

Topic: A Study of Effects of Wind Energy on Power System Stability and Quality using Probabilistic Methods

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ABSTRACT

This study quantitatively assesses the effects of stochastic wind energy on power quality and stability of a power system using both stochastic and probabilistic methods. The stability analysis method is newly developed in this thesis basing on the theory of stochastic stability and is called the stochastic stability index (*SSI*). To compute *SSI*, several processes have to be done consisting of the determination of steady state variables, estimation of well-defined energy function, and formulation of stochastic differential equations. Energy function method, basing on Lyapunov's theory, is used to determine the region of attraction of stable equilibrium points and the critical values of energy. The wind power is modeled using aggregated doubly-fed induction generator (DFIG) and squirrel cage induction generator (SCIG) wind turbines.

The stochastic stability index (*SSI*) can quantify the effects of increasing wind power and its noise intensity on power system stability. When the stochastic wind power increase, *SSI* will decrease and the system is less stable, especially, when there is exchanged power to or from an infinite bus. The results of *SSI* are corresponded to the results of the simulation. If apply white noise for wind power, when wind power increase 50%, 100%, and 150%, the *SSI* decrease about 56%, 75%, and 84%, respectively, comparing with base case. However, the percentage of decreasing of *SSI* when apply colored noise are larger than when apply white noise.

To maintain the synchronization of the system, the wind power generation should be limited at an appropriate value for a given noise intensity. This index gives an alternative analysis for power system stability by stochastically incorporating wind power. This stochastic stability analysis method can analyze the nonlinear and stochastic power system stability with less time and computational effort.

Keywords: stochastic stability index; small signal stability; energy function method; Lyapunov's stability; theory of stochastic stability; deterministic method