SYNCHRONOUS CONDENSERS

SUPPORT

AUSTRALIA'S CLEAN ENERGY TRANSFORMATION

Csaba Szabo, ABB Australia's HV and MV motor and generators product manager, explains how synchronous condensers are making a major comeback to help stabilise power grids as the penetration of solar and wind power increases.

One of ABB's synchronous condensers installed in-situ.

A report published in September 2018 by the Australian National University's (ANU) Energy Change Institute indicates the country's renewable energy industry will install more than 10GW of new solar and wind power by the end of 2019. If that rate is maintained, Australia will reach 50 per cent renewables in 2025.

This is great news for Australia's energy transition. But the intermittency and variable nature of solar and wind power presents a growing challenge for our power networks. The use of renewable energy alone, without a reliable backup energy source, means that it is unable to tolerate network faults or fully play a grid support role. As renewable energy plays an increasingly important role in the energy mix, there will be a corresponding reduction in the resilience and stability of electricity networks.

One example of this challenge is the medium to large scale solar farms that use inverters to convert the direct current (DC) produced by solar panels to the alternating current (AC) required for the local power network. A fault occurring somewhere in the network can cause the inverter's protection equipment to take it offline. The result is that the solar farm has no capability to ride through network faults.

A further effect of the increased use of renewables is that many conventional power plants are being decommissioned. That means there are fewer sites with the large rotating generating equipment that grids have relied on for the short-circuit power and inertia to maintain their stable operation.

Synchronous condensers – a traditional solution for new problems

A growing number of network operators and renewable energy developers, especially in Southern Australia, are now turning to synchronous condensers (SCs) to provide additional short-circuit power to strengthen their grid. SCs also help maintain power quality and provide fault ride-through capability.

SCs are rotating electrical machines that closely resemble synchronous generators. However, they are not a generator as they are not driven by an engine or turbine. They're also not a motor, as they do not drive a load.

ABB has been manufacturing SCs for around a century. They were used widely to provide reactive power to networks to compensate for induction motors and other highly inductive loads. However, advances in power electronics led to a decrease in their use over the past two decades. This trend is now in reverse – with SCs being on the uptake – as today's networks evolve to handle the increased penetration of renewable energy. This is because short circuit power and kinetic reserve are only available from rotating machines such as SCs.

ABB's modular synchronous condenser solutions

ABB's synchronous condensers feature a brushless or static excitation system that allows for considerable over-excitation (field forcing) to cope with network contingencies. Excitation control is provided by an automatic voltage regulator (AVR) which is tuned to match the requirements of the specific application.

A typical ABB SC module includes equipment such as condenser cooling, lube oil supply, auxiliary power distribution, excitation system, and starting equipment supplied in combinations with computer simulation models. This enables the SC module to be delivered as a complete, self-sustained package tailored for specific performance requirements, site conditions and optimal costs.

To achieve effortless control coordination, ABB can provide the condenser control panels with all necessary monitoring, protection and regulation functions configured with customer requirements.

Large power capability for fault support and provision of kinetic energy

Engineers specify the direct fault support in megavolt amperes (MVA) and kinetic reserve in megawatt seconds required for their network. This determines the number and unit power of the SCs to be installed. It's possible for SCs to deliver six to ten times the nominal power for reactive fault support. If extra kinetic energy is needed, then we will specify a flywheel or oversized machines.

ABB supplies SCs in the power range 1-75MVA at a system voltage of 3-15kV. Network voltages are usually much higher, so a step-up transformer is used. The modular design enables several SCs to be combined for higher outputs of hundreds of MVA. This solution also provides better redundancy and availability than a single large unit.

SCs can be started by a frequency converter, direct online, or using a pony motor. Normally, SCs are water-cooled, but other cooling methods are also available. For example, ABB's air-water-air (CAWA) cooler enables SCs to be installed outdoors at sites where no water is available.

To support Australia's transition to clean energy ABB can supply SCs on a product basis. However, ABB also offers a turnkey approach that starts with a pre-study to understand the specific application and site needs. Based on the results, ABB can develop a complete SC solution including switchgear, ancillary equipment and buildings. **E**