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Interdependency of Gas and Electricity Infrastructures for Enhancing Energy Efficiency and Security

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***Abstract*:** Electricity grid and natural gas network are two essential infrastructure systems in the U.S. energy sector, which have been traditionally operated and controlled rather independently. In emerging power systems, smart grid technology has been playing an increasingly important role for enhancing energy reliability, sustainability, resiliency, and economics. Specifically, because of significant advantages over traditional coal-fired units, such as faster ramping capability to support a deeper penetration of renewable generation resources, combined-cycle gas turbines (CCGT) have been increasingly installed in recent decades and are becoming the major generation technology in today's power system operations.

Given the critical role of CCGTs as well as their tight dependence on the gas network, this talk will discuss several issues related to the interdependency of gas and electricity infrastructures for enhancing energy efficiency and security: (i) a hybrid CCGT model for day-ahead market clearing of system operators, which, by taking benefits of combined offers on both configurations and individual physical turbines from CCGT market participants, can accurately reflect their physical operation features and enhance their operation flexibilities in practice; (ii) a method to accurately identify and rank vulnerable components of interdependent natural gas-electricity systems by simultaneously considering topological and functional vulnerabilities; (iii) a co-optimization scheduling model of interdependent natural gas-electricity systems while considering heterogeneous uncertainties of the natural gas and electricity systems (e.g., power/gas loads, renewable energy, and random outages of assets) as well as physical limitations of electricity and gas networks. Additional and emerging technologies, such as dual-fuel generating units, power-to-gas (PtG), and integrated gas-electricity demand response, are also considered to enhance the secure and economic operation of interdependent natural gas-electricity systems and facilitate a deeper penetration of volatile renewable energy.

Short Bio: Lei Wu is an Associate Professor at Stevens Institute of Technology, and before that was a Professor at Clarkson University. His current research involves optimization and statistical analysis applied to electric power system operations and electricity markets, the public policy and technical issues associated with electricity transmission and distribution under market restructuring, the economic implications of integration of renewables, and the co-optimization of critical interdependent infrastructures. He is the receipt of the NSF CAREER Award in 2013 and the IBM Smarter Planet Faculty Innovation Award in 2011. He has a demonstrated track record in completing research and development projects funded by agencies such as the DOE and NSF, including over $5M funds from DOE, NSF, New York State Energy Research and Development Authority (NYSERDA) focusing on the design and development of community microgrids and distributed renewable resource integration. He is collaborating with Midcontinent Independent System Operator (MISO) on the modeling and optimization of combined-cycle gas turbines and pumped storage units, and with Portland General Electric on the modeling and optimization of cascading hydro units.