



# POWER MOVES

***Synchronous condensers are an old technology enjoying a new lease of life, enabling more renewables to connect to the grid.***

ANDREW WADE REPORTS

In terms of the disparity between a thing's importance, and the average person's knowledge of how that thing works, electricity grids must be right up there. Most people have some grasp on how electricity is generated via various sources, and many of us can make a decent effort to wire a plug at the other end, but the bit in between can be somewhat complex and a bit of a mystery, for non-engineers at least.

In the UK, thankfully, it's not something that troubles us day to day, as invariably when we switch something on, it works. However, this uninterrupted supply of electricity at our fingertips requires a careful balancing act, maintaining a frequency of 50Hz across the UK grid as well as stable voltage at the various different stages of transmission, from plant to plug.

The ability to respond to fluctuations in electricity demand quickly is known as grid inertia, a vital component of any healthy power network. For decades, grid inertia has been inherent in thermal generation, supplied by the rotating mass found in the turbines and generators driven by the combustion of fossil fuels. But as fossil generation is gradually replaced with wind and solar energy, more and more of this grid inertia is being lost, threatening the stability of the electricity system.

"The reason this discussion is coming up now in recent years is based on the fact that our generation mix in our countries is changing," Christian Payerl, an engineer and sales executive at industrial giant ABB, explained to *The Engineer*.

"The tricky thing is that when you have this solar and wind, there is no big rotating unit...and this rotational mass that

was always existing – which is called inertia – is decreasing a lot. And with that, power system operators like National Grid have to think about how we can secure our stability and the operation of our grid.”

The inertia from rotating generators in power stations acts as a buffer for frequency response, providing crucial seconds for thermal generation to flex up and down and closely match grid demand at any given time. Another way rotating mass provides flexibility is by delivering and absorbing reactive power. Reactive power, sometimes referred to as phantom power, doesn't run or charge appliances, but it helps maintain the right voltage across the grid, allowing active power to do the actual work we associate with electricity. Deviations in voltage as small as five per cent can damage the grid and even lead to blackouts, so maintaining the right level of reactive power in the system is absolutely vital, akin to having the right level of pressure in a fire hose.

Integrating more solar and wind on to the grid means novel solutions for reactive power need to be found, or in the case of ABB's new project, the reintroduction of an old solution. First used on grids as far back as the 1950s, synchronous condensers (SCs) are large rotating motors that aren't connected to any driven loads. Instead, they spin freely, acting somewhat like shock absorbers for the grid, helping to maintain both grid frequency and voltage. Their use was largely phased out due to the evolution of power electronics, but the demands of the 21<sup>st</sup> century grid mean the old dog is being called on to perform some new tricks.

“Synchronous condensers became a little bit out of favour when there was more and more power electronics engaged in the controlling of the power system,” said Payerl. “But power electronics have problems with all the new renewables coming in, because they cannot provide the short circuit support (voltage) and inertia support (frequency) in the same way.”

As part of a pathfinder project with National Grid and Norwegian renewable energy provider Statkraft, ABB is installing a pair of synchronous condensers at Lister Drive in Liverpool. The site will couple two 67 megavolt amps reactive (MVAR) synchronous condensers with 40 tonne flywheels that boost the available inertia by a factor of 3.5.

“When it comes to the two SCs at Lister Drive in Liverpool, they will provide together more than 900 MWs (megawatt-seconds) inertia,” Payerl explained. “The total maximum system inertia today in UK is about 220GWs. So our installation will provide about 0.5 per cent of the total UK inertia.

“This sounds little, but be aware that this 220GWs will reduce drastically during the coming years and during some periods, when there is more wind blowing, already today the total inertia is dropping down from 220GWs to maybe 30-40 per cent less. And our synchronous condensers are running even when other power plants switch off, because of

low energy prices on the stock market or because they will be decommissioned and closed for good.”

ABB has deployed SCs in Australia, Canada and Scotland to reinforce power networks in recent years, but according to the company, the Lister Drive project is the first in the world to include the high-inertia flywheel pairings.

“You just add on additional rotating mass,” said Payerl. “You link, purely mechanically, some more mass to the axles of the machines. And with that you provide more inertia to the grid.”

Another way in which the technology has evolved in the decades since SCs were more prevalent, is in the size and efficiency of the units themselves. The SCs of yesteryear were proper monster machines, comparable in size to double decker buses. The units ABB delivers today are more like mid-sized vans – even with flywheels attached – but can still deliver enormous punch.

“To deliver big inertia in the past you had even bigger machines to be able to deliver this inertia,” said Payerl. “Now you can deliver this with a relatively small machine, and a small machine normally means lower losses...optimised for this inertia support which National Grid is requiring.

“In our case, we say that our small machine of 70 MVA can provide as much inertia as a 300 MVA turbo-generator. And you can imagine the difference in losses.”

The Lister Drive project includes a 10-year service contract between ABB and Statkraft. Given how important SCs are likely to become for the grid in the years ahead, it's no surprise that this contract will see ABB provide digital condition monitoring solutions and predictive maintenance with a view to avoiding any unplanned downtime. A more decentralised grid with distributed renewable generation will mean more SCs will need to be integrated at the local level, but ultimately, if done correctly, we'll be left with a much more resilient system that can better cope with the ebb and flow of wind and solar energy.

“I think we will see maybe a number of 30-40 units in the UK for synchronous condensers,” said Payerl. “In removed areas, you have to have this fault current, otherwise you cannot transfer power.” **THEENGINEER**

↓ ABB is working with National Grid to install two synchronous condensers at a site in Liverpool

