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Coordination of Wind Turbines and Synchronous Generators for System Frequency Control

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ABSTRACT

Variable speed wind turbines provide temporary frequency support by releasing kinetic energy, this lasts only a few seconds. The coordination with the synchronous generators in the system is required to improve the frequency control performance of the system. In this study, a low limit of the rotor speed of the wind turbines is implemented to reduce the large mechanical power drop during the frequency control. The power shape of releasing the wind turbine kinetic energy and the coordination of the control between the wind turbines and the synchronous generators are proposed. The kinetic energy of the wind turbines is used to reduce the rate of change of frequency and the synchronous generators are controlled to produce additional power to assist with the recovery of the frequency and the wind turbines' rotor speed. A simulation analysis using Matlab/Simulink was conducted to illustrate the effectiveness of the proposed control strategy. The results show a significant improvement in the frequency control and demonstrate the stable operation of the wind turbines. As a result, the stability of the power system is maintained under high penetration of wind power.

KEYWORDS

Wind turbine, frequency control, kinetic energy, synchronous generator, coordinate control

1. INTRODUCTION

The widely installed variable speed wind turbines (WTs) are partly or completely decoupled from the power network by converters, the WTs lost the nature response to reduce system frequency variation like the synchronous generators (SGs). The capability of a power system with high wind power penetration to maintain frequency stability is reduced and large frequency variations will occur if there is an imbalance between the power consumption and generation. The improvement of the frequency regulation of power systems with high penetration of wind power has attracted the interest of system operators and researchers[1].

Over the last 10 years, several WT frequency control schemes have been reported[2]-[14]. The research results have shown that variable speed WTs improve the frequency

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