Western Victoria Renewable Integration PADR Submission

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Planning and Consultation
AEMO/TransGrid

Dear Niluksha Herath

Submission to the AEMO 'Western Victoria Renewable Integration' Project Assessment Draft Report

Smart Wires are pleased to make this submission in response to the AEMO Western Victoria Renewable Integration Project Assessment Draft Report (PADR). As the leading provider of modular power flow control solutions, we believe we are in a position to provide a unique and valuable perspective on the practical use of state of the art power flow control technology to maximise the utilisation and capability of the existing and future transmission network in the context of the Western Victoria Renewable Integration project, and welcome the opportunity to contribute towards the development of a reliable, flexible and efficient solution to address the electricity supply needs of Victoria and the National Electricity Market (NEM).

The PADR describes the thermal limitations in the Western Victoria 220 kV transmission network that are expected to heavily constrain renewable generators that connect in the area. These limitations are expected to result in both inefficient development of new generation, and inefficient generation dispatch, both of which are expected to lead to higher costs to consumers. The AEMO 2018 Integrated System Plan (ISP) classifies augmentation to address the limitations as a priority Group 1 project, identified as providing immediate benefits that should be undertaken and completed as soon as possible.

Recognising this need, the preferred option described in the PADR, and the imperative provided by the ISP to implement the necessary network augmentations as soon as possible, we would like to provide our thoughts on employing modular power flow control technology to assist in providing the identified solution, while also delivering a portion of the benefits prior to the construction of the proposed line augmentations, along with providing additional benefits to the network and the market that may not be provided by traditional solutions. This would be achieved by using power flow control equipment to provide the series compensation functionality that is required to balance flows on the existing and proposed 220 kV lines between Bulgana and Ballarat, optimising the network in both its present and future configuration.

Modular power flow control equipment

Modern power flow control technology duplicates the function of a number of traditional high voltage power system solutions, while possessing unique characteristics that can be used to offer considerable advantages in the development and operation of the transmission network. It allows previously unavailable options for network augmentation to be considered when planning and assessing solutions that are responsive and adaptable to the rapidly changing needs of modern power systems arising from the energy transition that is currently being experienced both in Australia and across the globe.

The power flow control equipment that we propose to be considered in this case is Smart Wires' modular static synchronous series compensator (M-SSSC) technology, commercially known as SmartValve™. The SmartValve is a modular FACTS device that is installed in series with a transmission line, providing for control of power flow

along the line by modifying the apparent series impedance of the line. Able to synthesise both a positive or negative reactance, it can be used to either decrease or increase the power flow on a line.

In comparison to other traditional methods of power flow control and equipment, the M-SSSC technology has a number of beneficial characteristics:

- Controllable series reactance – The level of series compensation provided by the M-SSSC can be continuously varied, and operated as a series inductance if required, to provide adjustable power flow control to balance line flows in addition to providing other benefits related to series compensation services. This can be used to address varied operational scenarios, such as different generation patterns, generation additions and retirements, or other changes in network configuration or line ratings over time, etc.
- No sub-synchronous resonance – As the effective series capacitance provided by a M-SSSC is synthesised at the main system frequency (50 Hz), there are no sub-synchronous resonant frequencies resulting from the equipment being installed in the network, and therefore no associated risks of sub-synchronous resonance (SSR) occurring.
- Management of sub-synchronous control interactions – The injection voltage generated by the voltage-sourced converter within the M-SSSC can be controlled to be independent of the line current, thus decoupling the control system of the M-SSSC from the control systems of inverter-based renewable generators and eliminating the risk of sub-synchronous control interaction (SSCI) occurring.
- Adaptable – The modular and controllable nature of the power flow control technology allows the system to be adapted to future changes in network topology, or even be repurposed to another network need if required. The solutions are rated for maximum continuous line currents and designed to be voltage-agnostic such that the same devices can be operated at 220 kV or 330 kV, for example.
- Timely implementation – Address network constraints and deliver network benefits in timeframes that are considerably shorter (e.g. under one year) than those required by traditional network augmentation (several years for planning, permitting, and construction).
- Cost effective – Defer or eliminate the need for expensive network augmentations, such as line upgrades or new builds, by increasing utilisation of existing assets through the balancing of flows on lines to increase transfer capacity of transmission corridors.

Application to the Western Victoria Renewable Integration

The solution proposed in the PADR provides for increased renewable generation along the Horsham to Ballarat 220 kV transmission corridor by constructing two new high-capacity 220 kV Bulgana – Ballarat circuits. As these circuits would operate in parallel with the existing 220 kV Horsham – Waubra – Ballarat circuits, which have approximately half the proposed rating of the new circuits, series compensation of the new circuits is proposed to allow their rated capacity to be fully utilised before the existing lines imposes a thermal constraint. The installation of series compensation on the new Bulgana – Ballarat 220 kV circuits raises a number of technical issues.

The potential for sub-synchronous resonance or sub-synchronous control interaction to occur exists with conventional series compensated lines. There is also the possibility of creating renewable generator connection exclusion zones along line routes that have been compensated by traditional series capacitors, limiting the ability to connect renewable generators along the line route in the favourable wind resource areas between Bulgana and Ballarat. The use of a M-SSSC power flow control solution allows the positive benefits of series compensation to be obtained without the drawbacks that typically accompany conventional series compensation equipment.

Further, the requirement to balance line flows between the new and existing 220 kV circuits according to rating could be met by a slightly different approach that would allow some benefits of the project to be accrued before the new 220 kV lines are constructed, while reducing the magnitude of series compensation required to balance flows. By installing power flow control on the existing Waubra – Ballarat 220 kV circuit, and using it to increase the series impedance of the line, thus reducing the loading on the line, additional wind generation could be dispatched onto the existing network.

Installing power flow control on the existing Waubra – Ballarat 220 kV circuit would simultaneously also result in the series compensation requirement of the new Bulgana – Ballarat 220 kV circuits to be reduced accordingly. In addition to early realisation of partial market benefits, the overall cost of the series compensation may therefore also be less, since the magnitude of the reduction in the series compensation equipment required on the two new high-rated lines would be greater than the amount of power flow control equipment required to be installed on the single existing low-rated line. By using power flow control equipment to provide this reactance increase, the ability to control the level of inductance allows the network to adapt to new connections of loads or generation, or changes in line ratings, etc. Figure 1 shows the possible location for installation of power flow control on both the new and existing 220 kV circuits.

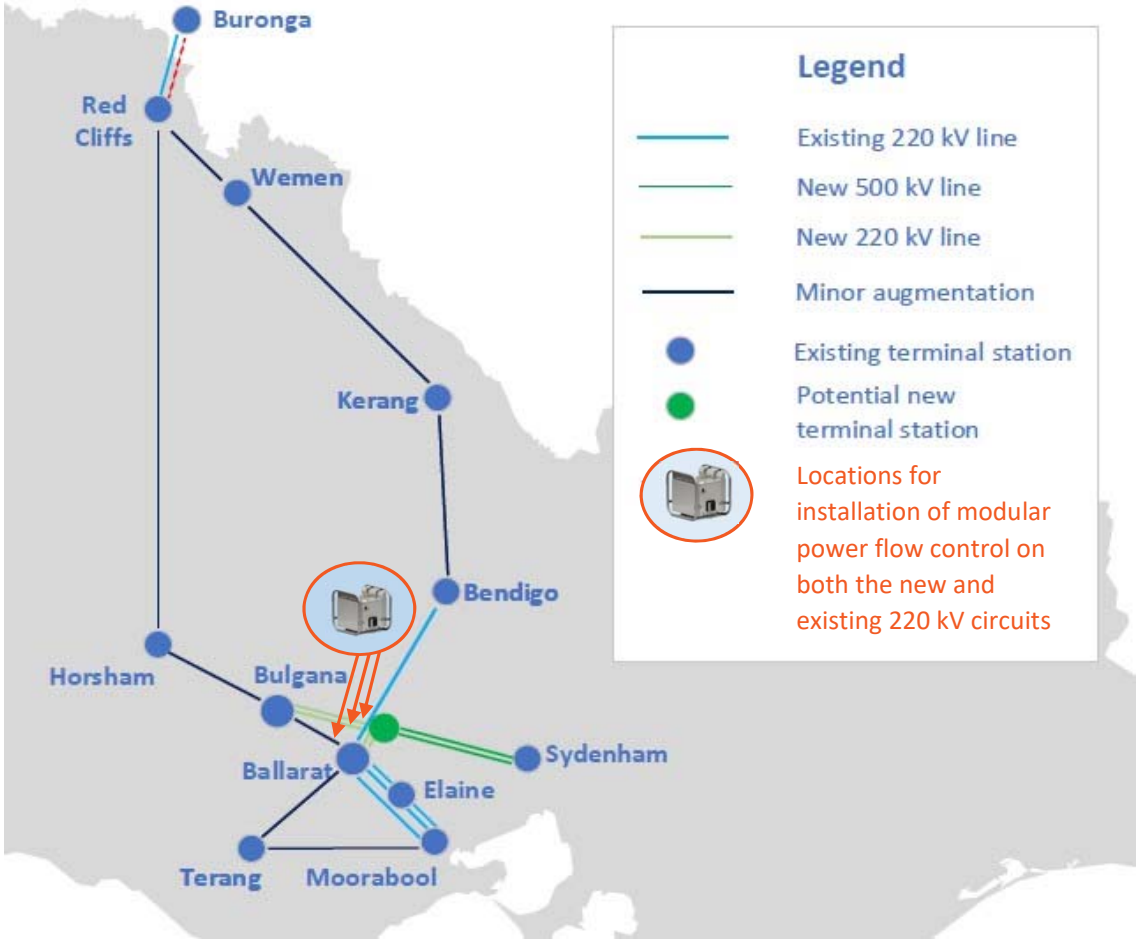

Figure 1 – Possible locations of power flow control on both new and existing 220 kV circuits

Project technical specification and other considerations

While the current preferred option specifies a requirement for approximately 30 - 50% series compensation on the new Bulgana – Ballarat 220 kV circuits, there are a number of other technical considerations that have been outlined in this submission; potential for SSR and/or SSCI, generator connection exclusion zones along the new line route, delivery of potential early benefits, ability to optimally balance line flows following future load or generator connections along the line route. We would like to suggest that these issues are addressed in both the technical requirements schedule for the tender, and in the tender assessment criteria to ensure that the benefits provided by all technological solutions are adequately considered and assessed. We would also suggest that the specification of any series compensation requirement not be defined in an overly prescriptive manner that prevents the potential for benefits to be provided prior to the construction of the new 220 kV circuits, as described in this report through a modified line-balancing power flow arrangement.

We hope that the description of this application of our technology has provided useful ideas for AEMO to consider in their assessment of the PADR's preferred augmentation option. We welcome any queries regarding the content of this submission and look forward to collaborating with AEMO on the Western Victoria Renewable Integration project to together exploring the solution ideas described in this submission.

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James J. Codd | Business Development Associate, APAC
+61 (0) 45 1123 115 (AUS) | james.codd@smartwires.com

Paul Harrington | Manager of Customer Solutions, APAC
+61 (0) 405 510 872 | paul.harrington@smartwires.com

Yves Meyer | Vice President, International Business Development
+1.415.859.1270 | +61.0.437.413.935 | Yves.Meyer@smartwires.com

