Electric Power and Power Electronics Institute

INVITED SEMINAR

Wednesday April 22, **10-11am (Special Time)**, WEB 236C

Title: Bridging the gap between real-time control and optimization in distribution systems

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Abstract

Approaches under investigation to manage distribution systems with high penetration of inverter-interfaced renewable sources of energy are designed to mirror legacy architectural and control frameworks of bulk power networks. Accordingly, these frameworks are organized in a top-down, layered, and hierarchical manner, and they establish an explicit temporal boundary between network-wide (steady-state) energy management and real-time control. Specifically, operating at a fast time scale, real-time (local) control approaches under consideration are designed to maintain uniform voltages and frequency across the network in spite of fast variations in sources, loads, and exogenous disturbances; at a larger time scale, network optimization tasks provide setpoints to the real-time controllers such that power losses and voltage deviations in steady-state are minimized, even for high renewable-penetration levels. While this modus operandi has served well to maintain stability and guarantee availability in bulk power systems (where both generation and load are predictable and slow-varying), it is not compatible with the form and function of distribution systems with high renewable -penetration, and limits the opportunities for fast feedback from both physical (in terms of power flows) and cyber (in terms of actionable data) subsystems, especially under fast-varying ambient and load conditions.

In an effort to break the temporal and spatial gaps between real-time control and network-wide steady-state optimization, this talk outlines one way to address the synthesis of feedback inverter controllers that provably steer the inverter output powers towards solutions of relevant optimization problems; for example, the controllers continuously seek solutions of steady-state AC optimal power flow (OPF) renditions that encapsulate economic objectives and voltage-regulation constraints. The guiding motivation is to ensure that renewable-energy systems operation and control strategies are adaptable to changing ambient conditions and loads, and enable seamless end-user participation without compromising system efficiency. The design of the controller is grounded on dual epsilon-subgradient method, whereas semidefinite programming relaxations are advocated to bypass the non-convexity of AC OPF problems. Throughout the talk, global convergence of inverter output powers will be demonstrated under mild technical conditions, for the case where affordable computational limits and communications constraints involve asynchronous updates of the controller signals.

Speakers Bio

Emiliano Dall'Anese received the B.Sc Degree M.Sc Degree from the University of Padova, Italy, in 2005 and 2007, respectively, and the Ph.D. in Information Engineering from the Department of Information Engineering, University of Padova, Italy, in 2011. From January 2009 to September 2010, he was a visiting scholar at the Department of Electrical and Computer Engineering, University of Minnesota, USA. From January 2011 to November 2014, he was a Postdoctoral Associate at the Department of Electrical and Computer Engineering and Digital Technology Center, University of Minnesota, within the group directed by Prof. Georgios B. Giannakis. Since December 2014 he has been a Senior Engineer within the Distributed Energy Systems Integration (DESI) group at the National Renewable Energy Laboratory (NREL). His research is centered around the analysis, algorithms, and application of Optimization and Statistical Signal Processing methods to energy management in power systems, cyber-physical systems, and grid informatics.