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Ingenuity for life

Variable Shunt Reactor with 80 percent regulation range

Flexible and economic step into the future

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The challenge

The German energy turnaround is underway, posing challenges to the transmission grid operators. The need for additional reactive power compensation equipment is increasing, as conventional power plants are shut down and TSOs are forced to partially switch from OHL to HV cables. In addition equipment needs to become more flexible because the feed in from renewable energies (mainly wind and photovoltaics) is volatile, leading to seasonal and daily load variations in the grid.

Amprion and Siemens have jointly developed an innovative economical solution, covering not only the current challenges but also future grid development. Therefore, in addition to the latest compensation demand forecast, they also considered the interaction with existing MSCDN equipment and slowly increasing compensation demand during black starts.

The solution

Siemens Transformers is a trusted partner to Amprion and developed a completely new solution in close cooperation with the customer and Maschinenfabrik Reinhausen: A large variable shunt reactor (VSR) with a regulation range of 80 percent. It is equipped with a tap changer with 33 tappings to cover a rating from 50 up to 250 MVAr at a voltage level of 400 kV (3-phase-units).

The main challenges for Siemens were the general layout of the winding arrangement, the lead concept to the tap changer, and the huge shunt reactor dimensions. It weighs 367 t and has the dimensions of a large power transformer

Up to now, two units have been successfully manufactured and tested. The first unit was commissioned in 2016. More units are in Siemens' order backlog for 2018 and 2019.

Variable shunt reactor in the test bay.

Amprion GmbH

Amprion GmbH operates a transmission grid at 380 and 220 kV of approximately 11.000 km with about 160 substations. Its main target is to deliver energy at market-friendly prices at any time.

Flexible asset optimization for highest reliability and availability.

Benefits of variable shunt reactors
Siemens Transformers has decades of experience in the design and manufacturing of reactors with high power ratings.

Variable shunt reactors combine the proven design of shunt reactors with the reliability of tap changers that have been used successfully for decades in power transformers. Thus, they offer the necessary flexibility to respond to changing network requirements and are an efficient solution for optimizing reactive power compensation.

Grid operators benefit from improved voltage control and reduced reactive power loading of the grid. These two benefits reduce losses in the lines, connected equipment, and the variable shunt reactor itself compared to a fixed shunt reactor.

Technical features
Coordination with existing MSCDNs
The new variable shunt reactors with an extremely large regulation range of 80 percent are easily coordinated with the MSCDNs, leading to comprehensive reactive power control solutions and reducing the use of expensive SVC equipment to dynamic grid operations.

Conserving circuit breaker operation
Thanks to the extremely large regulation range, there is generally no need to completely disconnect the shunt reactor from the grid and subsequently switch it on again via circuit breaker. Therefore Amprion also benefits from reduced switching transients.

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Tap changers allow for connection / disconnection of winding coil sections.

Improved black start capability
Due to the wide regulation range, optimized reactive power compensation is also assured when the grid is switched on again step by step during a black start. This simultaneously improves grid stability.

Test
Can a variable shunt reactor boost your grid's efficiency?

If one or more of the following statements apply to your grid, the use of a CSR might also make economic sense for you.

- Parts of the grid/lines are exposed to continuous change between no load / low load and load operation
- Tight limits have been specified with the upstream network operator for voltage stability and reactive power transfer.
- There is a large share of distributed generation and/or wind-/solar power generation in my grid.
- My grid or the conditions of my grid will change considerably in the future, but I cannot forecast those changes exactly at the moment.
- I already use fixed shunt reactors, but I never switch them on/off as I'm concerned about the switching impulse consequences and a low circuit breaker life time.
- I already use fixed shunt reactors in different voltage levels and need a flexible spare unit.

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