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Ph.D. DISSERTATION DEFENSE

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Title:	Supporting the Sustainable Development of Electricity Systems via Consumer Behavior and System Modeling
Chairperson:	Dr. Philip Odonkor, School of Systems and Enterprises
Committee Members:	Dr. Ashley Lytle, School of Humanities, Arts, and Social Sciences Dr. Lei Wu, Department of Computer and Electrical Engineering Dr. Steven Hoffenson, Endevor

ABSTRACT

Today's energy and power systems generate many societal benefits, such as reliable and affordable electricity, jobs, and economic growth, but they also produce harmful emissions and waste. Promoting a deeper deployment of renewable energy sources such as solar and wind power is one approach to reducing the environmental impact of the electricity grid, although it raises concerns about energy costs and grid reliability. The successful integration of increased renewable energy capacity requires cooperation amongst key stakeholders including government agencies responsible for crafting regulations, utility companies responsible for the transmission infrastructure, and the energy consumers whose energy behaviors shape the need for renewables. Viewing the electricity grid and its stakeholders as a multi-agent system, this dissertation generates new knowledge on consumer electricity behavior and explores novel approaches to modeling electric power systems. The improved system model incorporates a more robust understanding of consumer behavior that can support producer and policy decision-making regarding the portfolio of power sources, the design of incentives, the offering of renewable energy programs, and other policy alternatives.

Specifically, this work involves consumer behavior experiments, multi-agent electricity system modeling, and domain expert simulation testing for usability and value of decision-making and trade-off analysis. Consumer behavior experiments examine electricity choices, investigating how social norms and incentives impact consumer perspectives, beliefs, and intentions (e.g., likelihood of installing solar photovoltaic systems), as well as the likelihood of opting into renewable energy credit programs. These experimental results inform the creation of consumer agents in an agent-based electricity system model and examine how different assumptions, model architectures, and policy scenarios affect the system-level outcomes. Finally, experimental vignettes conducted with energy industry and policy decision-makers examine the simulation's usability, perceived value, and key findings.