Abstract

Renewable energy sources (RESs) have been extensively employed to replace fossil fuels for reducing carbon footprints. Since RESs are normally coupled to the power grid by fast-response power converters without providing any inertia, the power system inertia generated by synchronous generators continues to decrease, making modern power systems sensitive to frequency events. As a result, undesirable load-shedding, cascading failures, or even large-scale blackouts may occur under severe frequency events. In other words, the performances of frequency regulation will be weakened due to the increased shares of renewable energy generation, and the grid frequency would be more sensitive to the disturbance caused by the imbalance between generation and demand in the power system.

To address the inertia concerns, the focus of this research topic is to improve the frequency regulation and enhance the power system inertia by emulating the inertia through power electronic converters. Conventionally, the straight-forward way is to run extra synchronous generators, but the high operation costs would be the biggest concern. Instead of running extra synchronous generators or other hardware equipment, several control strategies have been proposed for inertia emulation by grid-connected power converters. These methods will not bring any extra hardware, and with the proposed methods, the power system inertia would be high enough so that the grid frequency would be stable even with high penetration levels of RESs.

All the proposed control algorithms have been verified in simulation using MATLAB / SIMULINK and PLECS. The down-scale experimental test bed has been built for validating the feasibility of the proposed methods.

Publications

J. Fang, **R. Zhang**, H. Li, and Y. Tang, “Inertia enhancement by gird-connected power converters with frequency-locked-loops for frequency derivative estimation,” in *Proc. PESGM 2018*, Portland, Oregon, USA, 5–9 Aug. 2018.

J. Fang, **R. Zhang**, H. Li, and Y. Tang, "Frequency Derivative-based Inertia Enhancement by Grid-Connected Power Converters with a Frequency-Locked-Loop," *IEEE Transactions on Smart Grid*, pp. 1-1, 2018.

R. Zhang, J. Fang, H. Li, and Y. Tang, “Inertia emulation through supercapacitor energy storage systems,” in *Proc. ICPE 2019-ECCE Asia*, Bexco, Bushan, Korean, 27–31 May 2019, **under review**.