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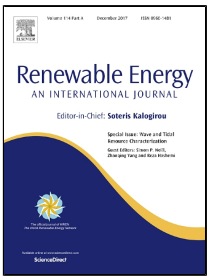

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Adaptive Virtual Inertia-Based Frequency Regulation in Wind Power Systems

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Abstract: In this paper, frequency sensitive-based virtual inertia control techniques are discussed, to extract the kinetic energy of the wind turbine and stored energy from the DC-link capacitor for short-term frequency regulation. This paper presents a comparative analysis between the permanent magnet synchronous generator and doubly fed induction generator-based wind power system on the basis of virtual inertia control. The gains of the kinetic energy-based and DC-link capacitor-based inertia controls are varied dynamically with system events to improve the primary frequency response of the wind energy system. Two control schemes are proposed on the basis of modulating the inertia gains, one is a dynamic equation-based scheme and other is an adaptive fuzzy-based scheme. The proposed schemes modulate the gains of inertia controls dynamically for a wide range of wind speeds on the perspectives of wind turbine stability and frequency security. The efficacy of the proposed control schemes are validated by MATLAB/SIMULINK platform. Further, the results based on hardware-in-the-loop (HIL) simulations are presented in support of the proposed schemes. The HIL is implemented with two units of the real-time simulator (RTS) manufactured by OPAL-RT Technologies.

Keywords: DC-link capacitor, Fuzzy logic control, Hardware-in-the-loop (HIL), Inertia control, kinetic energy, Variable speed wind turbine generator.