SECOND UPDATE TO THE 2016 NATIONAL TRANSMISSION NETWORK DEVELOPMENT PLAN

FOR THE NATIONAL ELECTRICITY MARKET

Published: **October 2017**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

AEMO has prepared the Update to the 2016 National Transmission Network Development Plan under clauses 5.20.2 and 11.101.7 of the National Electricity Rules. This report is based on information available to AEMO up to 25 September 2017.

Disclaimer

This report contains data provided by or collected from third parties, and conclusions, opinions, assumptions or forecasts that are based on that data.

AEMO has made every effort to ensure the quality of the information in this report but cannot guarantee that the information, forecasts and assumptions in it are accurate, complete or appropriate for your circumstances.

Anyone proposing to use the information in this report should independently verify and check its accuracy, completeness and suitability for purpose, and obtain independent and specific advice from appropriate experts.

This document or the information in it may be subsequently updated or amended. This document does not constitute legal or business advice, and should not be relied on as a substitute for obtaining detailed legal advice about the National Electricity Law, the National Electricity Rules, or any other applicable laws, procedures or policies.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this document:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this report; and
- are not liable (whether by reason of negligence or otherwise) for any statements, opinions, information or other matters contained in or derived from this publication, or any omissions from it, or in respect of a person's use of the information in this report.

Version control

Version	Release date	Changes
1	13/10/2017	

SECOND UPDATE TO THE 2016 NTNDP

On 12 December 2016, AEMO published the 2016 *National Transmission Network Development Plan* (NTNDP).[1] The NTNDP assessed whether further Network Support and Control Ancillary Services (NSCAS) are required in the next five years. NSCAS are non-market ancillary services designed to maintain power system security and reliability, and to maintain or increase the power transfer capability of the transmission network.

Transmission Network Service Providers (TNSPs) have the primary responsibility for acquiring NSCAS. Each year, AEMO identifies any NSCAS need forecast to arise over a five-year minimum planning horizon (NSCAS gap). This assists TNSPs with decision-making about their NSCAS procurement.

In the 2016 NTNDP, AEMO identified an NSCAS gap to provide system strength in South Australia, and stated that the gap would be confirmed in 2017 following completion of more detailed analysis. AEMO has since published a report which evaluated the adequacy of system strength in South Australia for various levels of synchronous and non-synchronous generation.[2]

On 13 September 2017, AEMO published an update to the 2016 NTNDP declaring an NSCAS gap for system strength in South Australia.

Following this, on 19 September 2017, the Australian Energy Market Commission (AEMC) determined changes to the National Electricity Rules (NER) for managing system strength.[3] After careful consideration of the final rule, AEMO now considers that South Australia's system strength needs will be better managed under the new framework.

This document has effect as a notice under clause 11.101.7 of the NER that AEMO withdraws the NSCAS gap for system strength in South Australia declared on 13 September 2017, and declares a new system strength NSCAS gap. This permits the new system strength framework to be utilised in accordance with clause 11.101.6 of the NER.

1.1 System strength

System strength is an inherent characteristic of any power system, and can materially impact its operation. Higher fault levels, or high currents following a fault, are typically found in a stronger power system, while lower fault levels are representative of a weaker power system.

System strength also reflects the sensitivity of system variables, such as voltage magnitude and angle to a disturbance. Low system strength can increase the difficulty of managing power system stability.

The 2016 NTNDP highlighted that system strength is expected to decline across the National Electricity Market (NEM), particularly in areas of high non-synchronous generation like South Australia. Emerging challenges resulting from declining system strength include:

- Generator fault ride-through.[4]
- Correct operation of protection.

Failure of generator fault ride-through can result in multiple generators disconnecting from the system in unison. Inappropriate operation of protection could result in excessive disconnection of transmission or generation, or failure to clear faults (a risk to safety and equipment).

[1] AEMO. *2016 National Transmission Network Development Plan*, December 2016. Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Transmission-Network-Development-Plan.
[2] AEMO. *South Australia System Strength Assessment*, September 2017. Available at: http://www.aemo.com.au/Media-Centre/South-Australia-System-Strength-Assessment.
[3] AEMC. Completed rule changes: Managing power system fault levels. Available at: http://www.aemc.gov.au/Rule-Changes/Managing-power-system-fault-levels.
[4] Both synchronous and inverter-connected generator fault ride-through is considered.

The primary concern in South Australia is a sudden loss of generation that ultimately results in the disconnection of the Heywood Interconnector and a state-wide frequency or voltage collapse (that is, a state-wide blackout). The 2016 NTNDP discussed the implications of these challenges in detail.

AEMO is continuing to support ElectraNet in assessing the system strength requirements of appropriate protection operation, and will update the NTNDP if increased support services are required.

On 19 September 2017, the AEMC published a rule for managing system strength.[5] The rule allocates responsibility for the management of system strength, providing a framework for Network Service Providers (NSPs) to maintain system strength at generating connection points above an agreed minimum level.

1.2 Current operating requirement

On 2 December 2016, AEMO determined that at least two large synchronous generating units must be online in South Australia to ensure sufficient fault level available to synchronous machines, wind generation, and dynamic reactive support plant, and therefore to maintain a secure operating state.[6]

On 6 September 2017, considering the available equipment presently installed in South Australia, and following a series of in-depth power system simulation studies, AEMO determined that more complex combinations of large synchronous generating units must be online.[7]

One or more combinations of online synchronous generators are required to maintain sufficient system strength to withstand a credible fault and loss of a synchronous generator. The following table summarises the combinations of synchronous generators that provide sufficient system strength for up to 1,200 megawatts (MW) of non-synchronous generation, such as wind or solar photovoltaic (PV).

Table 1 Current system strength requirement for up to 1,200 MW of non-synchronous generation in South Australia

ID	Torrens Island A				Torrens Island B				Pelican Point			Osborne		Quarantine / Dry Creek
	Ax	Ax	Ax	Ax	Bx	Bx	Bx	Bx	GTxx	GTxx	ST18	GT	ST	QPS5 or Dry Creek (1 to 3)
A					✓	✓			✓		✓			
B					✓	✓						✓	✓	✓
C									✓		✓	✓	✓	✓
D	✓	✓	✓		✓	✓								
E					✓				✓	✓	✓			
F	✓	✓							✓		✓			✓
G	✓				✓				✓		✓	✓	✓	
H	✓	✓	✓		✓							✓	✓	
I	✓	✓			✓	✓						✓	✓	

[5] AEMC. Completed rule changes: Managing power system fault levels. Available at: http://www.aemc.gov.au/Rule-Changes/Managing-power-system-fault-levels.
[6] AEMO. Market Notice 56089. Available at: https://www.aemo.com.au/Market-Notices?currentFilter=&sortOrder=&searchString=56089.
[7] AEMO. *South Australia System Strength Assessment*, September 2017. Available at: http://www.aemo.com.au/Media-Centre/South-Australia-System-Strength-Assessment.

AEMO has recently issued numerous directions to maintain power system security in accordance with the current operating requirement in South Australia. AEMO intends for the system strength framework to replace the need for similar directions.

1.2.1 Three-phase fault level requirement

Rather than being provided by synchronous generating units, the system strength requirement could be provided through other means (such as synchronous condensers).

The minimum three-phase fault level required at the Davenport 275 kilovolt (kV) transmission connection point is approximately 1,250 megavolt ampere (MVA). AEMO's studies have found that approximately 620 MVA of this requirement should be provided by synchronous machines within South Australia. This fault level requirement was derived from the current operating requirement, which is explained in more detail in the *South Australia System Strength Assessment*.[8]

Without system strength limitations, AEMO considers that there might be periods where no synchronous generators would operate in South Australia. Therefore, AEMO identifies a system strength NSCAS gap for 620 MVA at the Davenport 275 kV transmission connection point (to be provided by synchronous machines within South Australia).

Fault current is used as a proxy for the level of inertia, fault current, synchronising torque, and other synchronous characteristics which a power system needs. However, it cannot be used as the only metric for system strength needs. Any new services proposed to provide system strength must be validated through detailed Electromagnetic Transient (EMT) studies.

1.3 NSCAS gap for system strength in South Australia

AEMO now withdraws the NSCAS gap for system strength declared on 13 September 2017, and declares a new NSCAS gap for system strength in South Australia under clause 11.101.7 of the NER.

This NSCAS gap:

- Requires the provision of system strength services, including fault current, for areas of South Australia with high non-synchronous penetration levels.
- Is required for maintaining power system security.
- Exists today, and is required for the remainder of the current five-year NSCAS planning horizon (until 1 July 2021) and beyond.

The indicative three-phase fault level required to meet this NSCAS gap in South Australia (as measured at Davenport 275 kV fault level node) is 620 MVA each year for the remainder of the current five-year NSCAS planning horizon and beyond. This fault level should be supplied by synchronous machines within South Australia.

The provision of fault current should be shared across a specific combination of plants, so credible contingency events can be withstood. The fault levels identified are a broad metric and are indicative only – any proposed solutions will need to be validated with EMT studies.

In the short term, AEMO will ensure the commitment of generating unit combinations outlined in Section 1.2. AEMO will collaborate with ElectraNet to validate the technical capability of any proposed solutions to ensure power system security.

[8] AEMO. *South Australia System Strength Assessment*, September 2017. Available at: http://www.aemo.com.au/Media-Centre/South-Australia-System-Strength-Assessment.

1.4 Next steps

AEMO will continue to review the technical capability of different solutions (including synchronous condensers and combinations of generating units) to providing power system security, and will update its website[9] with any findings.

AEMO has asked ElectraNet to confirm within 30 days that they will meet this NSCAS gap from 30 March 2018. This date was chosen to allow time for ElectraNet to negotiate with potential service providers, and to precede the very low demand periods in April and May when the service will likely be required.

ElectraNet may choose to meet this NSCAS gap as a fault level shortfall under the new system strength framework.[10] Under this framework, AEMO will be required to approve the technical specifications, and performance standards of any system strength service[11]. AEMO will endeavour to provide transparency to this process by consulting with the Australian Energy Regulator (AER), and by publishing its assessments.

If ElectraNet agrees to meet this NSCAS gap but does not treat the NSCAS gap as a fault level shortfall, they may only address the period up until 1 July 2019.[12] If ElectraNet does not commit to meeting this NSCAS gap from 30 March 2018, AEMO will consider whether to acquire the NSCAS for the period until 1 July 2019 in accordance with clause 3.11.3 of the NER.

[9] Updated assessments will be available at: http://www.aemo.com.au/Media-Centre/South-Australia-System-Strength-Assessment.
[10] AEMC. Completed rule changes: Managing power system fault levels. Available at: http://www.aemc.gov.au/Rule-Changes/Managing-power-system-fault-levels.
[11] Outlined in clause 5.20C.4(d) of the NER.
[12] NSCAS cannot be used to meet a fault level shortfall after 1 July 2019, as defined in clause 11.101.5 of the NER.