Special Topics: Improving Power Systems’ Operations to achieve deep decarbonization

Spring 2021  ENV 718

Nicholas School of the Environment  Duke University

Time
Tuesdays 12:00 – 1:30 PM

Instructor
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Pre-requisites ENV716 and ENV717

Course Description
Increasing penetration of wind and solar power generators augments both the variability and uncertainty of the available power generation and this increases the risk of having instances when demand and supply do not match, or when transmission line loadings are above safe limits. Failing to preposition all the power system’s components to economically respond to deviations from DA forecasts of wind and solar generation forces Power System Operators to make costly dispatch adjustments in the real time. The numerous deleterious effects of these adjustments include: higher system operation costs, more severe scarcity events, higher divergence between DA and RT prices, increased need for out-of-market revenue sufficiency guarantee payments to generators (aka uplift payments) and inequitable distribution of revenue. In this seminar, we will study different approaches by balancing authorities in the U.S. to set operational reserve targets and to dispatch their power generation fleet.

Course Objectives
At the end of this course students will have a better understanding of:
- the challenges to integrate energy from wind and solar resources in the US electricity system and how different Balancing Authorities are tackling them
the tools to characterize the uncertainty on demand, renewable energy production, and the performance of conventional generators
- alternatives to the conventional unit commitment/economic dispatch algorithms, including stochastic unit commitment and stochastic market clearing

Course evaluation
1. Two class presentations (30%)
2. Quizzes (30%)
3. Mid-term report (15%)
4. Final report (25%)

*Mid-term and final report: flexible options as explained in class

Weeks 1-2: Review of Power System Operations

Weeks 3-4: Challenges of renewables integration and determination of reserves

Week 5-6: Characterization of Uncertainty

**Week 7-8 Reserves determination - Flexible reserves**


Krad, I., E. Ibanez, and E. Ela. Quantifying the potential impacts of flexibility reserve on power system operations. in 2015 Seventh Annual IEEE Green Technologies Conference. 2015. New Orleans, Louisiana: IEEE.


**Week 9-10 Flexible Assets - BES**


**Week 9-12: Stochastic Unit Commitment:**


Price, J.E. *Evaluation of stochastic unit commitment for renewable integration in California’s energy markets*. in 2015 IEEE power & energy society general meeting. 2015. IEEE.


**Week 13: Risk Management**
