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Adaptive Virtual Inertia-Based Frequency Regulation in Wind Power Systems

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

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

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