Chapter 7:
Renewable energy

7 Renewable energy

Key highlights

- This chapter explores the potential for the development and connection of renewable energy generation to Powerlink's transmission network.
- The generation connection capacity of Powerlink's 132kV and 110kV substations for the existing transmission network is identified to facilitate high level decision making for interested parties.
- Compared to most other States in the NEM, Queensland's network presently has a much lower proportion of intermittent renewables (to total generation capacity) and is capable of accommodating a considerable number of additional renewable connections without immediate concern for overall system stability.
- Where economies of scale can be achieved through project cluster, Powerlink may consider the development of Renewable Energy Zones (REZs), subject to regulatory approvals and the conditions of its Transmission Licence.

7.1 Introduction

Queensland is rich in a diverse range of renewable energy resources – geothermal, biomass, wind and hydro – however the focus to date has been on solar, with Queensland displaying amongst the highest levels of solar concentration in the world. This makes Queensland an attractive location for large-scale solar powered generation development projects. There is significant potential for energy supply from renewable resources in Queensland. The rapid uptake of renewable energy systems is stimulating the development of supporting technologies, which in turn is improving the affordability of these systems.

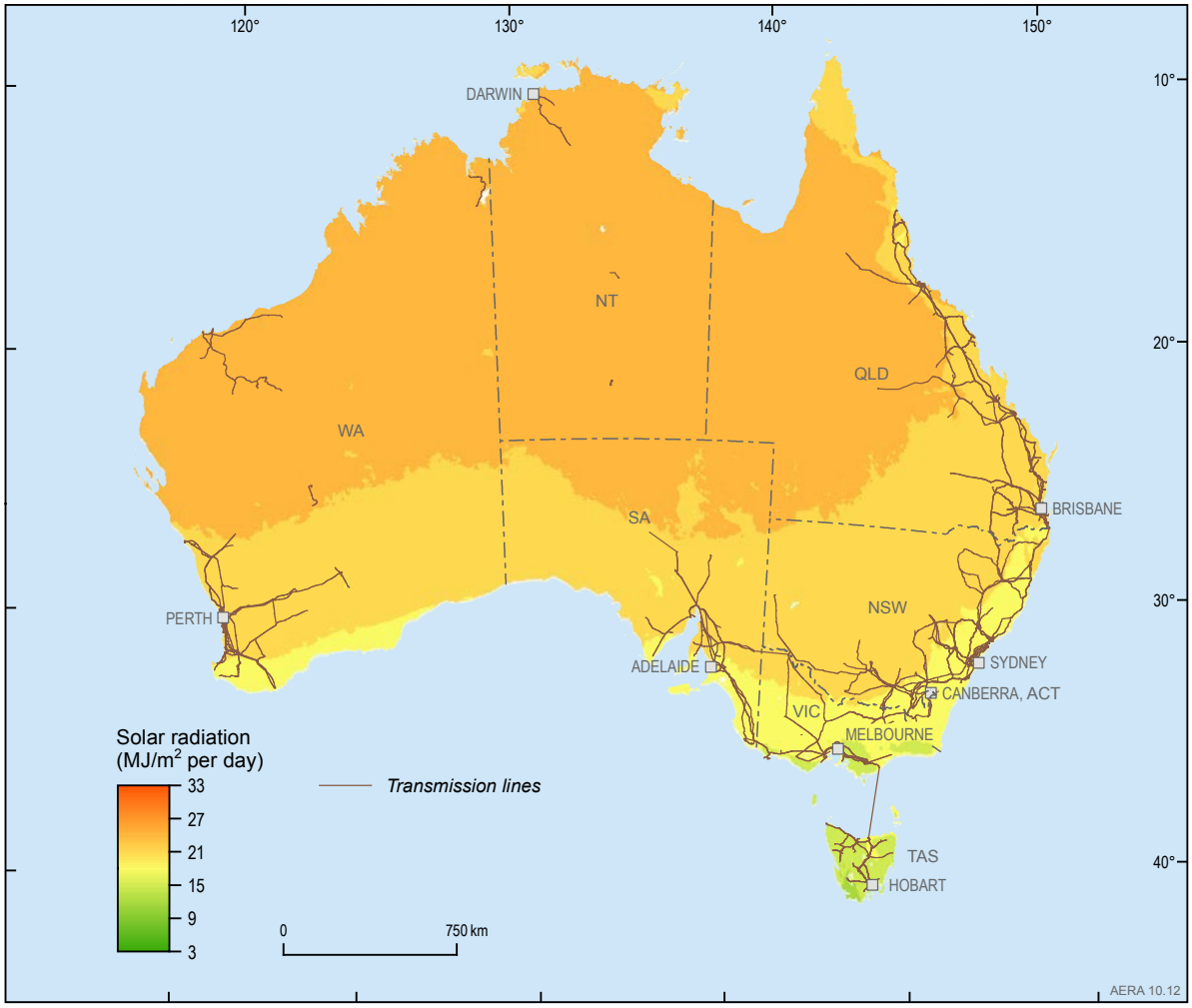
The uptake of over 1,500MW of small-scale solar in Queensland to date provides strong indication that Queensland consumers are no longer meeting their energy requirements entirely through conventional means. New technologies such as solar PV, smart appliances, and energy storage technologies are changing the way customers consume and produce energy. Revised policy frameworks, State based incentive schemes, Federal Government support programs, and climate change concerns are influencing developments in the energy sector, and will continue to have an impact. Powerlink is continually adapting to align with changes in its operating environment.

Due to the recent volume of interest in solar development projects in Queensland, this newly-developed chapter of Powerlink's 2016 Transmission Annual Planning Report (TAPR) focuses on solar energy project development opportunities. Powerlink is committed to supporting the development of all types of energy projects, however for the reasons outlined above, solar is a key focus area going forward. It should be noted that the network capacity information presented in this chapter is applicable to all forms of generation[1].

The Australian Government Department of Geoscience has published an assessment of Australia's energy resource across the continent. The report acknowledges that Australia's potential for renewable energy generation is very large and widely distributed across the continent. The annual average solar radiation map in Figure 7.1 indicates Queensland's solar energy potential, and in particular the proximity of Powerlink's high voltage transmission infrastructure to this energy resource.

[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.

Figure 7.1 Australian annual average solar radiation



Source: Geoscience Australia and Bureau of Meteorology[2]

7.2 Network capacity for new generation

Powerlink has assessed the ability of various locations across the existing transmission network to connect additional generation capacity without significant network congestion emerging. This section provides a broad overview of the results of this assessment. Interested parties are invited to use this data as a first pass to facilitate high level decision making. The data presented here is not exhaustive, and is not intended to replace the existing procedures and processes that must be followed to access Powerlink's transmission network.

2 © Commonwealth of Australia (Geoscience Australia and Bureau of Meteorology) 2016. This product is released under the Creative Commons Attribution 4.0 International Licence. http://creativecommons.org/licenses/by/4.0/legalcode

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Locations assessed for generation connection capacity were selected based broadly on their distance from metropolitan load centres. Locations close to major cities were considered unlikely to host a large renewable energy connection, and were excluded from the assessment. In addition, plant operating at 275kV (and higher) were excluded from this study as they can generally accommodate significant levels of generation. The approach used to establish the available capacity at the selected sites was as follows:

- A notional generator was placed sequentially at each of the selected locations and its output was gradually increased. The capacity of the location was established when either:
  - the loss of a network element caused an overload of one or more adjacent elements or
  - the size of the notional generator connection exceeded the network strength[3].

The results of the assessment are shown in Table 7.1.

Table 7.1 Indicative connection point capacity limits in the existing transmission network[4]

132kV and 110kV Substation Connection Nodes Assessed			Indicative Connection Point Capacity Limit
Baralaba	Egans Hill	Norwich Park	up to 50MW
Biloela	Grantleigh	Oonooie	
Cardwell	Ingham South	Peak Downs	
Coppabella	Innisfail	Proserpine	
Dingo	Kamerunga	Turkinje	
Edmonton	Moura		
Alligator Creek	Collinsville North	Pandoin	between 50MW and 150MW
Bluff	Dan Gleeson	Rocklands	
Bowen North	Dysart	Strathmore	
Bulli Creek	Kemmis	Tangkam	
Burton Downs	Mackay	Tully	
Chalumbin	Moranbah South	Wandoo	
Chinchilla	Mt. McLaren	Woree	
Clare South	Newlands		
Alan Sheriff	Larcom Creek	Pioneer Valley	between 150MW and 400MW
Blackwater	Lilyvale	Ross	
Boulderombe	Middle Ridge	Teebar Creek	
Callemondah	Moranbah	Townsville Sth	
Columboola	Nebo	Woolooga	
Gin Gin	Palmwoods	Yabulu South	
Blackstone	Calliope River	Gladstone South	potentially greater than 400MW

This information will be revised as new information related to available network capacity becomes available. Please refer to the TAPR 2016 Addendum for the updated network capacities.

[3] Network strength is measured through the fault level and short circuit ratio in an area.
[4] 275kV and 330kV connections were excluded from this assessment on the basis that they can generally accommodate significantly higher levels of generation.

The findings indicate that the Queensland transmission network is sufficiently strong, and well positioned to accommodate sizeable quantities of new generation without encroaching stability limits. These results are encouraging, particularly given the volume of interest shown in renewable energy projects in Queensland. The results are also presented graphically in Figure 7.2, together with an overlay of the Queensland solar radiation depicted in Figure 7.1.

Key points to note:

- Generation opportunities presented in this section are not cumulative. If a new generator connects to the network, it will likely impact the capacity of other areas in the network. Similarly, changes to the existing network arrangement will impact transfer limits and consequently, available capacity. Network capacity must be reassessed each time the network topology changes or a prospective generator commits.
- The capacity limits are based primarily on thermal limits and network strength[5], with the assumption that the proposed generation facility will comply with the NER's automatic access standard for reactive power dispatch. A formal connection enquiry could trigger an assessment of other stability limits, including the potential for network congestion.
- While some areas may appear to have restricted capacity, there may be low cost solutions available to accommodate much larger capacities. Fast run-back schemes are often used to curtail generation to avoid breaching thermal limits. The capacities stated in Table 7.1 are therefore not absolute. They are presented as a guideline, and starting point for further discussions.

[5] Network strength is measured through the fault level and short circuit ratio in an area. Fault level is the maximum current expected to flow in response to a short circuit at a given point in the power system. A project-specific measure of system strength for a generator connection is the Short Circuit Ratio (SCR), which is the ratio of the power system fault level at the proposed connection point to the rated generator connection. Both the minimum fault level and the minimum SCR are important values in establishing the limit of an asynchronous generator connection (such as wind or solar).

Figure 7.2: Transmission network capacity for new generation with solar radiation overlay

7.3 Supporting renewable energy infrastructure development

7.3.1 Renewable Energy Zone (REZ)

Powerlink is committed to supporting the development of renewable energy projects in Queensland. While the majority of recent interest has focussed on solar related activity, Powerlink recognises that considerable opportunity exists for wind, biomass, geothermal and hydroelectric projects in Queensland. Where economies of scale can be achieved through project clusters, Powerlink may consider the development of Renewable Energy Zones (REZs), subject to regulatory approvals and the conditions of its Transmission Licence.

The implementation of a REZ would require that consideration be given to a range of criteria, including economic benefit to customers, energy resource potential, infrastructure availability and access, stakeholder and local authority support, environmental suitability, and where possible, opportunity for deferral or replacement of planned network investment projects.

A REZ may be viewed as an expansion of the existing network into the zone of interest, as a high capacity transmission line or a connection hub, either of which would be aimed at supporting clusters of renewable energy projects. These arrangements are generally more cost effective than the creation of multiple connection paths to the grid as infrastructure sharing reduces the need for asset duplication. Although this concept is aimed at identifying priority areas for development, it is not intended to preclude the development of renewable energy projects outside the targeted zones.

Figure 7.3: REZ with high capacity transmission line

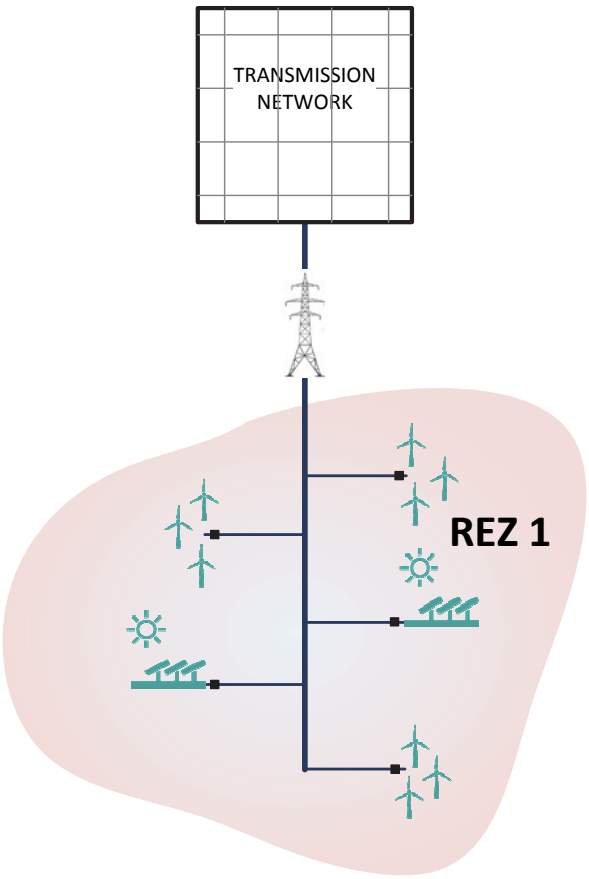
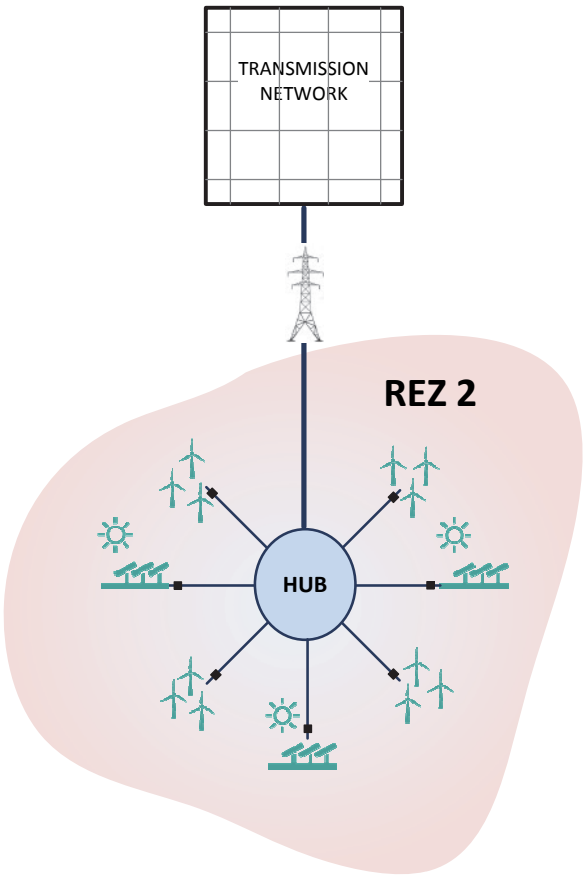


Figure 7.4: REZ with dedicated connection hub



Powerlink will continue to engage broadly with developers and interested parties to understand the needs and expectations of its stakeholders. Powerlink expects to work with the relevant government agencies to further explore efficient connection arrangements for renewable energy development schemes in Queensland.

7.3.2 Technical considerations

Due to the high level of growth in renewable energy systems in Queensland, Powerlink, in conjunction with Ergon Energy, considered the potential impact of large-scale renewable energy penetration on grid stability. The high level findings were:

- There are presently no anticipated network stability issues arising from projects under consideration that require solutions outside of normal customer connection planning processes.
- Compared to most other States in the NEM, Queensland's network presently has a much lower proportion of intermittent renewables to total generation capacity.
- Powerlink's transmission network is sufficiently strong, with capability to accommodate a considerable number of additional renewable energy connections without immediate concern for overall system stability.
- Monitoring the network for potential stability impacts will need to continue as intermittent renewable connections increase.

These findings will be reassessed for each new generator commitment.

7.3.3 Proposed renewable connections in Queensland

There has been significant interest in renewable energy projects in Queensland. The Queensland Government Department of Energy and Water Supply (DEWS) maintains mapping information on proposed (future) renewable energy projects that have been publicly announced, together with existing generation facilities (and other information) on its website. The data used to populate the *Proposed Renewable Energy Projects in Queensland* map shown in Figure 7.5 has been sourced from DEWS and is included in this chapter for completeness. For further information on proposed renewable energy projects in Queensland, please refer to www.dews.qld.gov.au.

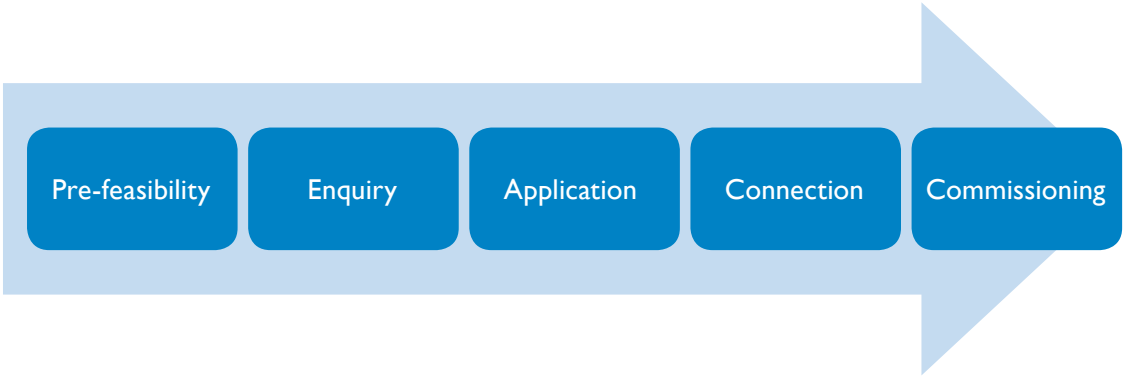
Figure 7.5: Proposed renewable energy development projects in Queensland

Data Source: Queensland Government Department of Energy and Water Supply (DEWS)

7.4 Further information

Powerlink will continue to work with market participants and interested parties across the renewables sector to better understand the potential for renewable energy, and to identify opportunities and emerging limitations as they occur. The National Electricity Rules (Clause 5.3) prescribes procedures and processes that Network Service Providers must apply when dealing with connection enquiries. Powerlink uses a five-stage approach as illustrated in Figure 7.6 below to facilitate this process.

Figure 7.6: 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[6] www.powerlink.com.au.

[6] Refer to Connecting to Powerlink's Network on the Powerlink website.