CHAPTER 7

Strategic planning

7.1 Introduction

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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, the upturn in variable renewable energy (VRE) developments in Queensland, 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, 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-regional and within Queensland across critical grid sections. These impacts and possible network augmentation options for the Central West to Gladstone and Central Queensland to Southern Queensland (CQ-SQ) grid sections are discussed.
- Powerlink is actively participating in energy market reform initiatives, in particular the coordination of investment in renewable generation and transmission infrastructure.

7.1 Introduction

Australia is in the midst of an energy transformation driven by advances in renewable energy technologies, displacement/retirement of existing fossil fuelled generation, changing customer expectations and Government 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 photovoltaic (PV) and wind farm generation. Section 6.2 outlines that 2,457MW of large-scale VRE generation is 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, while still demanding reliability and greater affordability. The future load is also uncertain due to different economic outlooks, emergence of new technology, orchestration of significant DER, and the commitment and/or retirement of large industrial and mining loads.

These changes are creating opportunities and challenges for the power system. The changing generation mix and uncertain load levels will impact the utilisation of existing transmission infrastructure. Optimising the utilisation of existing assets and any new development requirements will be vital to achieving lower cost solutions that meet energy security and reliability, affordability and reduced emissions.

To achieve these objectives the network must support the integration of large-scale VRE generation. The network must also enable the transition to a lower carbon future by supporting the sharing of generation between areas and National Electricity Market (NEM) regions. However, all developments must continue to be economic and efficient to support sustainable affordability.

Powerlink is investigating the future network needs by assessing the impact of uncertain load growth and the connection of VRE generation to meet Government emissions reduction targets on the utilisation of grid sections and interconnectors.

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. Section 7.2 discusses the possible impact these uncertain loads may have on the performance and adequacy of the transmission system.

The changing generation mix also has implications for investment in the transmission network, both inter-regional and within Queensland across critical grid sections. Section 7.3 discusses these impacts and possible network augmentation options for the Central West to Gladstone and CQ-SQ grid sections.

Increasing the capacity of interconnection between NEM regions could be pivotal to meeting Australia's long-term energy targets, providing the advantage of the geographic diversity of renewable resources so regions could export power when there is local generation surplus, and import power when needed to meet demand. Appropriate intra-regional transmission capacity could also be required to support these objectives. Investigations underway to inform the efficient development of the network include joint planning with:

- Australian Energy Market Operator (AEMO) and other Transmission Network Service Providers (TNSPs) to develop the Integrated System Plan (ISP)[1].
- TransGrid to investigate the economic benefits of increasing the transmission transfer capacity between Queensland and New South Wales (NSW). Powerlink and TransGrid have commenced the formal Regulatory Investment Test for Transmission (RIT-T) consultation process (refer to Section 5.7.14).

Against this backdrop of the rapidly changing electricity sector, the AEMC completed its initial review of the Coordination of Generation and Transmission Investment (CoGaTI). This review made a series of recommendations for how investment in generation and transmission should be better coordinated into the future. The most significant of these recommendations relates to reforms to the management of congestion and access on the transmission network. These recommendations are being progressed by the AEMC through 2019 and Powerlink is actively participating in energy market reform initiatives including participating in technical working groups established to assist the AEMC in their work. Section 7.4 summarises the scope of these reviews and the various linkages.

7.2 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.

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 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, 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.

1 AEMO will publish the second ISP in mid-2020.

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.

Details of feasible network options are provided in sections 7.2.1 to 7.2.5, 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.

7.2.1 Bowen Basin coal mining area

Based on the medium economic 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 exceeding the limits established under Powerlink's planning standard occur following the retirement of assets. 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 as described in Section 5.7.2.

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 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 the Strathmore 275/132kV transformer, a 132kV transmission line between Nebo and Moranbah substations, the 132kV transmission line between Strathmore and Collinsville North 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 7.2.4.

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 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.

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 transmission line 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.

7.2.2 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 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 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 transmission line from Strathmore Substation but with only a single transmission line 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 transmission line
- second 275/132kV transformer at Strathmore Substation
- turn-in to Strathmore Substation the second 132kV transmission line between Collinsville North and Clare South substations.

7.2.3 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 7.2.4.

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 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 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.

7.2.4 CQ-NQ grid section transfer limit

Based on the medium economic 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 forecast to reduce as additional VRE generators are commissioned in North Queensland (NQ) and consequentially voltage control is forecast to become increasingly challenging and potentially lead to high voltage (HV) violations. As outlined in Section 5.7.4 a possible network solution includes the installation of shunt bus reactor.

However, as discussed in sections 7.2.1, 7.2.2 and 7.2.3 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.

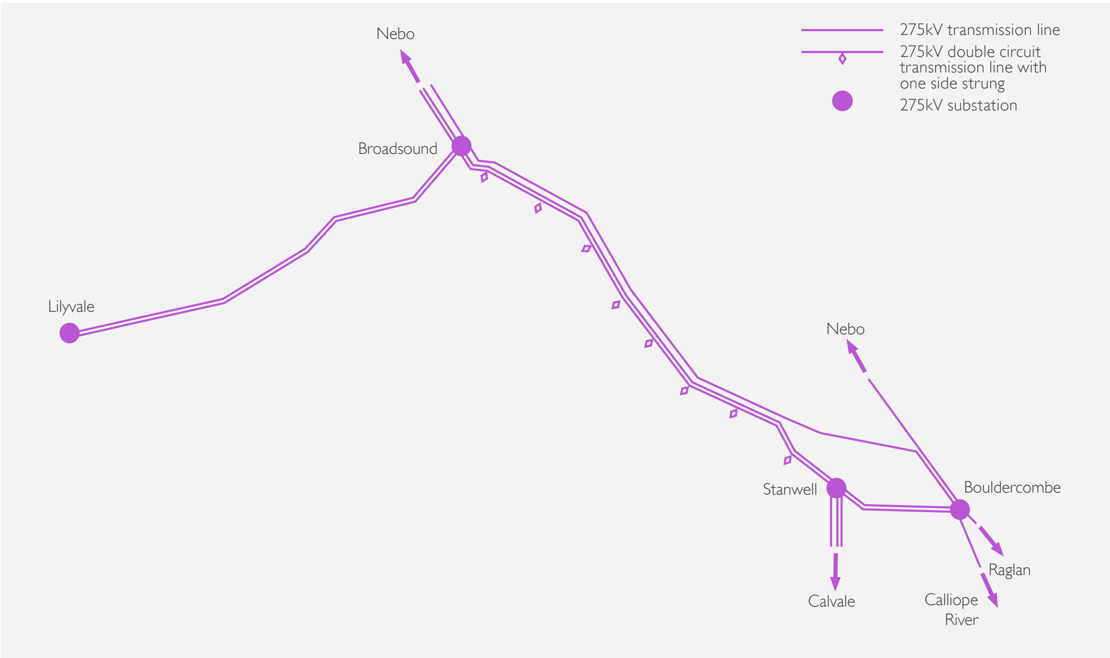
Network limitations on the CQ-NQ grid section may occur if a portion of these new loads commit. Power transfer capability into northern Queensland is limited by thermal ratings or voltage stability limitations. Thermal limitations may occur on the Bouldercombe to Broadsound 275kV line during a critical contingency of a Stanwell to Broadsound 275kV transmission line. Voltage stability limitations may occur during the trip of the Townsville gas turbine or 275kV transmission line 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 current commitment of VRE generation in North Queensland and any future uptake of VRE generation 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 7.1). A feasible network solution to increase the power transfer capability to northern Queensland is to string the second side of this transmission line.

Figure 7.1 Stanwell/Broadsound area transmission network



7.2.5 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 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 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 transmission lines between Western Downs and Columboola, and between Columboola and Wandoan South substations (refer to Figure 7.2).

Possible network solutions

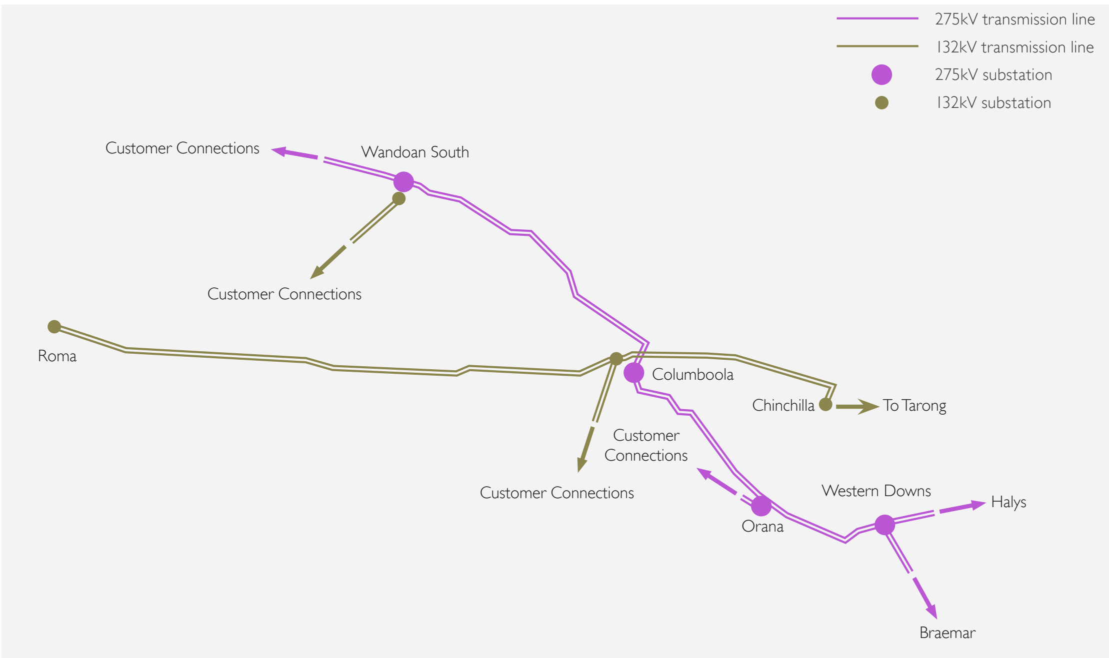
Due to the nature of the voltage stability limitation, the size and location of load and the range of contingencies over which the instability may occur, it may not be possible to address this issue by installing a single Static VAr Compensator (SVC) at one location.

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 Condensors (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 7.2 Surat Basin north west area transmission network



7.3 Possible impact of the changing generation mix on critical grid sections

Since January 2016, Powerlink has seen an unprecedented level of renewable energy investment activity with over 2,450MW of large scale renewable energy projects commencing construction or finalising commercial arrangements (refer to tables 6.1 and 6.2). This will continue as Queensland moves towards its Queensland Renewable Energy Target (QRET) target of 50% renewable generation by 2030. Powerlink continues to process numerous connection applications many of which are in central and north Queensland.

The existing, committed and expected investments in VRE generation are expected to increase the utilisation of the Central West to Gladstone and CQ-SQ grid sections. While not impacting reliability of supply, this investment has the potential to cause congestion depending on how the thermal generating units in central Queensland bid to meet the NEM demand.

7.3.1 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 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 5.7.4).

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

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). Powerlink has now implemented 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 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. 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.

7.3.2 CQ-SQ grid section transfer limit

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 6.6.4) 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 incidence of congestion may increase if additional southerly transfer capacity on the Queensland/New South Wales Interconnector (QNI) is shown to be economically justified (refer to Section 5.7.14).

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 continues 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 CQ-SQ reinvestment strategies in 5.7.6 will be adjusted to align with future generation and network developments if this planning analysis identifies economic triggers to increase the CQ-SQ capacity.

If material emerging constraints are forecast, Powerlink must demonstrate that the economic benefit to the market exceeds the cost of addressing the constraint. In the case of emerging constraints across the CQ-SQ, the potential investments to address these constraints are likely to be significant. Powerlink will consider these 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

Depending on the emergence of network limitations between CQ and SQ it may become economically viable to increase its power transfer capacity to alleviate constraints. Feasible network solutions to facilitate efficient market operation may differ in scale and 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-connected storage system
- a new western single or double circuit 275kV line connecting CQ to SWQ/Surat zones and
- adoption of other technologies, including high voltage direct current (HVDC) between zones.

7.4 Coordination of generation and transmission investment

In August 2018, the Council of Australian Governments (COAG) Energy Council requested the Energy Security Board (ESB) to deliver a work program to 'convert the ISP' into an 'actionable strategic plan', including 'how the Group 1 projects identified in the inaugural ISP can be implemented and delivered as soon as practicable and with efficient outcomes for customers, and how the Group 2 projects will be reviewed and progressed.'

This culminated with the AEMC finalising a rule change (4 April 2019) that streamlines the RIT-T processes. The rule change allows the three AER post RIT-T assessments (any dispute lodged, the preferred option assessment, and the contingent project revenue determination) to be run concurrently. This anticipates reducing the RIT-T timeframe by approximately six to eight months, for three projects[2].

Further, the progression of subsequent projects identified in ISPs are to occur through an 'actioned' ISP. To allow this, and following the release of the Coordination of Generation and Transmission Investment Review (CoGaTI) Final Report in December 2018, the AEMC, ESB and the Senior Committee of Officials (SCO) are consulting on the necessary reforms and rule changes required to embed the ISP in the regulatory framework. It is proposed that the draft ISP will identify credible network options, developed in consultation with TNSPs, which address the system wide needs. The inclusion of credible options analysis in the draft ISP will potentially allow the Project Specification Consultation Report (PSCR) to be removed from the RIT-T for ISP projects, streamlining the regulatory process.

The AEMC propose to pair the 'actioned' ISP with mechanisms necessary to allow generation to contribute to the enhancement of the networks and the management of congestion. The AEMC is of the view that change is needed now to better coordinate investment in renewable generation and transmission infrastructure, so that regulatory frameworks evolve to match this transition in the NEM. The AEMC has made a series of recommendations for how investment in generation and transmission should be better coordinated into the future. Recommendations are made across five key aspects; planning, access, charging, connection and economic regulation. The recommendations complement each other to transform the way generation and transmission is planned, invested in and operated in the NEM.

Key recommendations include:

- Phased implementation of dynamic regional pricing
  Dynamic regional pricing will put a price on network congestion by creating pricing regions through existing dispatch processes. This will introduce a signal to generators that reflects the short-run costs of using the network, providing better locational information to generators.
- Generators to fund transmission network augmentation in return for financial firm access
  Generators will have the choice to compel TNSPs to provide transmission services consistent with the level of firm access (that is, guaranteed access to the wholesale market) paid for by generators.
- Review of inter-regional Transmission Use of System (TUOS) and the broader TUOS framework
  The AEMC considers that there may be some elements of the existing inter-regional transmission charging arrangements that could be changed to better align the costs of interconnectors with those that benefit from the investment.

The detailed design of these reforms including better managing network congestion and access is being progressed by the AEMC throughout 2019.

Powerlink is actively participating energy market reform initiatives and technical working groups established to assist the AEMC with these initiatives.

[2] Upgrades to QNI and VNI, and the proposed interconnector between South Australia and NSW – Project EnergConnect.