

Managing the Uncertainty of Renewables:

Stochastic Optimization for Robust Energy Systems Planning

Warren B. Powell

Director, Princeton Laboratory for Energy Systems Analysis (PENSA)

The growing interest in using wind and solar is placing increased attention on the challenges of dealing with the uncertainty of forecasting wind and solar energy. In this talk, I will review the issues of variability and uncertainty that arise with wind and solar, highlighting the hopes and realities of using renewables to power our grid. I will then describe SMART-ISO, a stochastic, multiscale model of the PJM energy markets and power grid, which has been designed to carefully model the sequencing of decisions and information that arises in energy markets. SMART-ISO is being used to study the use of offshore wind, as well as mixed portfolios of onshore wind and solar. I will then address the issue of handling uncertainty in energy planning, which has attracted considerable attention from the stochastic optimization community with proposals using names such as stochastic programming and robust optimization. I will present a unified framework for solving stochastic optimization problems, which consists of four fundamental classes of policies. I will argue that current industry practice, which I describe as a parametric cost function approximation, represents a powerful algorithmic strategy that has received almost no attention in the research literature. I will show that this approach would allow PJM to handle over 100 GW of wind generation capacity, but the cost in terms of reserve capacity would be substantial and requires more attention. I will report on the results of an extensive series of simulations.