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Journal of Modern Power Systems and Clean Energy

Special Section on Dynamic Performance and Flexibility Enhancement of RES-dominated Power Systems with Grid-forming Converters

High penetration of distributed generators (DGs) and renewable energy sources (RESs) in the electric network is a key solution in response to the challenge of economical harvesting of electrical energy and considering the environmental issues. However, recent studies have investigated that relatively high integration of DGs/RESs could have some negative impacts on power grid dynamics, power quality, frequency control, voltage regulation, as well as other control and operational issues. In consequence, this challenge significantly limits the rate of renewable power penetration and overall system stability margin. Decreasing system inertia, increasing uncertainties and dynamic variable nature of DGs/RESs are known as the main reasons. These impacts may increase for the weak power grids at the penetration rates that are expected over the next decades.

The control flexibility of grid-forming (GFM) converters motivates the use of these converters to develop additional ancillary services to improve the power grids dynamic performance and control. It is known that the quality of control and functions of these power converters in different operation modes significantly affect the grid dynamic performance. Appropriate control of GFM converters has the potential to offset the intermittent nature of distributed energy resources and provide control support to the host utility during abnormal conditions. A basic idea towards stability and dynamic performance enhancement of a grid with numerous distributed DGs/RESs is to virtually compensate system inertia and weak dynamics, using GFM converters. This may be established by emulating desirable dynamics, such as inertia, droop, and damping properties, by flexible shaping of their output active and reactive powers. This approach provides a promising solution to improve power grid stability and performance in the presence of a high penetration of RESs.

This special section aims to address the newest solutions and advances on power grid dynamics shaping using controlled GFM converters. Topics of interest include, but are not limited to:

- Dynamic impact analysis of GFM converters on the grid stability and performance
- Updating the power system frequency and voltage response models in the presence of GFM converters
- Transient and steady state stability analysis of renewable integrated power grids
- Advanced GFM control strategies for grid integration, such as providing virtual dynamics and new control functions
- Applications of GFM converters in providing ancillary services and regulation/control support
- Applications of GFM converters in improving inertial response, primary control, secondary control, and power quality

- Dynamic challenges and solutions in hybrid operation of GFM, grid-following (GFL) converter and synchronous generators in a microgrid or a power system
- GFM technology applications in oscillation damping, transient overvoltage suppression, fault-ride-through control, and protection in the grid

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