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Removing the Barriers of Developing Intermittent Renewable Generation

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Abstract—The U.S. is currently increasing the use of renewable energy to decrease the reliance on imported fossil fuels and pollution. The development of the smart grid will facilitate the integration of renewable energy sources into the power grid. However, the stochastic nature of solar and wind energy resources complicates the integration of renewable generation applications. There is no significant control over wind and solar generation. Also, wind generation is often not correlated with load and may be even discarded when abundantly available. Solar generation is not available during nighttime. This problem can be viewed and addressed from two perspectives: feeder scale and grid scale. For feeder scale, we developed a genetic algorithm-based optimization method together with a two-point estimate method to minimize the installation costs of a hybrid power system including PV, wind units and energy storage to supply the feeder load. Load shifting functions have been added to the optimization problem to increase the flexibility and decrease the cost of the hybrid power system. Later, the reliability of the system is evaluated using Monte Carlo simulation. For the grid scale problem, a stochastic optimization method based on a particle swarm optimization (PSO) is proposed to minimize the sum of operation and congestion costs over a scheduling period energy. The proposed method optimally places and adequately sizes energy storage units to enhance the efficiency of wind integration. Also, the proposed method is used to carry out a cost-benefit analysis for the IEEE 24-bus system and determine the most economical technology. Moreover, a multi-stage multi-objective transmission network expansion planning (TNEP) methodology is developed which considers the investment cost, absorption of private investment and reliability of the system as the objective functions. This facilitates the integration of large-scale wind farms within a transmission grid. A Non-dominated Sorting Genetic Algorithm (NSGA II) optimization approach is used in combination with a probabilistic optimal power flow (POPF) to determine the Pareto optimal solutions considering the power system uncertainties. Using a compromise-solution method, the best final plan is then realized based on the decision maker preferences. The proposed methodology is applied to the IEEE 24-bus Reliability Tests System (RTS) to evaluate the feasibility and practicality of the developed planning strategy.

Bio—I received my MSC degree in Electrical Engineering from Sharif University of Technology, Tehran, Iran, and PhD degree from University of Nevada Reno, Nevada, USA in 2010 and 2014, respectively. Upon graduation, I served as an instructor at UNR for one semester in 2014. Currently, I am a research assistant at the Energy Management Department, NEC Labs America, Inc., Cupertino, CA. My research interests include power system operation and planning, power market, energy management, renewable energy and storage sizing, Electric vehicles, fault location and state estimation. I have been the author and co-author of 14 journal papers and 18 conference papers.

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