Title: Stochastic Scheduling of Power Grids with High Penetration of Wind

Speaker: Ali Al-Awami, UW EE Ph.D. Candidate

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Abstract

In the past few years, researchers, utility companies, governmental agencies, and other stakeholders in the electric power industry have developed the concept of the smart grid. The smart grid gives rise to a power grid that is more autonomous, more reliable, and more environmental-friendly than a traditional power grid. In addition, the smart grid can facilitate the integration of high penetration of renewable energy sources to the existing power grids.

One of the main challenges in the operation of the smart grid is the high uncertainty associated with the power output of many renewable energy sources (RES), such as wind and solar. This high uncertainty makes the task of operating the power grid more challenging to grid operators.

The problem of optimally maintaining the generation-load balance in a power grid is called “economic dispatch (ED)”. In this work, a new stochastic dispatch (SD) formulation for a power grid with high penetration of wind power is presented. The formulation takes into account the stochastic nature of the wind power output. The objective function considered is to minimize the expected value of the system operating costs. The operating costs include thermal units’ fuel costs, wind plants’ operating costs, and imbalance charges. Simulation results show that SD can lead to a net saving of more than 2% over the traditional ED.

In addition, The SD formulation is expanded to optimize two conflicting objective functions: the operating cost and the thermal units' emissions. The concept of Pareto optimality is utilized. To identify the Pareto-optimal set of solutions, multi-objective particle swarm optimization (MO-PSO) is used. Several simulation runs are conducted to study the effect of different system conditions on the Pareto-optimal solutions.

Ali Al Awami earned his B.Sc. and M.Sc. degrees in Electrical Engineering from King Fahd University of Petroleum & Minerals, Saudi Arabia, in 2000 and 2005, respectively. In 2000 he joined the Saudi Electricity Company as a control engineer in the System Operation Dept. In 2002, he joined the EE Dept. at KFUPM as a Graduate Assistant, where he is currently a Lecturer there. He is now working towards his Ph.D. at the University of Washington. He authored and co-authored several papers and a book chapter in his research areas. His research interests include power system operation and optimization and the integration of renewable energy sources into the smart grid.