South Australian Energy Transformation – PADR Submission

August 2018

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Mr Hugo Klingenberg
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Dear Mr Klingenberg

Submission to the ElectraNet 'South Australian Energy Transformation' Project Assessment Draft Report

Smart Wires are pleased to make this submission in response to ElectraNet's South Australian Energy Transformation (SAET) 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 integration of state of the art power flow control technology with new and existing transmissions assets in the context of the SAET, and welcome the opportunity to contribute towards the development of a reliable, flexible and efficient solution to address the electricity supply needs of South Australia and the National Electricity Market (NEM).

The preferred option described within the PADR currently employs specific types of electrical power equipment to achieve desired outcomes with regard to network capability, reliability, and security, while also giving attention to efficient costs and effective market outcomes. While we acknowledge the essential nature of the solution, most notably the establishment of major new transmission circuits and the significant benefits that are forecast to flow to the NEM following their implementation, we would like to present the idea of an alternative to the technology and equipment traditionally employed to enable the operation and control of power and voltage on the proposed transmission lines.

As an example of one such viable alternative, we present the use of modular power flow control, based on power electronics, in place of the more traditional use of phase shifting transformers and series compensation as detailed in the PADR.

Characteristics of modular power flow control equipment

Modern power flow control technology serves the function of a number of traditional high voltage power system solutions, but also possesses several unique characteristics that offer particular advantages in the development and operation of modern electricity networks. This allows a new approach to network planning and development that is responsive and adaptable to the needs arising from the energy transition that is currently being experienced both in Australia and across the globe.

The power flow control equipment outlined here is a modular FACTs device that is installed in series with a transmission line. It comprises the latest power electronics that are proven to be reliable and robust, and provides control of power flow along a line by modifying the apparent series impedance of the line. This is achieved by injecting a series sinusoidal voltage waveform in quadrature to the line current, effectively synthesising a series inductance or capacitance as required. Adjusting the magnitude of the voltage injection allows the impedance change to be controlled, and the same device can operate in either inductive or capacitive mode.

When compared with traditional solutions for bulk power flow control, such as phase shifting transformers (PST), series reactors, and series capacitors, modular power flow control has a number of distinct advantages, with the added benefit of having potential to provide the combined functionality of these devices in a single installation. These beneficial characteristics are summarsied below in the context of the preferred option of the SAET PADR.

No subsychronous resonance (SSR)

As the series inductance or capacitance is synthesised at the main system frequency only, there is no possibility of resonant phenomena occurring at any other frequency. In addition to eliminating the risk of SSR, the need for associated detailed transient studies is removed, both initially and whenever changes to the network topology occur in the future.

Controllable series reactance provides MW flow control and improved voltage performance of the line

In comparison to traditional series capacitors that are generally of a fixed value, the level of series compensation provided by our modular power flow control is adjustable, allowing the series impedance of a line to be precisely adjusted to achieve the desired value, allowing power flows to be shared amongst parallel transmission paths and interconnectors in an optimal fashion. This means that the technology can simultaneously provide the functionality and benefits of both a phase shifting transformer and series compensation. In a future that includes significant levels of wind and solar generation, this is particularly important to achieve maximum interregional flows, providing greater sharing of renewable energy resources across the NEM, with the transmission network able to be optimised to suit the changing generation pattern and line flows that occur at times of either high wind, or high solar availability.

Scalability and flexibility allows an economically efficient 'no regrets' investment

The modular power flow control solution provides an economic and scalable solution that can be installed incrementally as required. The need for a large installation to achieve economy of scale, typical of many traditional transmission assets, no longer applies. Modest levels of series compensation and/or power flow control can be installed economically, with the ability to expand the installation over time due to the modular nature of the solution. With controls and communications established for the initial installation, additional units can be readily added when needed, with little fixed overhead and in very short time frames.

Management of voltage unbalance

The ability to control the level of impedance injection on an individual phase means that voltage unbalance that occurs due to varying levels of renewable power injection along the length of the line route can be readily controlled by making minor adjustments to the level of reactance injection on each phase independently and automatically.

Inherent redundancy

The modular nature of the power flow control solution means the failure of any single device results in only an incremental loss of performance, with replacement of the failed unit taking only a short time, especially if spare units are kept onsite. In comparison, PSTs or series reactors are prohibitively expensive for carrying spares and the lead time for procuring a replacement is significant.

Low maintenance

With no oil, tap changers, high voltage insulation or bushings to monitor or maintain, and few moving parts, modern solid state power flow control equipment is designed to be virtually maintenance free.

Cost and time effective

In most instances the cost of a modular power flow control solution is similar to, or less than, the traditional alternatives, but provides additional functionality in terms of being flexible, adaptable and controllable. The modular nature of the equipment means that it can be supplied and installed in a time scale that is much shorter than traditional power system facilities that are often designed and manufactured to a custom specification.

Shorter lead times allows faster response to unforeseen circumstance of a swiftly changing network, or allows greater visibility of an arising network need due to not having to commit to a particular solution or course of action as early as would otherwise be necessary.

Specification of function rather than technology

While the more traditional and conventional power system equipment and solutions, such as phase shifting transformers and series capacitors, have been specified and used to cost and rank the options being considered under within the PADR, we hold the view that the final project specification should not be so prescriptive with regard to what technologies and equipment should be used to provide the required function and performance.

Although it is practical and convenient to use specifications for traditional power system equipment to define the technical characteristics and performance requirements of equipment to be supplied, this should not preclude the tender of alternative technologies and equipment that could provide equivalent or better functionality, potentially offering superior value in terms of cost and/or performance characteristics.

We hope that the description of the application and performance characteristics of our technology has provided a better understanding of the scope for alternative solutions to be offered to deliver the needs of the preferred network development option described in the PADR.

We look forward to the further opportunity to respond to the ongoing SAET RIT-T, and would welcome any enquiries from ElectraNet arising from this submission.

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