

Supplementary frequency control in a high-penetration real power system by renewables using SMES application

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Abstract-

In modern power systems, the penetration level of Renewable Energy Sources (RESs) is strikingly increasing. Where, many synchronous generators are being replaced by the RESs-based the power electronic devices, this will reduce the overall system inertia. Moreover, the intermittent nature of the RESs causes several control problems such as frequency/voltage instability problem. Hence, these disturbances threaten preservation the power system stability and can lead to system collapse. In addition, the secondary frequency control action (i.e., Load Frequency Control (LFC)) will not be sufficient to maintain the system frequency close to its scheduled value. Therefore, this paper proposes an application of Superconducting Magnetic Energy Storage (SMES) system based on an optimal PID controller, which is optimally designed by the Particle Swarm Optimization (PSO) to enhance the frequency stability of modern power systems due to high RESs penetration. From the perspective of the LFC, the proposed controlled SMES can be used as a feedback controller with the aim of supporting the frequency control loops for frequency stability enhancement of the power systems. Moreover, the effectiveness of the proposed control strategy is tested and verified through a real hybrid power system in Egypt (i.e., Egyptian Power System (EPS)) that includes thermal, gas, hydraulic power plants, wind, and solar energy. The obtained simulation results by Matlab/Simulink software reveal that the proposed control strategy achieved superior dynamic responses satisfying the LFC requirements in all test scenarios. Consequently, the frequency stability is improved regarding peak undershoot, peak overshoot, and settling time.

Index Terms- Renewable energy sources, Superconducting magnetic energy storage, Egyptian power system, Frequency control, Particle swarm optimization.

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