

A photograph showing several high-voltage powerline towers in a flat, green field under a clear blue sky. The towers are silhouetted against the horizon.

Network Planning

North Queensland System Strength Constraints

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Version Control

Version	Release date	Changes
1	9 September 2020	Initial version
2	7 October 2020	Added five new combinations (5e, 7c, 7d, 8a.1 and 8a.2)
3	9 November 2020	Constraints modified as a result of updated settings at Mt Emerald WF. Deleted 1, 2, 3, 4, 6, 7a-b and 8b-c. Added 10, 11 and 12.
4	24 November 2020	Added two new combinations 10b and 11c.
5	11 December 2020	Updated 11c.
6	1 June 2021	Deleted 5a-e, 7c-d, 8a,a.1,a.2, 10a-b, 11a-c, 12a-b Added 9a.1, 9a.2, 9c, 13 Modified 9b
7	5 August 2021	Modified 9b
8	20 August 2021	Added 14

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1 Introduction

System strength is a measure of the stability of a power system under all reasonably possible operating conditions. It describes a system's overall performance and its ability to recover quickly from sudden events.

System strength affects the stability and dynamics of generating systems' control systems, and the ability of the power system to both:

- Remain stable under normal conditions, and
- Return to steady-state conditions following a disturbance (such as a fault).

This document describes the constraints on North Queensland Inverter Based Renewable (IBR) generation due to system strength under system normal conditions.

2 Constraints

Table 1 summarises the combinations of the synchronous generating units and associated constraints on IBR plants in North Queensland (NQLD).

The constraints were developed using Powerlink's system-wide PSCAD model. The PSCAD model extends from Far North Queensland to the Hunter Valley in New South Wales (NSW). It includes plant specific models for IBR and synchronous generators (including voltage control systems) and transmission connected dynamic voltage control plant (Static Var Compensators and Statcoms). All the IBR generators connected to the transmission network have been considered in this analysis. IBR generators larger than 40MW and connected to the distribution network have also been taken into consideration in the assessment.

The PSCAD analysis revealed that the load level in NQLD impacts the hosting capacity of the IBR generation in the area. Different loading levels were studied for different generation dispatches in NQLD.

The NQLD load is measured as sum of Scheduled and Semi scheduled generation north of Central Queensland – North Queensland (CQ-NQ) grid-section and CQ - NQ Northerly transfer.

The Ross and Far North Queensland (FNQ) load is measured as sum of Scheduled and Semi scheduled generation north of Ross cut-set and Ross cut-set Northerly transfer. Ross cut-set is defined across

- Ross – Strathmore 275kV feeders, and
- Clare South – Strathmore 132kV feeder, and
- Clare South – King Creek 132kV feeder.

The PSCAD analysis shows that the Kareeya and Barron Gorge power stations have a considerable impact on the IBR generation hosting capacity in NQLD.

The following table describes limit equations for the IBRs in NQLD and considers current reconfiguration of the network north of Ross. The Boolean AND operation is applied to the system conditions across a row. If the expression yields a 'True' value then the maximum capacity quoted for the farm in question becomes an argument to a MAX function. If 'False' then zero (0) becomes the argument to the MAX function. The maximum capacity is the result of the MAX function.

NQLD system strength constraints

No	Stanwell	Callide B	Callide C	Callide B + C	Gladstone	Total of Stanwell + Callide + Gladstone	Kareeya	Barron Gorge	NQLD Load	Ross + FNQ Load	Mt Emerald WF (MW)	Sun Metals SF (MW)	Haughton SF (MW)	Other NQLD plants (MW)	
9a	≥2	-	-	≥1	≥2	≥7	≥2	-	-	-	0%	0%	0%	N/A	Day/Night
9a.1	≥2	-	-	≥1	≥2	≥7	≥0	-	-	-	0%	0%	0%	N/A	Day/Night
9a.2	≥2	-	-	≥1	≥2	≥7	≥2	-	>350MW	>150MW	100%	100%	100%	N/A	Day/Night
9b	≥2	-	-	≥1	≥2	≥7	≥0	-	>350MW	>150MW	100%	100%	50%	N/A	Day/Night
9c	≥3	-	-	≥0	≥3	≥7	≥2	-	>450MW	>250MW	100%	100%	100%	N/A	Day/Night
13	≥3	-	-	≥0	≥2	≥6	≥2	-	>450MW	>250MW	80%	80%	80%	80%	Day/Night
14	≥3	-	-	≥2	≥2	≥8	≥0	-	>450MW	>250MW	100%	100%	100%	N/A	Day/Night

Notes:

* 'Night' conditions refer to the total solar horizontal irradiance at Sun Metals, Haughton, Clare and Ross River < 4 and there are no inverters online at Sun Metals and Haughton.