeting the evening peak demand.

As well as energy, synchronous plants provide power system stability services such as frequency control, system strength, inertia, voltage control and damping for power system oscillations. The impacts of the changing generation mix is already leading Powerlink to identify emerging reactive power and voltage control limitations (refer to Section 5.7.4). Many of these broader power system issues are inter-related and solutions need to be examined holistically to ensure an optimal and economic development path. Powerlink is taking an integrated approach to long-term planning of the transmission grid which takes in account the dependency of issues associated with the transitioning power system.

Powerlink is continuing to monitor and assess the impacts of changing load profiles and generation mix on the transmission network, and is taking an integrated planning approach to address emerging issues and challenges with the transitioning power system.

7.3 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 AEMO's Central scenario forecast.

The new large loads, listed 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, North West Mineral Province (Mt Isa) and Surat Basin. These loads have the potential to significantly impact the performance of the transmission network supplying these areas. The degree of impact is also dependent on the location and capacity of new or withdrawn generation in the Queensland region.

The new load developments in the Bowen Basin and Surat Basin and associated coastal port facilities are embedded within the existing Powerlink transmission system footprint. However, the connection of new loads in the Galilee Basin and the connection of existing loads in the North West Mineral Province will require transmission network extensions to these remote locations.

The commitment of some or all of these loads may cause transmission limitations to emerge on the network. These limitations could be due to plant ratings, voltage stability and/or transient stability. However, all of these loads will have a positive impact on the minimum load issues discussed in Section 7.2. This is particularly since the load profile for these mining, metal processing and industrial loads are typically relatively flat.

Options to address the transmission 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, in the RIT-T, 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 tables 6.1 and 6.2 have 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. Powerlink will consider these potential limitations holistically with the emerging condition based drivers as part of the longer term planning process and in conjunction with the ISP.

Details of feasible network options are provided in sections 7.3.1 to 7.3.5, for the transmission grid sections potentially impacted by the possible new large loads in Table 2.1. 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.

7.3.1 Bowen Basin coal mining area

Based on AEMO's Central scenario forecast defined in Chapter 2, the committed network described in Chapter 9, and the committed generation described in tables 6.1 and 6.2 network limitations are not forecast to exceed the limits established under Powerlink's planning standard.

However, 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 AEMO's Central scenario forecast for this Transmission Annual Planning Report (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 a 132kV transmission line between Nebo and Moranbah substations, or the 132kV transmission line between Lilyvale and Dysart substations (refer to Figure 5.6).

The impact these loads may have on the CQ-NQ grid section and possible network solutions to address these is discussed in Section 7.3.4.

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 (NQ) 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 CSG load profile would be expected to be relatively flat, it is unlikely that the daytime PV generation profile will be able to successfully address all emerging limitations.

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

- 132kV phase shifting transformers to improve the sharing of power flow in the Bowen Basin within the capability of the existing transmission assets
- construction of 132kV transmission lines between the Nebo, Broadlea and Peak Downs areas
- construction of 132kV transmission line between Moranbah and a future substation north of Moranbah.

7.3.2 Bowen Industrial Estate

Based on AEMO's Central scenario forecast defined in Chapter 2, no additional capacity is forecast to be required as a result of network limitations within the 10-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 AEMO's Central scenario forecast.

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 transmission line from Strathmore Substation but with only a single transmission line connected. During outages of the single 132kV supply to Bowen North the load is supplied via the Ergon Energy 66kV network from Proserpine, some 60km to the south. An outage of the 132kV single connection during high load 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 and connection of the second Strathmore to Bowen North 132kV transmission line.

7.3.3 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 AEMO's Central scenario 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 7.3.4.

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 transmission line 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 transmission line between Broadsound and Lilyvale substations.

The location, type and capacity of future VRE generation connections in Lilyvale, Blackwater and Bowen Basin areas may 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 profile would be relatively flat, it is unlikely that the daytime PV generation will be able to successfully address all emerging limitations.

7.3.4 CQ-NQ grid section transfer limit

Based on AEMO's Central scenario forecast outlined in Chapter 2 and the committed generation described in tables 6.1 and 6.2, network limitations impacting reliability are not forecast to occur within the 10-year outlook of this TAPR. However, midday power transfer levels are reversing from northern to southern transfers. The incidence of light loading on the transmission system is forecast to increase as additional VRE generators are fully commissioned in NQ. Voltage control is therefore forecast to become increasingly challenging and lead to high voltage violations. As outlined in Section 5.7.4 a possible network solution to the voltage control limitation is the installation of a shunt bus reactor.

As discussed in sections 7.3.1, 7.3.2 and 7.3.3 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. There is also the potential load in the North West Mineral Province. If connected this load would connect to a new substation south of Powerlink's Ross Substation. The combined loads could be up to 930MW (refer to Table 2.1) but have not reached the required development status to be included in AEMO's Central scenario forecast of this TAPR.

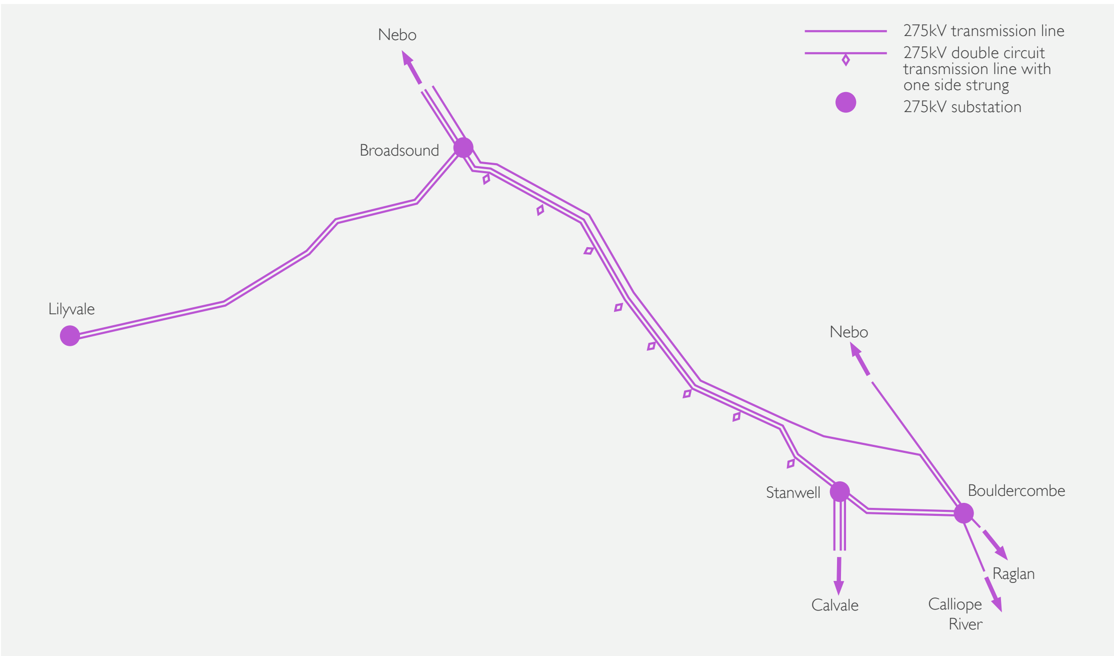
Network limitations on the CQ-NQ grid section may occur if a portion of these new loads commit. Power transfer capability into northern Queensland is limited by thermal ratings or voltage stability. Thermal limitations may occur on the Bouldercombe to Broadsound 275kV line during a critical contingency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

Currently generation costs for the majority of synchronous generation in NQ are high. As a result, there may be positive net market benefits in augmenting the transmission network. The current commitment of VRE generation in NQ and any future uptake of VRE generation would be taken into account in the 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 7.3). A feasible network solution to increase the power transfer capability to northern Queensland is to string the second side of this transmission line.

Figure 7.3 Stanwell/Broadsound area transmission network



7.3.5 Surat Basin north west area

Based on AEMO's Central scenario forecast defined in Chapter 2, network limitations impacting reliability are not forecast to occur within the next five years 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 AEMO's Central scenario 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 transmission lines between Western Downs and Columboola, and between Columboola and Wandoan South substations (refer to Figure 7.4).

Possible network solutions

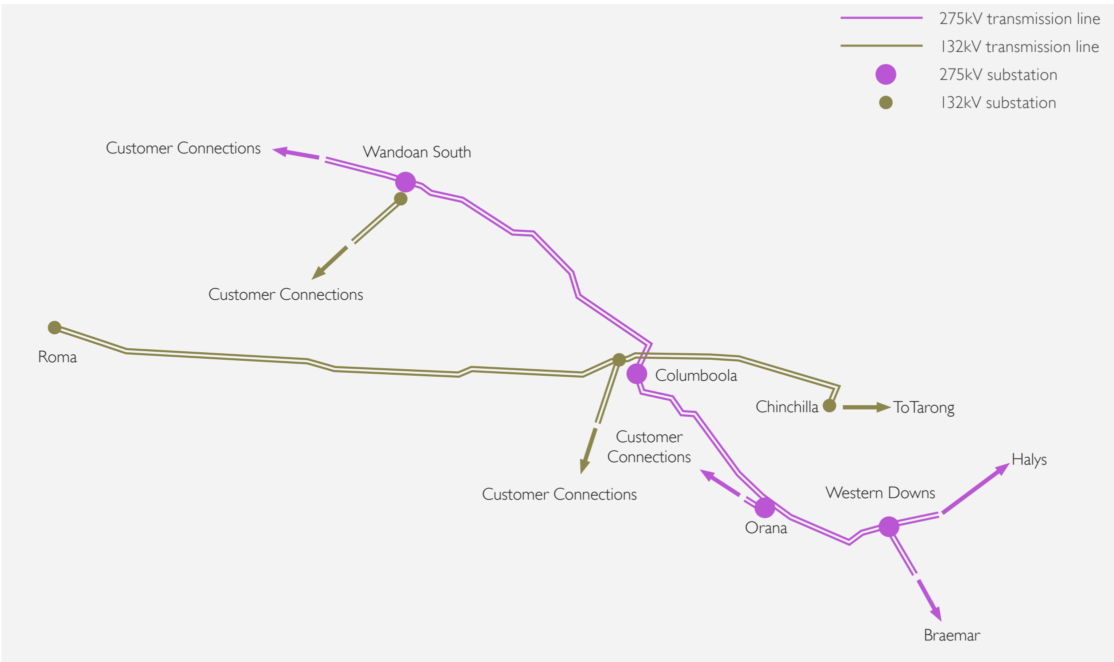
Due to the nature of the voltage stability limitation, the size and location of load and the range of contingencies over which the instability may occur, it may not be possible to address this issue by installing a single Static VAr Compensator (SVC) at one location.

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 load 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, Static Synchronous Compensators (STATCOM) or Synchronous Condensers (SynCon) at both Columboola and Wandoan South substations
- additional transmission lines between Western Downs, Columboola and Wandoan South substations to increase fault level and transmission strength, or
- a combination of the above options.

Figure 7.4 Surat Basin north west area transmission network



7.4 Impact of the energy transformation

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 NQ and Central to South Queensland grid sections (refer sections 6.6.2 and 6.6.5 respectively) and the Queensland to NSW interconnector (QNI). This has implications for investment in the transmission network both inter-regional and within Queensland.

These impacts have been investigated in AEMO's 2020 ISP. The 2020 ISP has identified that in order 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. These projects include:

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

Preparatory activities for these projects will be provided by 30 June 2021 to inform the development of the 2022 ISP.

7.4.1 Queensland to NSW Interconnector (QNI)

Increasing the capacity of interconnection between National Electricity Market (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 also required to support these objectives.

As outlined in Section 5.7.14 Powerlink and TransGrid released a Project Assessment Conclusion Report on 'Expanding NSW-Queensland transmission transfer capacity' in December 2019. The recommended QNI Minor option (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) is now committed and is expected to be completed by June 2022 at a cost of $217 million. All material works associated with this minor upgrade are within TransGrid's network.

The 2020 ISP identified that a further staged upgrade to the transmission capacity between Queensland and NSW (QNI Medium and QNI Large) was an integral part of the optimal development plan. The 2020 ISP identified that the additional transmission capacity would deliver net market benefits from:

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

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

The proposed project is a staged 500kV line upgrade to share renewable energy, storage, and firming services between the regions after the closure of Eraring or to support REZ developments. Each stage is a 500kV line; the first forecast for completion by 2032-33 and the second by 2035-36.

The 2020 ISP concluded that this project would reduce system costs, and enhance system resilience and optionality. The project is not yet 'actionable' under the new ISP Rules, but is expected to become actionable in the future. Preparatory activities, as outlined above, are to be completed by 30 June 2021 so that costs and capacity improvements can be included in the 2022 ISP.

Possible network solutions

The QNI Medium upgrade project proposed by AEMO as part of the optimal development path includes a single 500kV circuit between Queensland and NSW via the western part of the existing QNI. The proposed route traverses the North West New South Wales and Darling Downs REZs.

Specifically, QNI Medium includes:

- a single 500kV circuit between New South Wales and Queensland strung on double circuit towers via the western part of the existing QNI including terminal stations and supporting plant.
- the proposed route goes through North West New South Wales and Darling Downs REZs.

This augmentation can be expanded with a second stage to form the QNI Large upgrade.

QNI Large comprises:

- a second 500kV circuit between New South Wales and Queensland strung on the double circuit tower which was proposed in QNI medium stage.

AEMO also flagged in the 2020 ISP that it will work with Powerlink and TransGrid to explore further options in relation to Virtual transmission lines (VTLs). The 2020 ISP outlined that VTLs, coupled with suitable wide area protection systems, could provide a technically feasible solution to increase the capacity of QNI. A VTL could comprise of grid-scale batteries on both sides of a QNI (for bidirectional limit increases), or a grid-scale battery on one side and braking resistor or generator tripping on the other side (for unidirectional limit increases).

Powerlink and TransGrid anticipate commencing preliminary activities to assess the economic benefits of further upgrades to the QNI capacity (refer to Section 5.7.14).

7.4.2 CQ-SQ grid section reinforcement

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 of the CQ-SQ grid sections is therefore expected to increase (refer to Section 5.7.6 and Section 6.6.5) and may lead to levels of congestion depending on the response of the central and northern Queensland generators to the energy market. In addition, the utilisation may also increase following the commissioning of the QNI Minor project (refer to Section 5.7.14).

As outlined in Section 7.4.1, the 2020 ISP has identified a further upgrade of QNI capacity from 2032/33. The utilisation and adequacy of the CQ-SQ grid section is closely linked to the required efficient capacity of interconnection with NSW.

As outlined in Section 5.7.6 there are emerging condition and compliance risks related to structural corrosion on significant sections of the coastal CQ-SQ 275kV network between Calliope River and South Pine substations. Strategies to address the transmission line sections with advanced corrosion in the five year outlook are described in Section 5.7.6.

In parallel, Powerlink and AEMO (through the ISP process) continue to investigate the impact of large-scale VRE generation investment in the Queensland region on the utilisation and economic performance of intra-regional grid sections, and in particular the CQ-SQ grid section. The 2020 ISP identified the need for a material upgrade of CQ-SQ as part of the optimal development path. The 2020 ISP identified the early 2030s as the project timing. The upgrade is critical for unlocking renewable resources the Far North, Isaac, and Fitzroy REZs for efficient market outcomes.

Powerlink will consider the emerging and forecast constraints holistically with the emerging condition based drivers as part of the planning process. Such decisions will be undertaken using the RIT-T consultation process, where the benefits of non-network options will also be considered.

Possible network solutions

Feasible network solutions to facilitate efficient market operation may differ in scale. The 2020 ISP identified the need for a material upgrade. The proposed project by AEMO included a new 275kV double circuit transmission line between Calvale and Wandoan South substations.

As outlined in 7.4.1, Powerlink and TransGrid anticipate commencing preliminary activities to assess the economic benefits of further upgrades to the QNI capacity. Due to the linkages between the proposed REZ developments in Far North, Isaac, and Fitzroy and the utilisation and adequacy of the Central West to Gladstone and CQ-SQ grid sections and interconnection with NSW, these issues will be assessed holistically within this new RIT-T process.

As a result, additional network options that deliver a range of additional capacity improvements will be considered in addition to the 2020 ISP's new 275kV double circuit on option. These include:

- establishing a mid-point switching substation on the 275kV double circuit between Calvale and Halys substations
- reduce the series impedance of the 275kV double circuit between Calvale and Halys substations via a variety of technologies
- a grid-scale storage system. A 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 on the northern side.

7.4.3 Gladstone grid section 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 AEMO's Central scenario forecast defined in Chapter 2 and the existing and committed generation in tables 6.1 and 6.2, network limitations impacting reliability are not forecast to occur within the 10-year outlook period of this TAPR. This assessment also takes into consideration the retirement of the Callide A to Gladstone South 132kV double circuit transmission line (refer to Section 5.7.5).

However, the committed VRE generation in tables 6.1 and 6.2 in NQ is expected to increase the utilisation of this grid as generation in the Gladstone zone or southern Queensland is displaced. While not impacting reliability of supply, the committed VRE generation in NQ has the potential to cause congestion depending on how the thermal generating units in CQ bid to meet the NEM demand.

In addition, new loads in the resource rich areas of the Bowen Basin, Galilee Basin, North West Mineral Province and Surat Basin has the potential to further significantly increase the utilisation of this grid section. This may lead to significant limitations impacting efficient market outcomes.

Furthermore, the 2020 ISP has identified significant increases in VRE generation for the Far North, Isaac, and Fitzroy REZs (refer to Figure 7.5). With this generation the thermal capacity of the network between Bouldercombe, Raglan, Larcom Creek, and Calliope River will be reached. Upgrading this grid section is therefore critical for unlocking these renewable resources in these REZs as part of the optimal development path. The 2020 ISP identified the 2030s as the project timing. The timing could be brought forward with retirement of Gladstone generation[1].

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. Feasible network solutions to facilitate efficient market operation may include:

- transmission line augmentation between Calvale and Larcom Creek substations and rebuild between Larcom Creek and Calliope River substations with a high capacity 275kV double circuit transmission line
- rebuild between Larcom Creek, Raglan, Bouldercombe and Calliope River substations with a high capacity 275kV double circuit transmission line
- third Calliope River 275/132kV transformer.

[1] The potential closure of a large industrial load in the Gladstone zone also influences the required size and timing of this project.

7.4.4 Renewable Energy Zones (REZ)

As the NEM transforms away from synchronous generation and towards VRE, an additional 34GW to 47GW of new VRE needs to be installed depending on the ISP scenario. This is allowing for strong growth in DER and the large-scale VRE that is already installed or expected to be operational. In Queensland, under AEMO's Central scenario, approximately 11GW of large-scale VRE still needs to be installed by the early 2040s.

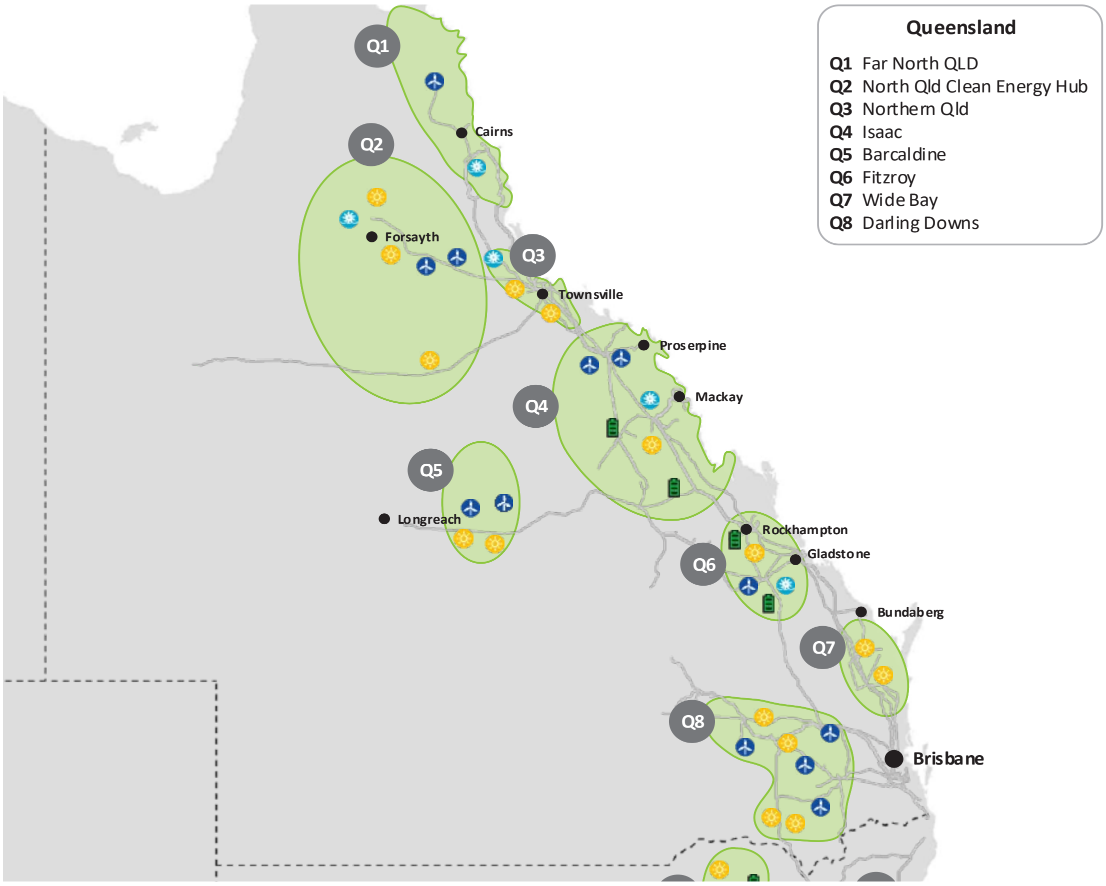
A number of REZ development opportunities for the Queensland region have been identified in the ISP's optimal development path. Under the Central scenario, additional VRE generation is planted in five out of eight candidate REZs; Far North Queensland (FNQ), Isaac, Fitzroy, Wide Bay and Darling Downs (refer to Figure 7.5).

These REZs are developed in phases. Initially VRE developments are planted to help meet Queensland's Renewable Energy Target (QRET). The additional VRE is planted where there is relatively good access to existing network capacity and system strength. The 2020 ISP identified wind and solar generation in the Darling Downs and Fitzroy REZs using this existing transmission capacity.

Finally VRE developments are associated with future ISP projects. Larger VRE development in the Fitzroy REZ (wind and solar) and Isaac REZ (wind) are supported by future ISP projects which include the Gladstone and Central to Southern Queensland grid section reinforcements and expansions of QNI (refer to sections 7.4.1, 7.4.2 and 7.4.3). Renewable developments in the FNQ REZ also require 275kV upgrades within this REZ.

In recognition of the potential value of REZ developments across Queensland (the three REZs in north, central and southern zones that overlay the REZs identified in the ISP), the Queensland Government announced $145 million for REZ support. Powerlink will continue to work with Government, AEMO, stakeholders and customers to drive the most efficient and cost-effective outcomes from this process.

Figure 7.5 2020 ISP Renewable Energy zone candidates in Queensland



Source: AEMO