CHAPTER 8

Renewable energy

8 Renewable energy

Key highlights

- This chapter explores the potential for the connection of variable renewable energy (VRE) generation to Powerlink's transmission network.
- Powerlink has a key role in enabling the connection of VRE infrastructure in Queensland.
- A number of Rule changes have been finalised since the publication of the 2017 Transmission Annual Planning Report (TAPR) impacting how customers may connect to Powerlink's network.
- Over the past year, Powerlink has supported a high level of connection activity, responding to more than 120 connection enquiries comprising over 25,000MW of potential VRE generation.
- In 2017/18, Powerlink finalised a further seven VRE generator Connection and Access Agreements (CAA) totalling 1,012MW.

8.1 Introduction

Queensland is rich in a diverse range of VRE resources – solar, wind, geothermal, biomass and hydro. This makes Queensland an attractive location for large-scale VRE generation development projects.

In January 2018, the level of roof top solar installations in Queensland exceeded 2,000MW and is presently increasing at approximately 25MW each month (refer to Section 2.1). This uptake provides a strong indication that Queensland consumers are seeking alternatives to meet their energy requirements. The development of complementary technologies, such as distributed energy storage, smart appliances, and electric vehicles will change the way customers consume and produce energy.

During the past year there has been a significant increase in the development of large-scale solar and wind generation farms. Fundamental external shifts such as these are shaping the operating environment in which Powerlink delivers its transmission services. Powerlink is responding to this changing operating environment by:

- implementing and adopting the recommendations of the Finkel and other reviews
- adapting to changes in electricity consumer behaviour and economic outlook.

Powerlink is committed to supporting the development of all types of energy projects requiring connection to the transmission network. Powerlink also has a key role in enabling the connection of VRE infrastructure developments, which aim to provide a sustainable, low-carbon future for electricity producers and users in Queensland.

The network capacity information presented in this chapter is applicable to all forms of generation including energy storage[1].

Since the publication of the 2017 TAPR, there have been a number of Rule changes. The Rule changes most relevant to the information provided in this chapter are:

- Managing Power System Fault Level
- Transmission Connection and Planning Arrangements.

Further information on managing power system fault levels, as it applies to the connection of new VRE generators, is available in Section 8.3.

Further information on the transmission connection and planning arrangements is available in Section 8.4.

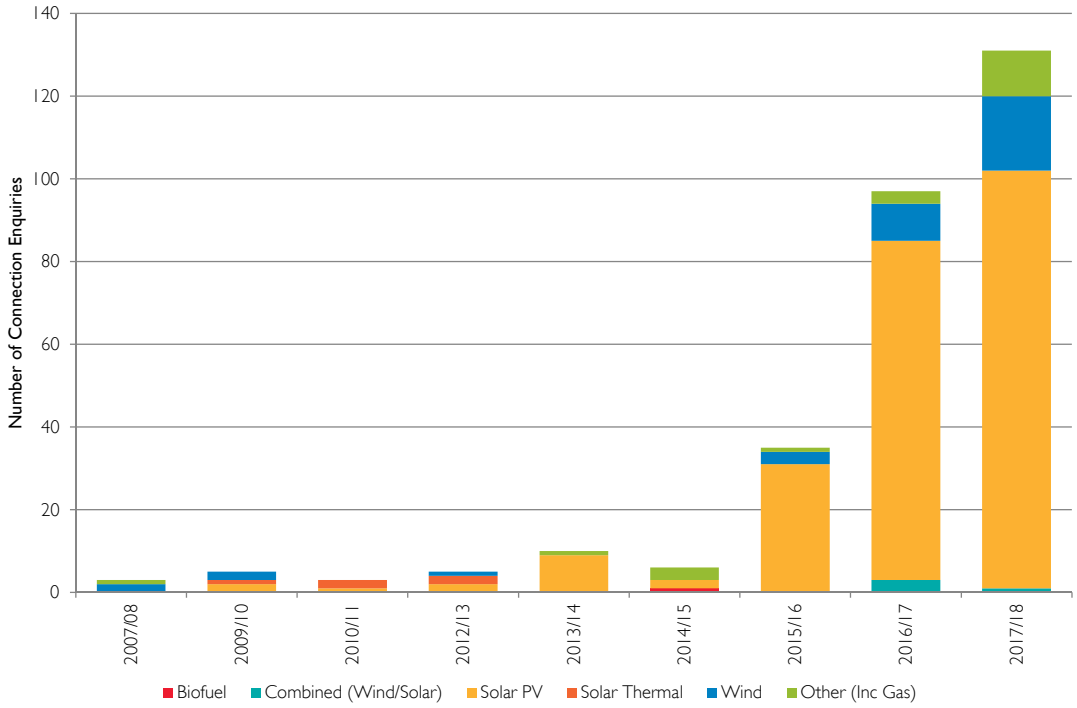
[1] The impact of new synchronous generator connections on existing fault levels has not been considered in the assessments conducted in this chapter. For further information on existing fault levels and equipment rating, please refer to Appendix E.

8.2 Connection activity during 2017/18

Powerlink continues to manage a high level of interest in transmission connections for VRE projects. In 2017/18, Powerlink received more than 120 new connection enquiries totalling in excess of 25,000MW[2].

Figure 8.1 illustrates the historical number of generation connection enquiries and the record levels that have been received over the last year.

Figure 8.1 Historical number of generation connection enquiries



During 2017/18, Powerlink finalised seven CAAs for new semi-scheduled VRE generation, totalling 1,012MW (refer to Table 8.1).

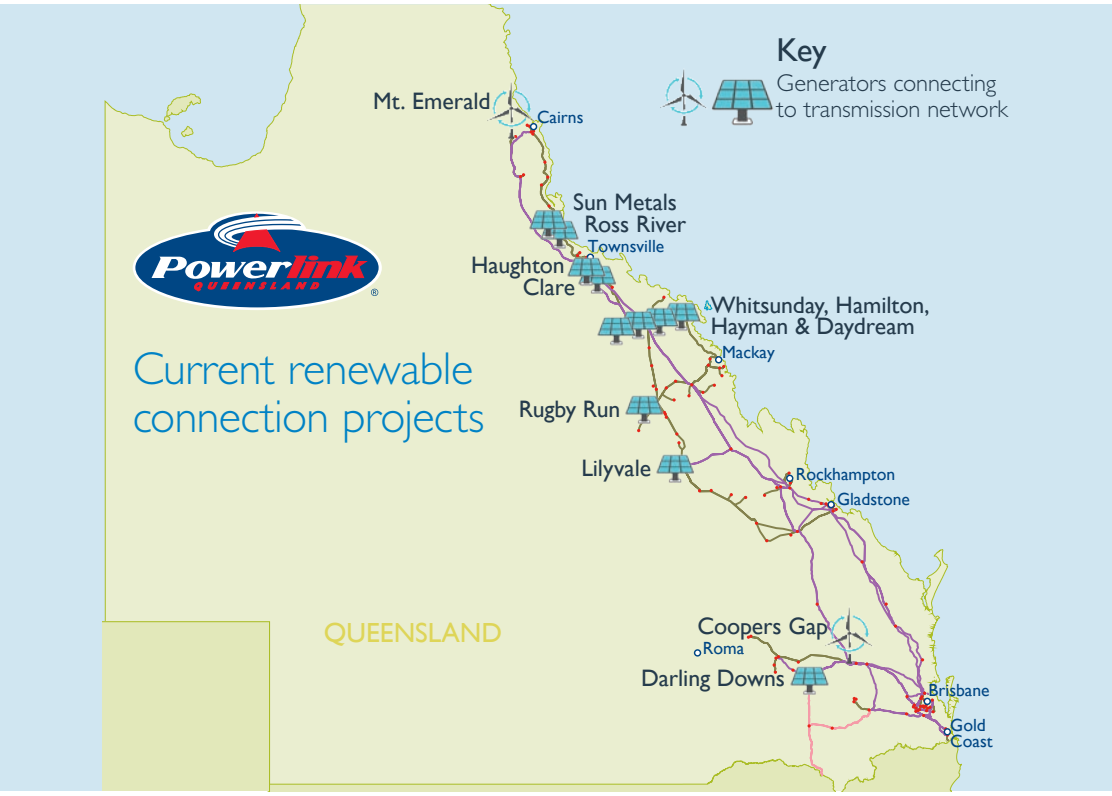
Table 8.1 Transmission connected VRE generation projects committed during 2017/18

Zone	Project	Registered capacity (MW)	Connection location
Ross	Sun Metals Solar Farm	107	Townsville South 132kV Substation
Ross	Haughton Solar Farm	100	New 275kV substation between Ross and Strathmore
North	Daydream Solar Farm	150	Strathmore 275kV Substation
North	Hayman Solar Farm	50	Strathmore 275kV Substation
North	Rugby Run Solar Farm	65	New 132kV substation near Moranbah
Central West	Lilyvale Solar Farm	100	New 132kV substation near Lilyvale
South West	Coopers Gap Wind Farm	440	New 275kV substation near Halys

Additionally, Powerlink has been advised of over 1,015MW of committed semi-scheduled renewable projects connecting within the distribution networks.

[2] Connection activity details as at 1 June 2018.

Figure 8.2 Committed projects connecting to the Powerlink network



8.3 Network capacity for new generation

Powerlink has assessed the potential generation capacity which could be accommodated at various locations across the transmission network. This information is available on Powerlink's website. The data presented is not comprehensive, and is not intended to replace the existing processes that must be followed to seek connection to Powerlink's transmission network.

8.3.1 Calculation methodology

Powerlink has assessed the available generation connection capacity at a number of locations across the network predominantly at the 275kV and 132kV level. Locations close to major urban areas were considered less likely to host a large VRE project and were excluded from the assessment.

Thermally Supportable Generation

A connection point's thermal capacity relates to the highest level of generation that can be injected into a connection point without exceeding the rating of a transmission circuit following the loss of a network element. It may be possible for generation to be installed in excess of this level if a fast generation runback scheme is implemented to limit generation output following the relevant network contingency events.

Each connection point's thermal capacity was calculated by applying generation of increasing levels to a connection point, displacing Queensland/New South Wales Interconnector (QNI) transmission line transfer, and performing contingency analysis. The thermal limit of a connection point was assessed as being reached when a rating breach was identified on the network surrounding the connection point. Powerlink has assessed each connection point individually, and has not assessed whether multiple generators in a region are likely to result in congestion on the main transmission network.

The capacity available for thermally supportable generation is based on summer daytime peak loadings, and does not take account of varying load, generation and market conditions that may drive other constraints at a local or system level.

System Strength Supportable Generation

Section 8.1 outlines that energy transformation underway, driven by advances in renewable energy technologies and displacement/retirement of existing synchronous generation. These changes are creating opportunities and challenges for the power system. One of these challenges is the impact that the displacement/retirement of synchronous generators has on the system fault levels. Section 8.3.2 describes the impact of this reducing system strength on the stability and security of the power system.

In response to these challenges, the Australian Energy Market Commission (AEMC) finalised Rule 2017 No.10 (Managing Power System Fault Levels). This Rule created a framework in the National Electricity Rules (NER) for the management of system strength in the NEM. As required under the Rule, the Australian Energy Market Operator (AEMO) published the System Strength Impact Assessment Guidelines for consultation on 5 March 2018, with an update on 14 May 2018. The final guidelines are to be published on 29 June 2018. As such, it is not possible for Powerlink to fully consider these in this TAPR.

Further detail on Powerlink's methodology on assessment of capacity for the Transmission Network is provided in the Generation Capacity Guide.

Overall VRE Supportable Generation

The overall VRE supportable generation is the lower of the thermally supportable generation and the system strength supportable generation at each location.

8.3.2 Network capacity results

As outlined in Section 8.1, Powerlink has received more than 120 connection enquiries and finalised seven connection agreements for new VRE generation since publication of the 2017 TAPR. As a consequence, the capacity results calculated via the methodology described in Section 8.3.1 are continually changing. On this basis, the detailed calculation results will be published on Powerlink's website in order to more efficiently address the dynamics of this evolving environment and best serve the needs of customers (refer to Powerlink's Generation Capacity Guide). Powerlink expects to maintain this data as required and encourages proponents to make informed investment decisions through the established connection enquiry process. This process includes the provision of detailed capacity and congestion information for customers seeking to connect to Powerlink's transmission network. To join Powerlink's Non-network Engagement Stakeholder Register (NNESR) and be notified of any updates to this data, please email networkassessments@powerlink.com.au.

The calculation methodology assumes the existing configuration of the transmission network and the technical standards that currently apply to transmission network design and power system operation. Only generation that has an executed CAA, an agreed Generator Performance Standard, and acceptance by AEMO of any requirements under National Electricity Rules (NER) 5.3.4A and 5.3.4B, is included in the calculation. The analysis also assumes that the proposed generation facility will comply with the NER's automatic access standard for reactive power capability (NER 5.2.5.1). Changes to the network configuration and the technical standards that apply to new connections have the potential to change the network capacity available to new generators.

Under the open access regime which applies in the NEM, it is possible for generation to be connected to a connection point in excess of the network's capacity, or for the aggregate generation within a zone to exceed the capacity of the main transmission system. Where this occurs, the dispatch of generation may need to be constrained. This 'congestion' is managed by AEMO in accordance with the procedures and mechanisms of the NEM. It is the responsibility of each generator proponent to assess and consider the consequences of potential congestion, both immediate and into the future.

Powerlink proactively monitors the potential for congestion to occur, and will assess the potential network augmentations to maximise market benefits using the Australian Energy Regulator's (AER) Regulatory Investment Test for Transmission (RIT-T)[3]. Where augmentations are found to be economic, Powerlink may augment the network to ensure that the electricity market operates efficiently and at the lowest overall long run cost to consumers. Generator proponents are encouraged to refer to Chapter 5, which provides more detail.

It is possible that the development, displacement or retirement of generating plant, changes to generation dispatch and/or load patterns, and/or changes to the underlying transmission network may alter transmission losses within the high voltage system, and hence Marginal Loss Factors (MLFs) used within the NEM dispatch and financial settlement processes. AEMO is responsible for the calculation of Marginal Loss Factors, and interested parties seeking further information on this are encouraged to contact AEMO, or refer to the AEMO website.

As a Transmission Network Service Provider, the scheduling of generation does not form part of Powerlink's role and as such, the indicative connection point generation capacity limits are not related to the scheduling and dispatch of generation in the NEM.

8.4 Transmission connection and planning arrangements

Powerlink, as part of the 2017 Transmission Network Forum, ran an engagement session on the upcoming rule change, seeking input from stakeholders on:

- What other information can Powerlink provide that would benefit connection applicants?
- How detailed should the functional specification be?
- How detailed should the Network Operation Agreement be, particularly with respect to operations and maintenance?

In May 2017 the AEMC published the final determination on the Transmission Connections and Planning Arrangements Rule change request. The final Rule sets out significant changes to the arrangements by which parties connect to the transmission network, as well as changes to enhance how transmission network businesses plan their networks.

In response to the Rule change and to further assist customers during the connection process, Powerlink has developed the following information and material:

- typical operations and maintenance scheduling
- standard suite of contracts (including the new network operating agreement)
- terms and conditions and fees for making a connection enquiry and a connection application
- design standards for substations and transmission lines, including current rating and configurations and land related policies
- equipment strategies for key plant, such as current transformers, circuit breakers, earth switches, surge arrestors, and voltage transformers
- standard layouts for Powerlink substations, overhead lines, underground cables and secondary systems.

A summary of the feedback from the 2017 Transmission Network Forum, and the information and material referred to above is available on Powerlink's website.

[3] Details of the RIT-T, including the market benefits which can be considered, are available on the AER's website: Regulatory investment test for transmission (RIT-T) and application guidelines 2010.

8.5 Supporting VRE development in Queensland

Powerlink is supporting a number of initiatives associated with the establishment of new generation in Queensland. Further information on these is provided in the following sections.

8.5.1 Shared network connections

In the broader context of supporting VRE generation connections, the concept of 'Renewable Energy Zones' (REZ) can be used to deliver lower cost connections to a number of parties. Powerlink is working to enhance the concept of the REZ based on recent experience around the connection of VRE, particularly in North Queensland.

As illustrated in figures 8.3 and 8.4, the existing concept of a REZ may involve:

- a high-capacity radial transmission line, with renewable projects connecting along the length of this line
- the establishment of a centralised hub, from which radial connections to individual renewable projects emanate
- a hybrid of these two options, with hub substations placed along the length of a new high-capacity transmission line.

Figure 8.3: REZ with high capacity transmission line

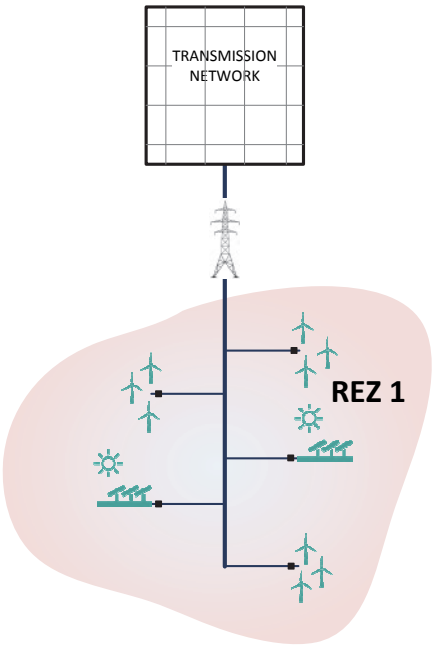
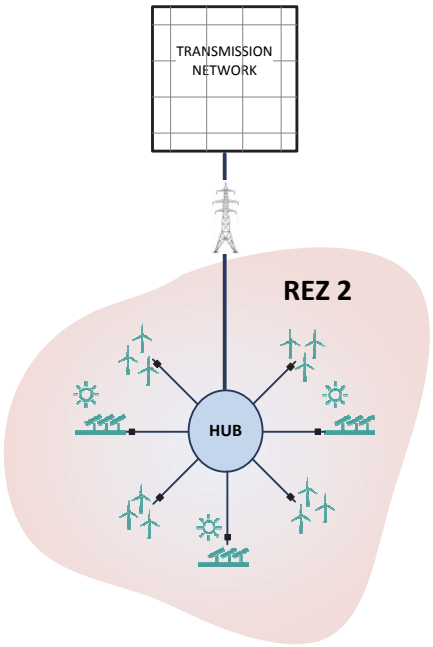


Figure 8.4: REZ with dedicated connection hub



Further to the concepts above, providing system firming services to facilitate the connection of new VRE generation may provide benefit, particularly in areas where the interest in VRE generation exceeds the available system strength.

Where new VRE generation is seeking to connect in areas of low system strength, there are a number of mitigation measures available to maintain adequate fault levels in the network. Powerlink considers that new VRE generation may be able to utilise one, or a combination of, the following methods to mitigate system strength issues:

- installation of a synchronous condenser to improve system strength
- contracting with existing synchronous generation to improve system strength
- modifying the scope of the connection works
- establishing intertrip schemes to mitigate against critical contingencies[4].

As with the establishment of a central hub and the high capacity line concept, system firming services may be utilised as a standalone solution or in combination with the other methods to deliver a REZ.

8.5.2 Delivering Clean Energy Hubs in Queensland

Powerlink, as part of the 2017 Transmission Network Forum, hosted an engagement session that provided an introduction into the potential development of a Clean Energy Hub (CEH) – a key action of the Powering Queensland Plan.

As part of the feasibility study into the CEH, discussions focused on connection options, technical and environmental considerations and operating models. Discussions also considered how the model could be replicated across Queensland.

Expression of Interest (EOI) in the CEH closed on 8 September 2017, with more than 30 submissions received from interested parties.

Powerlink, in collaboration with the Queensland Energy Security Taskforce and the Queensland Government, assessed these EOI responses including technical, economic, environmental, social and regional considerations. These assessments informed the CEH feasibility study.

The feasibility study is currently being considered within the context of broader Government energy policy.

8.5.3 Aldoga Renewable Energy Project

In April 2018, Energy Development Queensland announced Acciona as the successful tenderer for the Aldoga Renewable Energy Project. This project involves utilising a 1,250 hectare site adjacent to Powerlink's Larcom Creek Substation. Whilst the original concept for the site identified the potential to support more than 450MW of generation, detailed investigation has identified that the site capacity is limited to less than 300MW.

As a flagship project, it is envisaged that the Aldoga development will act as a catalyst for further opportunities. More information about this project is available on the website of the Queensland Department of Infrastructure, Local Government and Planning (DILGP).

8.5.4 Proposed renewable connections in Queensland

DNRME provide mapping information on proposed (future) VRE projects, together with existing generation facilities (and other information) on its website. For the latest information on proposed VRE projects and locations in Queensland, please refer to DNRME website.

8.5.5 Further information

Powerlink will continue to work with market participants and interested parties across the renewables sector to better understand the potential for VRE generation, and to identify opportunities and emerging limitations as they occur. The NER (Clause 5.3) prescribes procedures and processes that Network Service Providers (NSP) must apply when dealing with connection enquiries. Powerlink will continue to engage with interested parties who have lodged connection enquiries under the current Rules framework for connection of generation. Should an interested party wish to utilise the new connection framework referred to in Section 8.4, it will be necessary to submit a connection enquiry pursuant to the new Rule.

[4] Powerlink considers that these schemes are used to mitigate against single credible contingencies that result in a significantly lower available fault level (AFL).

Figure 8.5 Overview of Powerlink's existing network connection process

Proponents who wish to connect to Powerlink's transmission network are encouraged to contact BusinessDevelopment@powerlink.com.au. For further information on Powerlink's network connection process please refer to Powerlink's website.

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