

# Synchronous condensers for grid resilience

Synchronous condensers (SCs) were once ubiquitous in power grids but this traditional technology is making a comeback to support the transition to renewables. *Engineering* asked **Heikki Vepsäläinen** of **ABB** to tell us more

Heikki Vepsäläinen  
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Synchronous condensers (SCs) were once ubiquitous in power grids until they fell out of fashion in the 1960s. Now this traditional technology is making a strong comeback to support the transition to renewables and help maintain the stability of grids.

**Engineering:** What is your role in ABB?

**Heikki Vepsäläinen:** I am President of ABB's Large Motors and Generators Division. This division offers a comprehensive product portfolio of large AC motors and generators, from general purpose to highly customized designs for all major industries and applications.

**Eng:** Can you tell me a little about your background in the sector?

**HV:** I hold a masters degree in electrical engineering from the University of Technology, Helsinki. I started in this position in January 2021. From 2017 to 2021, I was Managing Director of ABB's Motors and Generators business. Before joining Motion, I held various leadership positions in ABB's Process Automation business.

**Eng:** What is a synchronous condenser?

**HV:** A synchronous condenser is a

synchronous machine. However, it is not a motor, as it does not drive anything. It is not a generator since there is no prime mover. Instead, it's a large rotating electric machine that has traditionally been deployed to produce reactive power, balancing out highly inductive loads, like electric motors.

The typical users of SCs were electrical utilities and heavy industries that operate transmission, distribution or industrial power grids.

**Eng:** Why did SCs fall out of fashion?

**HV:** While SCs were once very widespread across power grids they fell out of popularity from the 1960s onwards. This is because their former function of providing reactive power compensation is now handled more effectively by modern semiconductor-based equipment.

**Eng:** What are the challenges of grids today that have prompted the return of SCs?

**HV:** Large, fossil fuelled rotating generators across the world are being decommissioned to help combat global warming. At the same time the penetration of renewables – mainly

wind and solar – is increasing. The challenge is that these renewable energy sources don't provide the inertia that grid operators rely on to maintain grid stability.

Networks are evolving in response to these changes. So rather than the centralized configuration that has served us well for over a century, the networks of the future will look very different – see Figure 1.

Renewable power plants are often remotely located in weak network areas, and they are controlled by frequency converters or use inverters to synthesize DC into AC for the network. The combination of decentralized weak networks and synthesized power can result in stability issues due to the limitations in the renewable plants' rotating energy or inertia reserve.

**Eng:** How are SCs making grids more resilient?

**HV:** The changing nature of grids, and concerns at the loss of inertia, have stimulated interest in the capability of SCs. The technology mimics the operation of large coal or gas fired generators by providing an alternative source of spinning inertia to stabilize

Figure 1 – power grids are becoming decentralized.



the grid. As large rotating machines, SCs can both supply and absorb reactive power, delivering voltage support and dynamic regulation.

In short – this technology allows more renewables to be connected to the grid. These machines help maintain power quality and represent the most secure solution to mitigate severe faults or strengthen a weak grid.

SCs are tailored on the basis of network studies for the specific location where grid support is needed. This enables the creation of pre-designed SC packages that are easy to transport, install, commission and integrate. They are small or medium sized units that can be strategically sited for optimal results – providing an ideal decentralized solution to increase grid strength and stability.

**Eng:** Are the SCs of today the same as those from the last century?

**HV:** There is a great deal of similarity between modern SCs and those deployed 60 years ago. The main difference is that the units we are supplying now benefit from modern design. This makes them smaller and simpler, with the flexibility to be installed in almost any location. They also have the advantage of modern control and communication technology and low maintenance requirements. For redundancy, instead of one large unit, SCs are usually installed as two or more smaller units.

**Eng:** Can you tell us about a recent project where SCs are being deployed?

**HV:** In February 2021, ABB was awarded a contract by Statkraft, Europe's largest renewable energy producer, to design, manufacture and install two high-inertia SCs for the Lister Drive Greener Grid park in Liverpool, England. The innovative project, see Figure 2, will play a key role in stabilizing the local grid to handle more wind and solar power. This will help the UK National Grid meet its target of operating a zero-carbon electricity system by 2025.

This project will be the first anywhere in the world to feature a high-inertia

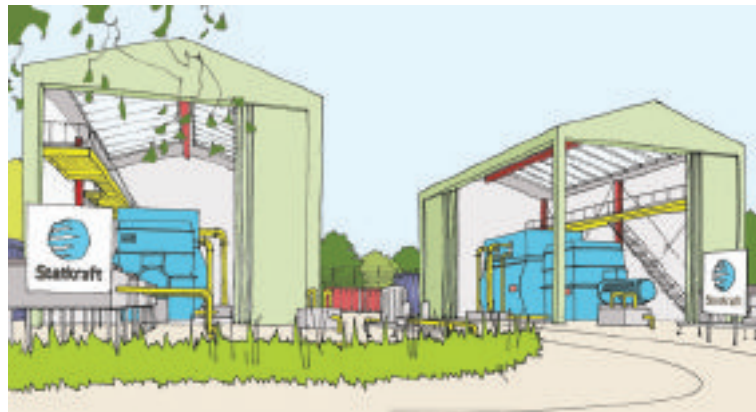


Figure 2 – Artists impression of the Lister Drive Greener Grid project.

configuration. This couples a 67 MVar SC with a 40-tonne flywheel that increases the instantaneously available inertia by 3.5 times.

In recognition of the need to ensure around-the-clock availability for this vital system, we have signed a 10-year services contract with Statkraft. In effect, Statkraft is purchasing a guaranteed level of availability or uptime – with maintenance included. Digital condition monitoring solutions will be deployed to optimize performance and predict maintenance needs. By assessing real-time data with cloud-based analysis, the service team will be able to plan corrective actions before issues occur, ensuring system reliability. The result is an outcome-based business model. These new business models, also known as XaaS (everything as a service), are already well-established in other sectors. The manufacturing industry is just a few steps away from a transformation and we are glad to be

early adopters in delivering this model to Statkraft.

**Eng:** How important will SCs be for the world's power grids?

**HV:** The two SCs at Lister Drive in Liverpool will together provide more than 900 MWs (megawatt-seconds) inertia. To put that in context, the UK currently has around 220 GWs (gigawatt-seconds). So, when it comes online, Lister Drive will provide about 0.5 percent of the UK's total inertia.

That seems like a small number. However, as more of the traditional generation plants are decommissioned and renewables are added, SCs will become increasingly important in maintaining grid stability. SCs have already been deployed to reinforce power networks in Australia, Canada, and Scotland, and we expect that other grids around the world will be looking to this technology as the transition to greener energy continues.



Figure 3 - Synchronous condensers installed at the Darlington Point solar farm in New South Wales, Australia.

<https://new.abb.com/motors-generators/synchronous-condensers>