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ORIGINAL PAPER

Utilization of superconducting magnetic energy storage and doubly fed induction generator for enhancing stability of interconnected power system

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Summary

As the share of wind power keeps on increasing, the interaction between synchronous and wind generators pose a challenging issue on power system stability. In order to investigate the impact of wind penetration on stability of power system, appropriate modeling of wind energy conversion systems (WECSs) is necessary. Moreover, it is needed to comprehensively study the impact of wind penetration on power system oscillations. This paper presents a didactic approach for integrating a doubly fed induction generator (DFIG)-based wind farm from SimPower Systems library to a five-area 68-bus power system modeled in Simulink. Inter-area oscillations with and without wind power penetration are investigated for their characteristics. Renewable energy sources are connected to the grid via power electronics converters at the cost of a reduction in inertia. The concept of virtual synchronous generator (VSG) produces virtual inertia by exchanging active power with the power system. The impact of superconducting magnetic energy storage (SMES) and DFIG on enhancing damping performance of inter-area is investigated. The increase in damping ratios of inter-area oscillatory modes verifies the enhancement in small signal stability by connecting SMES and DFIG to the power system. The usage of SMES operating in VSG mode to improve the dynamic stability with highly erratic wind profile is also investigated. The developed MATLAB/SIMULINK-based DFIG model is simple to use and can be expanded to build efficient controllers. The fidelity of the DFIG model and VSG technology is verified in real time by Opal-RT (OP4510).

KEYWORDS

doubly fed induction generator, dynamic stability, eigenvalue analysis, superconducting magnetic energy storage, virtual synchronous generator

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1 | INTRODUCTION

The world's electricity market is becoming more and more dependent on renewable energy sources (RESs), with wind energy the most common and fastest growing technology. Variable-speed wind turbines with frequency converters are commonly utilized in new wind generating facilities, rather than the traditional constant-speed squirrel-cage induction