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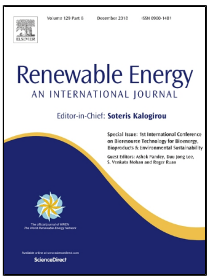

A Cascading Power Sharing Control for Microgrid embedded with Wind and Solar Generation

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A Cascading Power Sharing Control for Microgrid embedded with Wind and Solar Generation

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Abstract: Traditionally, wind power and solar photovoltaic (PV) power generation is non-dispatchable and their normal operation relies on Maximum Power Point Tracking (MPPT) control. Therefore, it can be of highly disturbance to the system dispatch in particularly context of microgrids. To effectively fulfill dispatch command or market schedule, a novel cascading power sharing control (PSC) scheme is proposed to coordinate wind and solar PV power productions in microgrids while reducing the loss of renewable energy production involved. Considering different properties of wind and solar PV power generation systems, the discrepancies between dispatch command (market schedule) and actual renewable generation is firstly counterbalanced by adjusting wind power output via temperately storing or releasing kinetic energy of turbine rotors. Only when rotors of wind generator reach their limitations, should solar PVs begin to reduce their generation. The proposed PSC scheme is fully simulated in a microgrid with wind and solar PV, and the simulation results clearly indicate it can be more energy efficient than the traditional dispatch method while fulfilling the dispatch demand.

Keywords: power system dispatch; wind generator (WG); kinetic energy (KE); photovoltaic (PV); power sharing control (PSC).

0. Introduction

In recent years, considerable attentions have been drawn on the secure and reliable operation of the power system due to the steadily growing penetration of renewables. Particularly, the popular maximum power point tracking (MPPT) algorithm adopted by distributed generations (DGs) such as wind and solar photovoltaic (PV) power generations may cause supply-demand imbalance of the power system from time to time [1]. Accordingly, the traditional synchronous generators (SGs) are required to operate at part-load levels or even shut down for some time to realize power balance in the system, which may result in a reduced life cycle and increased costs [2]. To minimize such impacts, some countries have required DGs mandatorily to fulfill the dispatch demand set by system operator by their grid codes [3].

The concept of microgrid was first proposed in the technical literature in [4], and it can be regarded as a cluster of loads, Distributed Generation (DG) units and ESSs operated in coordination to reliably supply electricity, connected to the host power grid at the distributional level at a single point of connection [5]. The adoption of microgrid renders a feasible solution for integration of massive renewable energy in a distributed, decentralized, and economical fashion, reducing the need for a complex and centralized coordination control, and facilitating the realizing of the smart grid. Currently, research effort is being put into the design of special control and protection schemes that enable reliable, secure and economical operation of microgrids in either grid-connected or stand-alone mode. In this paper, a novel cascading power sharing control (PSC) scheme is proposed to coordinate wind and solar PV power productions while achieving the secure and economical operation of microgrid.

0.1. Related work

To resolve the discrepancy between dispatch command and renewable generation, one direct solution is to utilize energy storage system (ESS), such as pumped water and flying wheel, which can mitigate renewable