ECE 6930 & 8930 All Sections
Virtual Power Plants and MicroGrids

Class Location/Time: GEC-102 & Watt 331

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Course Description

Integration of large-scale distributed energy resources (DER) into the electric grid introduces real-time and near real-time system operational challenges around reliability and security of the power supply. These challenges, if not addressed properly, will result in unexpected grid failures, impacting financial performance of the utility's and business' operations and utility's public relationship image.

To effectively address these challenges, it is necessary to plan, engineer/design and operate the electric grid with holistic and end-to-end solutions with Virtual Power Plant (VPP) and MicroGrid concepts. This course will address both technical and financial options for designing and operating a VPPs and MicroGrids including inertia.

By adding more converter-based generation from solar and wind energy in Distributed Energy Resources (DER) and MicroGrids, in conjunction with retiring traditional steam generators, the traditional power system is losing spinning reserves and system inertia. Significant mechanical inertia of the rotor in a synchronous generator is crucial for facilitating the cooperative grid forming capability of multiple such generators on the transmission and distribution network.

Prerequisite: Senior-level courses in power systems and/or power electronics.

Course Objectives

The main objectives of the course are:
- Provide in-depth knowledge on industry emerging trends, standards, policy, regulation and progress with development and deployment of integrated Virtual Power Plant (VPP) solutions, innovative technologies and advanced applications enabling DER's scale deployment.
- Emulating options and markets for system inertia
- Business case for cost-effective DER deployment considering benefits to all energy stakeholders.
- Provide an opportunity to apply learnings though practical and hands-on use-case modeling of inertia options for VPPs
- Term paper of analysis and market options

Required and Recommended Materials

1. Research Journal and Conference Papers
2. Renewable and Efficient Electric Power Systems 2nd edition: Gilbert M. Masters, ISBN: 978-1118140628.
3. Microgrid dynamics and control, by Hassan Bevrani, et al, Wiley 2017, ISBN: 9781119263692
4. Course Notes
5. Useful References:
    a. Photovoltaic power system: modelling, design and control, by Weidong Xiao, Wiley 2017.
    b. Electric Energy: An Introduction, Third edition, by El-Sharkawi, CRC Press, 2013.
    c. Design of Smart Power Grid Renewable Energy Systems, by A. Keyhani, John Wiley & Sons, Inc., 2011.

Topical Outline

Class Schedule for Fall 2017 shown below. Classes will be in workshop format. Students are expected to present findings and assignment results.

Weeks 1 - 5: Background Materials on VPPs and MicroGrids.
Weeks 6–10: VPP and MicroGrid Modeling and Design
Weeks 10–15: Analysis and presenting results.

First Class: Aug 23, 2018
Last Class: Dec 5, 2018
Term Paper Due: Dec 5, 2018

Grading

There are frequent project assignments and a comprehensive simulation options for inertia in VPPs. A final term paper in IEEE format will be the final deliverable. The weight of each item and the final grade is as follows:

Class Participation: 5%
Practical and Analysis Projects (2 Students per team): 35%
Final Term Paper: 60%
A: 90 - 100%
B: 80 – 89%
C: 70 – 79%
F: 70 % and below

Additional Policies

See Policy - ECE Common Course Syllabus - Fall 2018