NEED TO DEVELOP GRID-FORMING STATCOM SYSTEMS

Position Paper of the German Transmission System Operators

NEED FOR GRID-FORMING STATCOM SYSTEMS

The reactive power demand of the German transmission network is constantly increasing due to the higher line loading, the expansion of the transmission system and market-driven effects. Consequently, the German transmission system operators (TSOs) calculated a minimum requirement for stationary and actively controllable reactive power compensation elements in the grid development plan. The additionally needed controllable capacity has been stated to equal around 23 to 28 Gvar [1]. This demand has to be covered mostly by so-called STATCOM systems (static synchronous compensator).

To cover the very high demand of controllable reactive power with a minimum number of individual measures, the German TSOs consider it necessary to build future STATCOM systems in a range starting from 250 up to 600 Mvar per system. In order to already cover the demand in the short and medium term, the realisation of these controllable reactive power compensation systems needs to start immediately.

The STATCOM systems that are available today are certainly not suitable to cover the future system need for grid-forming capabilities, which today are mainly provided by synchronous machines hosted in conventional power plants connected to the transmission grid. Because of the further increase of in-feed from renewable sources as well as loads that are connected to the grid via power electronic converters, the German transmission system as well as the entire continental European interconnected grid continue to be penetrated by these power electronic devices. As these converters do not have grid-forming capability, this development leads to stability issues [2].
Stable system operation is only possible up to a certain ratio of today's grid-following or grid-supporting (i.e. controlled by means of current injection) converters to synchronous machines [2].

With the aid of grid-forming control concepts, it was demonstrated that operation with up to 100% power electronic based generation is possible [2], [3], [4]. In addition, these studies have shown that parallel operation of present generation units (controlled by means of current injection) and grid-forming systems (controlled by means of voltage injection) is possible. Through a successive introduction of grid-forming control concepts, the stability issues mentioned above can be reduced accordingly.

For these reasons, the German TSOs see a compelling necessity that all new converters connected to the transmission system (STATCOM, HVDC, directly connected generating units) are exclusively applied with grid-forming control concepts.

This demands a merger of the requirements of the TSOs on the one hand and the possible implementations of the manufacturers on the other hand. In the forum for system technology/system operations[1] a joint reference paper for the VDE-AR-N-4131[2] was published in order to approach the design requirements of grid-forming HVDC systems [5]. It serves as the first basis for the specification of grid-forming converters and should also be used for STATCOM systems.

Therefore, to ensure system stability and for the successful realisation of the energy transition, the German TSOs see an urgent need to develop a new generation of STATCOM systems. The objective of this paper is both to demonstrate the urgency for the said development and to describe the steps and requirements for a new generation of STATCOM systems from the point of view of the German TSOs.

[1] Forum Netztechnik/Netzbetrieb, FNN
[2] Technical requirements for grid connection of HVDC systems and modules

REQUIREMENTS FOR GRID-FORMING STATCOM SYSTEMS

For the implementation of grid-forming control concepts in newly installed STATCOM systems, the German TSOs differentiate between two technical realisation phases, which differ as follows:

- **Phase 1:** The topology of today's state-of-the-art STATCOM systems should be maintained. The grid-supporting control concept has to be replaced by a grid-forming control concept. It has to be possible to operate the STATCOM system in a stable manner, independently of the available short circuit ratio[3]. Because of the low reserves in the capacitors of the converter modules, only limited provision of an inertial response is possible.

  Phase 2: Topological changes are needed compared to the current STATCOM systems. Similar to phase 1, the grid-supporting control concept has to be replaced by a grid-forming control concept. The limited energy reserves in the capacitors of the converter modules have to be expanded to provide a certain share of inertia (e.g. by integrating supercapacitors). Here, it has to be possible to provide active power within the rated limits of the converter in a single-digit second range.

From the German TSOs point of view, the development of grid-forming control concepts to replace today's usual grid-supporting control concepts (with current injection) is indispensable.

For future STATCOM systems of the four German TSOs, a grid-forming control concept will be required. Therefore, special emphasis will be placed on a proof of grid-forming properties. The approach preferred by the German TSOs is described in [5]. Pursuant to this methodology, the manufacturer shall prove that the STATCOM system can be operated in a stable manner during all defined scenarios and it shall operate within the project-specifically generated envelope curves by means of time-domain simulations.

LIST OF REFERENCES

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[2] Heising, Meyer, Need for Grid-Forming Converter-Control in Future System-Split Scenarios, Dublin: 18th Wind Integration Workshop, 2019.

[3] B. Weise and A. Korai, Regelungskonzepte für leistungselektronische Erzeugungseinheiten zur Verbesserung der Netzstabilität: Direkte Spannungsregelung als Lösungsansatz, Berlin: ETG/GMA-Fachtagung, 2019.

[4] ENTSO-E, "High Penetration of Power Electronic Interfaced Power Sources and the potential contribution of grid forming converters," ENTSOE, 2019.

[5] VDE FNN, Spannungseinprägendes Verhalten von HGÜ-Systemen und nichtsynchronen Erzeugungsanlagen mit Gleichstromanbindung, Berlin: VDE, 2020.

[3] Short circuit power of the grid related to the nominal apparent power of the STATCOM