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A novel approach to Frequency Support in a Wind Integrated Power System

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Abstract

This paper discusses the impact of wind penetration on frequency control of a thermal dominated system considering Generation Rate Constraints (GRC) and dead band non-linearities. The hidden inertia emulation and coordinated operation of conventional power generation systems with wind energy can effectively alleviate the frequency excursions during sudden load disturbances. Conventional energy storage device like Flywheel Energy Storage (FES) system can be used in conjunction with wind integrated power system to overcome the intermittent nature of power generation. Thyristor Controlled Series Compensator (TCSC) is found to be effective in damping low frequency oscillations in weak tie-lines and supplement the frequency regulation. A stochastic population based evolutionary computation technique - Particle Swarm Optimization (PSO) is used to tune the controller gains. A strategy comprising inertia control, coordinated operation of conventional generation units with wind energy and TCSC-FES has been proposed to enhance the frequency regulation which is effective in controlling low frequency oscillations as established by the simulation results.

Keywords: Flywheel Energy Storage (FES), Particle Swarm Optimization (PSO), Thyristor Controlled Series Compensator (TCSC), Wind penetration

NOMENCLATURE

f Nominal System Frequency in Hz
 P_{ri} Rated Power in the i^{th} area in MW
 H Inertia Constant in s
 ΔP_{Di} Incremental load change in i^{th} area in pu MW
 ΔP_{Gi} Incremental generation change in i^{th} area in pu MW
 T_{12} Synchronizing coefficient in pu MW/rad
 R_i Governor speed regulation parameters in Hz/pu MW
 T_{Gi} Steam turbine time constant in s
 T_{Ri} Reheat unit time constant in s
 T_{Ti} Turbine time constant in s
 B_i Frequency bias constant in pu MW/Hz
 K_{Ri} Steam turbine reheat constant in s
 J Cost Index
 T_{TCSC} TCSC time constant in s
 K_{TCSC} TCSC gain constant
 T_{FES} FES time constant in s
 K_{FES} FES gain constant

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