

# OPTIMISED D-VAR TECHNOLOGY

*The scale of Collgar, and the level of commitment by the project investors, illustrates the world's steady trend toward less polluting forms of electricity production. Due to economies of scale, a key focus has been on installing large blocks of renewable capacity.*

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The Collgar Wind Farm, located in Western Australia, is expected to almost double the amount of renewable energy in the South West Interconnected System to 9 percent of the region's power supply. Upon completion in 2012, Collgar will have a capacity of 206 MW, which is larger than any wind farm currently operating in Australia. Annual generation from Collgar is projected to average 792,000 MWh, which represents the electricity consumption of 125,000 homes.

## TAILORED POWER ELECTRONIC SOLUTIONS

Regardless of plant scale, renewable generation is technically non-dispatchable, generally has limited reactive power capability, and marginal voltage ride-through. However, the commercialisation of tailored power electronic solutions and integrated "smart grid" strategies at the point of interconnection with the utility grid has greatly mitigated these issues.

## DYNAMIC REACTIVE COMPENSATION

The unique characteristics of wind generation, and the trend toward larger wind parks, means that projects require dynamic reactive compensation as a condition of interconnection. In fact, Australia was among the first countries to adopt dynamic voltage control requirements for wind farms connecting to the utility grid. Compliance with interconnection standards is straightforward with a D-VAR® system that can manage voltage sags or swells originating from the transmission grid.

The most capable D-VAR systems enhance the ability of the wind plant to stay online and help to prevent nuisance tripping of the wind turbine generators. This also helps maximise the power output of the wind plant, which leads to increased revenues. Additionally, step-voltage changes due to local or remote capacitor-bank switching are mitigated, or eliminated, thus preventing excess gearbox stress or failure. Capacitor-bank switching events are minimised, which reduces switch maintenance costs. Other D-VAR systems have been introduced in recent years, such as the D-VAR RT, which can actually be installed inside the tower of a wind turbine, enabling turbine manufacturers as well as wind farm developers, owners and operators to easily add the systems to new wind turbines or retrofit existing turbines. For both D-VAR and D-VAR RT, the most significant point is that overall grid interconnection costs are minimised.

## INTERCONNECTION A KEY TECHNICAL LINK

D-VAR reactive compensation systems are classified as FACTS (Flexible AC-Transmission System) power electronic solutions for alternating current (AC) power grids. These Smart Grid solutions are able to detect and instantaneously compensate for voltage disturbances by dynamically injecting leading or lagging reactive power into the power grid. The D-VAR interconnection solution being deployed at Collgar is vended by American Superconductor Corp. The Collgar configuration utilises D-VAR modules integrated with external smart-switched capacitor banks and proprietary AMSC controls that are optimised for wind farm applications. System operators at Collgar will rely on the D-VAR installation for dynamic voltage control, power

factor correction and post-contingency reactive compensation to stabilise the power grid and prevent undesirable events such as voltage collapse. The installation at Collgar is just one application among many as 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, within Australia, AMSC's grid interconnection solutions are already helping to connect more than one-third of the continent's wind power to the power grid.

## ENGINEERING DESIGN AND SIMULATION WORK

In addition to supplying the D-VAR reactive compensation systems, AMSC also provides critical engineering support to ensure successful integration of wind parks with the power grid. AMSC's planning and application engineering team actively engages both the wind park developer and the interconnecting utility to supply the engineering design and simulation work needed for a successful project that complies with the conditions of interconnection.

## POWER FACTOR CORRECTION CAPABILITY

The D-VAR system is capable of correcting the power factor of the Collgar wind power plant to any value required by the utility. A combination of the dynamic reactive output of the D-VAR device plus switched capacitors under control of the D-VAR is generally all that is needed to correct to +/-95% power factor. If additional leading (capacitive) or lagging (inductive) reactive capability is needed, switched capacitors or reactors can be added to achieve any desired or required power factor. The D-VAR system can be set to correct the power factor or regulate voltage either at the collector bus side of the power transformer or at the transmission voltage side of the transformer.

## LOW VOLTAGE RIDE THROUGH (LVRT)

As renewable generation such as that from Collgar becomes a larger part of a utilities resource mix, it becomes more important that the wind power plant not trip off due to voltage sags on the transmission grid. Although utility interconnection requirements for wind generators are not consistent as to the required depth and duration of the voltage sag that the wind power plant must ride through, all utilities appear headed toward including a LVRT requirement. To meet the LVRT requirement, the wind turbines must either contain highly tolerant power electronic components and controls or an external system must be added to prevent voltage from dropping below certain levels for certain time periods.

## CONCLUSIONS

The D-VAR system can also prevent high voltages from tripping wind generators because of its ability to act in an inductive mode and absorb VARs from the system. The D-VAR system can also be applied to mitigate the negative impacts of local, or remote capacitor bank switching and can also eliminate voltage flicker caused by current inrush during the starting of wind turbines on weak systems. In summary, the D-VAR system can solve multiple types of problems and can help a wind farm meet the utility interconnection requirements.

