Network Planning

North Queensland System Strength Constraints

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
9	26 November 2021	Deleted 9a and 9a.1 Added 9a.3, 9a.4 and 9b.1
10	16 August 2022	Added 15
11	30 September 2022	Deleted 9a.2, 9b, 9c, 13 and 14 Added 16-21 to include Kaban WF while 3rd 275kV feeder 8905 between Ross and Woree is not operational
12	13 February 2023	Deleted 9a.3, 9a.4, 9b.1 and 15 Added 16a.1, 16a.2

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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 following tables describe limit equations for the IBRs in NQLD. 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.

Under some network conditions, generating plants are required to disconnect all the inverters/turbines to avoid the adverse system strength impact (disconnection can be achieved by completely stopping firing of power electronics switches at inverters/turbines). The requirement for inverter/turbine disconnection for a generating plant is communicated real time through NEMDE via a system strength constrain ID.

Table 1 System strength constraint with Kaban WF while 3rd 275kV feeder 8905 between Ross and Woree is not operational

No	Stanwell	Total of Stanwell + Callide	Gladstone	Total of Stanwell + Callide + Gladstone	Kareeya	NQLD Load	Ross + FNQ Load	Haughton Synchronous Condenser	Haughton SF (MW)	Kaban WF (MW)	Other NQLD plants (MW)	
16	≥2	≥3	≥1	≥7	≥0	>350MW	>150MW	OFF	25%	25%	100%	Day/Night
16a.1	≥2	≥3	≥1	≥7	≥0	>250MW	>100MW	OFF	0% (Note 1)	0% (Note 2)	100%	Day/Night
16a.2	≥2	≥3	≥1	≥7	≥0	>250MW	>100MW	ON	100%	100%	100%	Day/Night
17	≥2	≥3	≥1	≥7	≥2	>350MW	>150MW	OFF	50%	50%	100%	Day/Night
18	≥2	≥3	≥1	≥7	≥2	>350MW	>150MW	ON	100%	100%	100%	Day/Night
19	≥1	≥4	≥1	≥6	≥2	>350MW	>150MW	OFF	50%	50%	80%	Day/Night
20	≥1	≥4	≥1	≥6	≥2	>350MW	>150MW	ON	100%	50%	100%	Day/Night
21	≥2	≥3	≥1	≥7	≥2	>350MW	>150MW	OFF	N/A	100%	Wind farms = 100% Solar farms = N/A	Night*

* '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 Solar Farms.

Note 1:
All inverters/turbines should be disconnected.

Note 2:
All inverters/turbines can remain connected.