Q&A: Connections to the Western Victoria transmission network

September 2021

IMPORTANT NOTES

- *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 are 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. This area is consistent with the Victorian section of the "West Murray Zone" (WMZ).[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 several 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. A detailed map of existing and proposed generation in Western Victoria is available on our website.[2]

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 WMZ area.[3]

With the integration of committed projects into the WMZ now complete,[4] the capacity of the existing network to host large scale inverter-connected generation has been reached. Further generation development in WMZ, comprising both western Victoria and south-western NSW, has and will continue to:

- Exacerbate existing thermal constraints for all (existing and new) generators in the area
- Potentially further reduce marginal loss factors (MLFs) 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 the connecting party
- 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.

New and existing generation across large parts of the WMZ will be materially constrained for significant periods of time pending large-scale network investments. This will restrict commercial output and may prevent or delay completion of commissioning for new projects.

Connections that rely on future regulated upgrades to the network cannot be assessed until those upgrades are substantially complete.

Thermal constraints

When 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 is restricted. When this happens, generators located near these lines are dispatched at less than their full output. This problem will be exacerbated as the number of connections increase along these lines.

To manage the potential impact of single contingencies on network limits, and frequency stability, AEMO has limited the combined output of generation in western Victoria. These limits will apply at least until committed and 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.

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 AEMO's System Strength Impact Assessment Guidelines (effective from 1 July 2018).[5] 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.

There is heightened risk that system constraints could materially limit generation in way that significantly delays commissioning processes.

Outage constraints

As more generation connects, the impact of planned transmission network outages will become more significant, to the extent that an outage of any one of the many elements in the Western Victorian transmission system will result in curtailment of most generation in Western Victoria. AusNet Services requires regular outages on the transmission network to conduct routine maintenance and refurbishment works. Over the life of a proponent's facility, including during commissioning, there may be a need for extensive outages to address long term maintenance issues and/or line replacement.

Marginal loss factors

Based on current prevailing network load flows and calculation methodologies, MLFs for generation in Western Victoria will likely continue to decrease as more generation connects in the area. This means that all affected generators will likely 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 which generators are dispatched, and how much they could be constrained. In addition to variable operational conditions and economic considerations (including bid amounts), the location of each generator relative to a network constraint and each other may be a significant factor.

Voltage stability and ancillary service constraints are resulting 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 planned outages (proposed by AusNet Services and other service providers), for maintenance and upgrades, AEMO considers several factors, such as:

- Forecast demand
- Weather conditions
- Other line outages
- Generator availability
- Gas outages
- Interconnector availability.

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. For planned outages, AEMO plans for loss of the remaining connection which can radialise the entire north-west network. Whether and how a particular generator is affected 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 COULD AFFECT 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.

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.

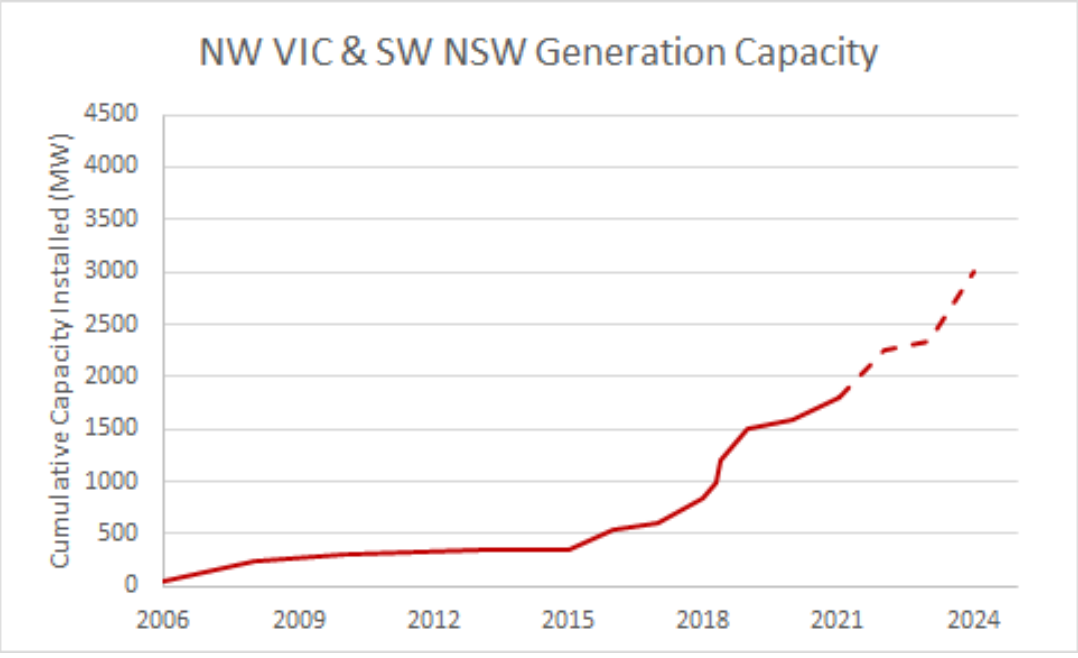
Further, AEMO has observed sub-synchronous oscillations of 16-19 Hz in the WMZ.[6] To identify and where possible resolve these issues, AEMO is:

- Working with relevant network service providers to install appropriate monitoring equipment
- Engaging with network service providers, participants, and broader power system engineering community nationally and internationally.

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 transmission capacity to accommodate their connections, as well as system strength remediation requirements and performance standards.

Recently, there has been a significant increase in connections, as shown below.



6. HOW IS AEMO AND THE INDUSTRY 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 and/or implementing in Victoria include the potential for shared generation connection solutions and reinforcing the power system to alleviate constraints.

Shared connection solutions

AEMO routinely initiates 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 constraints

Augmenting the transmission network can relieve constraints. However, in exercising its functions as the shared transmission network planner for Victoria, AEMO can only plan to augment shared transmission network 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.

Two examples of transmission projects earmarked for Western Victoria are described below. However, these projects' ability to alleviate network constraints will be affected by the number of existing and future connections to those parts of the transmission network.

Western Victoria Transmission Network Project

In July 2019, AEMO completed a Regulatory Investment Test for Transmission (RIT-T) to assess solutions to address forecast thermal constraints in Western Victoria.

The preferred option identified by the RIT-T 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 Project Assessment Conclusions Report (PACR) on the AEMO website.

In December 2019, Mondo, the commercial division of AusNet Services Group, was awarded the contract to consult on, design, seek planning approvals for, build, own, operate and maintain the transmission augmentations identified in the preferred option. The latest project information is available on AusNet Services' dedicated project website.[7]

The Western Victoria Transmission Network Project 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 2020 Integrated System Plan and the AEMO 2020 Victorian Annual Planning Report.

Project EnergyConnect

ElectraNet's "EnergyConnect" project is expected to generate a range of benefits for South Australia, New South Wales, and Victoria, including enabling a greater mix of renewable generation to connect to the transmission network. The proposed project includes a high-capacity interconnector between South Australia and New South Wales, with an added connection to north-west Victoria including a new line between Red Cliffs and Buronga.

At this stage of Project EnergyConnect's design, its impact is not included in the assessment of connection applications. AEMO's Victorian Connections team will provide further updates as its design progresses further. Please see the EnergyConnect website for current information on its status.[8]

Improving system strength

As power system operator, AEMO also conducts periodic assessments of minimum system strength requirements for each region of the NEM. Further, the Victorian Government has an initiative underway to increase system strengthen services across the Murray River, Western Victoria, and South West Renewable Energy Zones (REZs).[9] This initiative is explained in its Victoria REZ Development Plan Directions Paper (published February 2021).[10] The Victorian Government has requested that AEMO manage the Expression of Interest and tender processes for stage 1 of its REZ development plan.[11]

7. HOW DOES THIS AFFECT MARGINAL LOSS FACTORS?

Investors should carefully consider the impact of MLFs when assessing the financial viability of a project, including exposure to future MLF changes over time.

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 may 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, however this could also be offset by additional connections. The materiality of any change in MLFs would largely depend on the nature of the augmentation and other factors. Other factors that can also affect MLFs include:

- Changes in local demand growth and behaviour
- Changes in interconnector flows
- Retirement of baseload generation
- Increased energy storage or rooftop solar installations.[12]

8. WHAT CAN I DO TO REDUCE THE IMPACT OF SYSTEM CONSTRAINTS?

There are several 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.

9. WHERE CAN I FIND MORE INFORMATION?

Victorian transmission connection enquires	vic.connections@aemo.com.au
West Murray Zone information	https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/west-murray
Victorian Annual Planning Report	https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/victorian-planning/victorian-annual-planning-report
Integrated System Plan	https://www.aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp
Western Vic RIT-T Reports	https://aemo.com.au/initiatives/major-programs/western-victorian-regulatory-investment-test-for-transmission/reports-and-project-updates
Binding constraints and congestion	https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/congestion-information-resource

Q&A: Connections to the Western Victoria transmission network

September 2021

For any further enquiries, please contact AEMO's Information and Support Hub via

supporthub@aemo.com.au or

call 1300 236 600

[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. See West Murray Zone map at: https://aemo.com.au/-/media/files/electricity/nem/network_connections/west-murray/wmz-nsw_map.pdf?la=en&hash=9246DCFB744BD19A3F03DC8A23E6D02D

[2] See *NEM Generation maps* (updated quarterly) at: https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/nem-generation-maps

[3] See *West Murray* information at: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/west-murray

[4] See *West Murray FAQs* at: https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/west-murray/frequently-asked-questions

[5] *System strength impact assessment guidelines* at: https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/system-security-market-frameworks-review

[6] For more information on sub-synchronous oscillations in the WMZ, see: https://www.aemo.com.au/-/media/files/electricity/nem/network_connections/west-murray/sub-synchronous-oscillations-in-the-west-murray-area.pdf?la=en

[7] Ausnet's Western Victoria transmission network project website: https://www.westvictnp.com.au/

[8] Project Energy Connect: https://www.projectenergyconnect.com.au/index.html

[9] For more information on the Victorian Government's REZ development plan see: https://www.energy.vic.gov.au/renewable-energy/renewable-energy-zones

[10] Department of Environment, Land, Water and Planning, *Victorian Renewable Energy Zones Development Plan Directions Paper*, February 2021, at https://www.energy.vic.gov.au/__data/assets/pdf_file/0016/512422/DELWP_REZ-Development-Plan-Directions-Paper_Feb23-updated.pdf

[11] See Renewable Energy Zone Development Plan Stage 1 at: https://aemo.com.au/consultations/tenders/victorian-transmission/renewable-energy-zone-development-plan-stage-1

[12] For information on Marginal Loss Factors see: https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/market-operations/loss-factors-and-regional-boundaries