Generating Capacity Adequacy Evaluation Incorporating Wind Power Generation using MCMC

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In recent decades, the tendency toward using renewable energy resources has been a dramatic increase all over the world. This mainly due to the positive contributions can be derived from renewable resources to global, social, and economic environments. However, the intermittent nature of wind generation introduces various challenges for both the operation and planning of power systems. One of the problems of increasing the use of wind generation can be seen from the reliability assessment point of view. Indeed, there is a recognized need to study the contribution of wind generation to overall system reliability and to ensure the adequacy of generation capacity.

Wind power generation is different than conventional generation (i.e., fossil-based) in that wind power is variable and non-controllable, which can affect power system reliability. Therefore, modeling wind generation in a reliability assessment calls for reliable stochastic simulation techniques that can properly handle the uncertainty and precisely reflect the variable characteristics of the wind at a particular site. The research presented in this paper focuses on developing a reliable and appropriate model for the reliability assessment of power system generation, including wind energy sources. This paper uses the Monte Carlo Markov Chain (MCMC) technique due to its ability to produce synthetic wind power data that sufficiently consider the random and stochastic behavior of the measured wind data. Thereafter, the synthetic wind power data based on MCMC is coupled with a probabilistic Non-sequential (state-sample) Monte Carlo simulation technique for conventional generation in order to assess the overall adequacy of generating systems.

The study presented in this paper is applied to two test systems, designated the Roy Billinton Test System (RBTS) and the IEEE Reliability Test System (IEEE-RTS). A variety of reliability indices, such as loss of load expectation (LOLE) and loss of energy expectation (LOEE) can be obtained. To show the effectiveness of the proposed methodology, a further study is conducted to compare the obtained reliability indices using the MCMC model and the ARMA model, which is often used in reliability studies. The methodologies and the results illustrated in this paper aim to provide useful information to planners or developers who endeavor to assess the reliability of power generation systems that contain wind generation.