Control Strategy of Grid Forming VSC under Unbalanced AC Grid  
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Context  

An inevitable consequence of the global power system transition towards nearly 100% renewable-based generation is the loss (totally or partially) of conventional bulk generation by synchronous machines, their inertia, and accompanying frequency and volt-age control mechanisms [1], as depicted by Fig.1. This gradual transformation of the power system to a low-inertia system leads to critical challenges in maintaining system stability. Moreover, low-inertia power systems are characterized by large-scale integration of generation interfac ed by power converters, allowing frequency and voltage regulation at much faster time-scales compared to SMs. Indeed, power converters are already starting to provide new ancillary services, modifying their active and reactive power output based on local measurements of frequency and voltage. However, because of the dependency on frequency measurements, the current grid-following control techniques only replicate the instantaneous inertial response of SMs after a contingency with a delay and result in degraded performance on the time scales of interest. Thus, to resolve these issues, novel control techniques for converters, so-called grid-forming (Gfo) strategies, are expected to address these challenges and replicate functionalities that so far have been provided by synchronous machines [3].

Recently, several grid-forming control strategies (e.g., Droop control, Virtual Synchronous Machine, Matching Control, dVOC…) have been proposed and widely discussed in literature. However, these approaches and other control methods considered balanced grid conditions. It seems very interesting to investigate the performances of Gfo-VSC controllers under unbalanced ac grid conditions and enhance the operation during asymmetrical faults [4-5]. Then, the proposed study focus on the analysis and control of Gfo-VSC under unbalanced AC Grid. Inertia effect and load sharing capability of the proposed control strategy under imbalance AC conditions will be contemplated.

Objectives  

- Control design and synchronization of Gfo-VSC during unbalanced AC grid conditions;  
- Current limitation for unbalanced fault based on Grid forming operation;  
- Validation on offline simulation using Matlab software (Simulink and SimPowerSystem toolbox).

Progress  

The work progress should follow the following steps:  
1. Bibliographic research and study consolidation;  
2. Steady state and dynamics analysis of the Gfo-VSC to understand the converter degrees of freedom;
3- Analysis of the existing active power droop control under imbalance AC conditions;
4- Systematic grid forming control design, which enables full control of the VSC dynamics during unbalanced conditions;
5- Validation of the proposed Gfo controller based on offline simulation under Matlab environment.

References