Connecting Australia's Largest Wind Farm to the Power Grid

A Case Study by AMSC • December 2013

The Background

The Collgar Wind Farm, located in Western Australia and commissioned in late 2011, almost doubled the amount of renewable energy in the South West Interconnected System and ranked as Australia's largest wind farm to date. With a capacity of 206 megawatts (MW), annual generation from Collgar was projected to average 792,000 MWh, which represents the electricity consumption of 125,000 homes. Built over a land envelope of 18,000 hectares, the wind farm is made up of 111 Vestas V90 turbines.

Courtesy of Collgar Wind Farm

The Collgar Wind Farm was developed by international investment bank UBS and the Retail Employees Superannuation Trust (REST), Australia's largest superannuation fund by membership with 1.8 million members. The project strongly supports the Australian government's policy to generate 20 percent of the nation's power from renewable sources by 2020.

The Problem

The unique characteristics of wind generation and the trend toward larger wind parks create the need for dynamic reactive compensation as a condition of interconnection in many locations. In fact, Australia was among the first countries to adopt dynamic voltage control requirements for wind farms connecting to the utility grid.

The Collgar Wind Farm is connected to the Western Power grid and must comply with the Western Power Technical Rules for the interconnection of a large generating plant to the grid. These rules require the wind farm to provide reactive power support to the grid that is beyond the capability of the wind turbines themselves. The technical rules have requirements for both the minimum amount of reactive power required to be supplied by the wind farm, as well as requirements for the dynamic performance of that reactive support; specifically that the reactive support be used to regulate the system voltage in a carefully defined manner that ensures consistent, safe and stable operation of the wind farm and the greater power grid.

In order to meet these requirements, the installation of ancillary reactive support equipment and controls was necessary.

AMSC's Analysis

The members of AMSC's Network Planning Group are some of the world's foremost interconnection standard experts and have an intimate knowledge of Western Power's Technical Rules for generation interconnection. AMSC obtained detailed technical data on the Collgar Wind Farm and developed computer models using the same power system simulation software packages that Western Power uses. AMSC's Planning Group performed load-flow, dynamic, harmonic and

Classified as a Flexible AC Transmission Systems (FACTS) device, AMSC's D-VAR® STATCOM utilizes the company's proprietary and advanced control and monitoring algorithms that detect and instantaneously compensate for voltage disturbances by injecting leading or lagging reactive power (VARs) precisely when and where it is needed. The reactive power is generated by AMSC's proprietary four-quadrant IGBT inverters that are capable of fully injecting capacitive or inductive VARs in one line cycle. The system's full dynamic capability of up to 2.67 to 3.00 times its rated output can be provided for up to two seconds.

System operators at Collgar will rely on the D-VAR installation for dynamic voltage control, power factor correction and post-contingency reactive compensation to stabilize the power grid and prevent undesirable events such as voltage collapse. AMSC's D-VAR solutions are currently supporting more than 5,000 MW of electrical generating capacity at 70 wind power plants around the world. In fact, in Australia, AMSC's grid interconnection solutions are already connecting more than one-third of the country's wind power to the power grid.

stability studies to develop a solution that would ensure compliance with the Western Power Technical rules while also optimizing for performance, efficiency and cost.

AMSC then worked with both Vestas and Western Power to ensure confidence in the solution by assisting the Western Power Transmission Planning Team in simulating the wind farm with the reactive power solution on their computers. AMSC continued to support Vestas and Western Power to further optimize the system control through the final design, construction and commissioning of the project until commercial operation was achieved.

> "AMSC's D-VAR units are helping to connect Vestas wind turbines to electricity grids throughout Australia. AMSC's Planning Group possesses a deep understanding of Australia's interconnection standards, and when this knowledge is combined with its superior D-VAR system, the result is a powerful, cost-effective, reliable solution."
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> Serge Forza
> Vice President of Technology
> Vestas Asia Pacific

The Solution

The solution provided for Collgar consisted of two +/- 48 MVAR continuously rated D-VAR® STATCOM systems, one installed at each of the main 33kV collector buses at the site, for a total STATCOM rating of +/- 96 MVAR, continuously. In addition to the continuous rating, the STATCOM is capable of injecting up to 2.67 times its rated output (+/- 256 MVAR) for up to 2 seconds to help address certain transient and short term events. The solution also included multiple mechanically switched capacitor banks that are controlled by the D-VAR system's master controller to optimize the performance and efficiency of the solution. Furthermore, the D-VAR STATCOM master controller was configured to directly communicate with the Vestas wind farm controller to automatically coordinate the combined performance of the D-VAR STATCOM and the wind turbines in the event of abnormal system operations, such as system faults or equipment failures within wind farm or the nearby power system.

AMSC's solution was chosen following a competitive bidding process and was installed in early 2011. The full wind farm was placed into commercial operation in October of 2011.

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About AMSC

AMSC (NASDAQ: AMSC) generates the ideas, technologies and solutions that meet the world's demand for smarter, cleaner … better energy. Through its Windtec Solutions, AMSC provides wind turbine electronic controls and systems, designs and engineering services that reduce the cost of wind energy. Through its Gridtec Solutions, AMSC provides the engineering planning services and advanced grid systems that optimize network reliability, efficiency and performance. The company's solutions are now powering gigawatts of renewable energy globally and enhancing the performance and reliability of power networks in more than a dozen countries. Founded in 1987, AMSC is headquartered near Boston, Massachusetts with operations in Asia, Australia, Europe and North America.

smarter, cleaner
…better energy

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