AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Generator connections to the Western Victoria Transmission Network

Questions and Answers

Updated October 2019

Important note: AEMO has published this Q&A document in its capacity as the provider of shared network services for the Victorian transmission network. For information on similar issues in other parts of the National Electricity Market (NEM) power system please contact the local network service provider. Please be aware that the Q&A provide general information only, as at a point in time. They relate to a constantly developing situation, which may have evolved since this document was last updated.

1. What is the issue?

There is potential for widespread thermal and stability constraints across an area currently extending from Moorabool Terminal Station, west to Terang Terminal Station, north-east to Ballarat Terminal Station and to the 220 kV loop extending from Ballarat – Horsham – Red Cliffs – Kerang – Bendigo[1]. This region is an attractive location for new generation projects due to the quality and availability of renewable energy resources in the area. However, the grid is not currently equipped to accommodate large volumes of inverter-connected generation, either in terms of thermal capacity or system strength.

This area has a number of large scale operational and committed wind and solar generating facilities, as well as a significant number of connection applications currently being assessed by AEMO and distribution network service providers (DNSPs) in Victoria. The detailed map attached to this fact sheet (Attachment 1) illustrates existing and proposed generation in Western Victoria as at October 2019.

There are also several hundred megawatts of recently constructed and committed solar farms in south-west New South Wales, which have increased the overall inverter-connected generation capacity in the West Murray area.

Further generation development in West Murray (both western Victoria and south-western NSW) will:

- Add to existing thermal constraints for all (existing and new) generators in the area.
- Further reduce marginal loss factors (MLFs) for all generators in the area.
- Require rigorous assessment to identify and remediate adverse impacts on system strength, likely through the installation of additional synchronous condenser capability, at the cost of connecting generators.
- Require detailed assessment of the network stability impacts of each new connection, including low frequency voltage oscillations, which may require complex, bespoke generator tuning and settings.

Despite these challenges, interest in the development of new wind and solar farms in western Victoria remains high.

2. What does this mean for me as an existing or future wind or solar farm developer?

Generator access to the network is not guaranteed under the NEM framework, and the output of connected plant is likely to be constrained more frequently and to a greater degree.

Thermal constraints

If the loading along the transmission lines exceeds the thermal limit, or stability limits are exceeded, the amount of generation output that can flow through them will be restricted. When that happens, generators located near these lines will dispatch at less than their full output. This problem will be exacerbated as the number of connections increase along these lines.

In order to manage the potential impact of single contingencies on network limits, and frequency stability in particular,AEMO anticipates a need to limit the combined output of generation in western Victoria, at least until planned transmission network upgrades can be completed (see question 6).

If AEMO considers it necessary for adequate system operation and maintenance of power system security, non-scheduled generators may need to participate in central dispatch and could also be constrained.

[1] The issues also extend north from Red Cliffs into south western NSW. For more information on connection impacts in NSW please contact TransGrid or Essential Energy as appropriate.

System strength and stability

Due to low system strength in the area, additional constraints and remediation works will almost certainly be required for all new or modified generation connections. These works may include installation of synchronous condensers or other plant to raise fault levels. High volumes of existing and committed generation in the area mean that additional special protection schemes to manage system strength impacts are unlikely to be feasible due to their impact on power system operation and security.

For more information on system strength, see the System Strength Impact Assessment Guidelines published by AEMO and effective from 1 July 2018[2]. This document outlines the principles and methodologies used to assess the system strength impacts of a new or modified generating system.

Developers should be aware that given these considerations, new or modified connections in this area will be more complex and time-consuming to assess and could require significantly more expensive plant adjustments and additions. To ensure that new plant does not exacerbate stability concerns (for example by contributing to low voltage oscillations), plant settings must be specifically configured for the network conditions and extensively modelled.

Marginal loss factors

Based on current prevailing network load flows and calculation methodologies, MLFs for generation in Western Victoria will continue to decrease as more generation connects in the area. This means that all affected generators will receive less spot market revenue for their measured output. More detail is provided in question 7.

3. How will my generator's output be affected?

Several factors can affect the order in which generators are dispatched, and the amount by which they could be constrained. In addition to variable operational conditions and economic considerations (including bid amounts), the location of each generator relative a network constraint and to each other may be a significant factor.

Voltage stability and ancillary service constraints are likely to result in pre-contingent constraints being applied to generators to limit the total lost generation for a single contingency. Pre-contingent constraints include not only any generators that would trip as a direct result of a specific fault, but also any remote generators that trip or reduce output on a control scheme action following the fault.

There will be an increasing need to apply pre-contingent constraints to ensure the power system is operated within its technical limits. Constraints can be particularly onerous during prior planned and unplanned (forced) outages. When reviewing proposed planned outages for maintenance and upgrades, AEMO considers a number of factors, such as forecast demand, generator availability, interconnector availability, weather conditions, gas outages, other line outages, and constraints. AEMO applies operational constraints to generators to ensure the system is operated in a secure state. The north-west Victorian network essentially has three AC connections to the main system, via Darlington Point, Ballarat, and Bendigo/Ballarat. During a prior outage of one of these three connections, AEMO plans for the loss of a remaining connection, which subsequently radialises the entire north-west network via a single connection to the main system.

Whether and how a particular generator is impacted will depend on its characteristics, location, system strength limitations, and connection configuration. Establishing the potential impact on a particular connection requires detailed studies using accurate computer modelling information provided by generators. Any future connections could materially change the outcomes.

4. Are there other future risks or limits that may impact my output?

There are many possible outcomes or scenarios that could increase risk for generators in north-west Victoria.

As one example, AEMO is currently investigating the impact of high densities of solar and wind generation, including the potential for rapid ramping events, at various geographical areas.

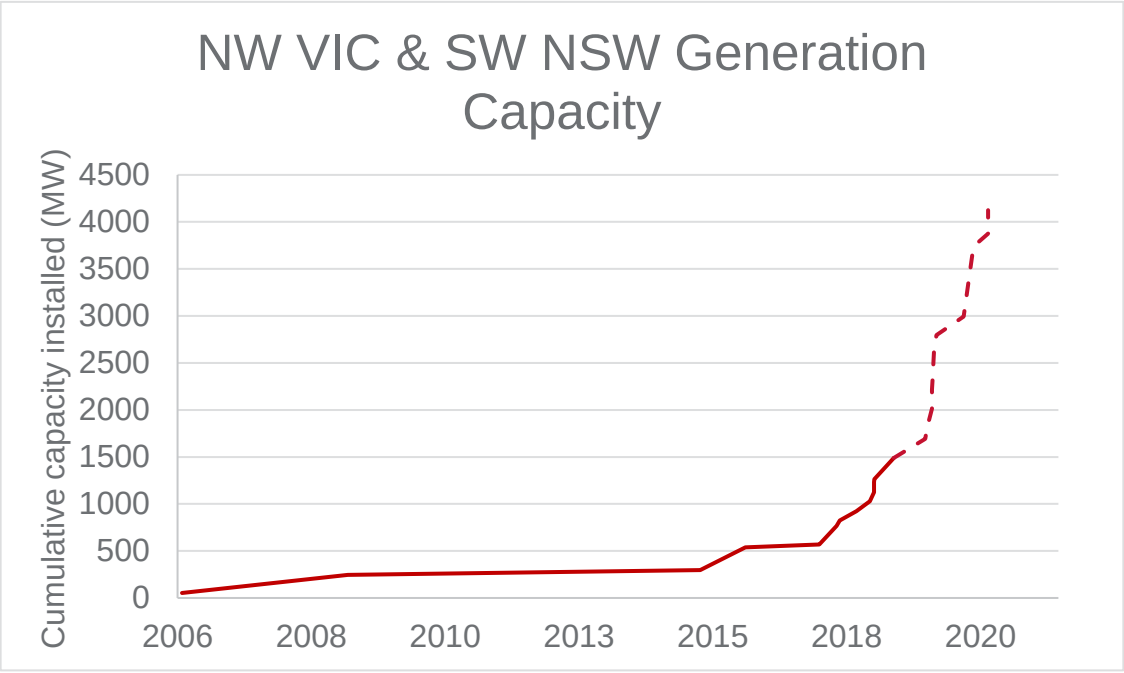
[2] At https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/System-Strength-Impact-Assessment-Guidelines.

If adverse impacts on the power system are identified, AEMO would need to take measures to manage power system security. This could include constraining generation, particularly where environmental conditions result in a significantly higher risk.

5. Can AEMO stop new connections in the area?

AEMO must process every connection application it receives and make offers to applicants who meet the relevant National Electricity Rules requirements. Offers may need to be conditional on the applicants funding additional capacity to accommodate their connections, as well as system strength remediation requirements and performance standards.

There has been a significant increase in connections over the past several years, as illustrated in the graph below.



6. How is AEMO addressing this situation?

AEMO is working closely with industry to evolve the power system through solutions that maintain power system security and deliver reliable and affordable energy to consumers. The initiatives AEMO is investigating in Victoria include the potential for shared generation connection solutions and reinforcing the power system to alleviate thermal constraints. As power system operator, AEMO also conducts periodic assessments of minimum system strength requirements for each region of the NEM.

Shared connection solutions

AEMO has recently initiated discussions with Network Service Providers and Connection Applicants to identify and develop potential opportunities for shared solutions to minimise connection costs and maximise the hosting capacity of the network, where this is both commercially and technically feasible.

Alleviating thermal constraints

In exercising its functions as the shared transmission network planner for Victoria, AEMO can only plan to augment transmission line capacity if there are sufficient net benefits to the broader market (that is, not solely to benefit connected or connecting generators) or if augmentations are funded by connecting generators.

AEMO recently completed a Regulatory Investment Test for Transmission (RIT-T) to assess solutions to address forecast thermal constraints in Western Victoria. The final step in the RIT-T process, the Project Assessment Conclusions Report (PACR), identifying a preferred option was published in July 2019.

The preferred option will support additional generation connections in Western Victoria and includes short term (present to 2021) and medium term (2021 to 2025) solutions. More information can be found in the PACR on the AEMO website.

The Western Victoria RIT-T is a first step in a much larger, strategic transmission infrastructure development plan underway to assess and coordinate future transmission and generation across the NEM, as outlined in AEMO's 2018 Integrated System Plan and the AEMO 2019 Victorian Annual Planning Report.

ElectraNet's South Australian Energy Transformation "EnergyConnect" project has also been exploring options to facilitate energy transformation. In February 2019, ElectraNet released the South Australian Energy Transformation PACR. . The PACR identified a high-capacity interconnector between South Australia and New South Wales, with an added connection to north-west Victoria including a new line between RedCliffs and Buronga, as the preferred option to generate a range of benefits for South Australia, New South Wales, and Victoria.

7. How does this impact Marginal Loss Factors?

If power flow from an area of the network increases in the direction of the regional reference node (RRN), the generator MLFs for that area will decrease. In Victoria, the RRN is at Thomastown in Melbourne.

The connection of new generation in north-west Victoria has increased power flow from that area toward the RRN and contributed to MLFs in the area decreasing, with some generators experiencing a decline of several percent year-on-year. The connection of additional generation will likely cause the MLFs in the area to drop further.

If the transmission network connecting the north-west Victoria area to the RRN is augmented, the MLFs in the area could increase toward 1. The materiality of any change in MLFs would largely depend on the nature of the augmentation.

Several other factors can also impact MLFs, including changes in local demand growth and behaviour, changes in interconnector flows, retirement of baseload generation and increased rooftop solar installations.

8. What can I do to reduce the impact of system constraints?

There are a number of actions available to project developers that could assist in alleviating the network congestion, including:

- If the project is in its early stages, assess the extent to which additional plant costs, unpredictable constraints, or loss factors could impact project viability, and consider alternative options.
- Investigate potential energy storage solutions to store excess electricity generated by a wind or solar farm.
- Remediation works to address system strength limitations, noting the feasible system strength remediation options may be limited.
- Configure the connection to minimise ancillary services constraints. AEMO's preference is for connected parties to be fully switched, but alternatives may be considered in some circumstances.
- Consider technology outputs (generation sources) which are complementary/anti-correlated to existing generators.
- Tune control systems to ensure they can be safely integrated to the broader power system, covering system normal as well as prior outage operating scenarios.
- Fund the cost of augmentation or other works by the network service provider to alleviate congestion, noting this will not guarantee exclusive access to the increased network capacity.

What if I need more information?

For connection enquires – connections@aemo.com.au

For Western Victoria RIT-T enquiries – WestVicRITT@aemo.com.au

For general enquiries – AEMO Support Hub – 1300 236 600

Attachment 1
Western Victoria Connections Map