

Annual Report for 2018-2019

Smart Grid Research Center

School of Information Studies, Syracuse University
205 Hinds Hall, school.syr.edu/smartgrid

I. INTRODUCTION

The Smart Grid Research Center is a multidisciplinary center at Syracuse University. It includes faculty, students and researchers from the School of Information Studies, where the center is housed, as well as the Maxwell School of Citizenship and Public Affairs, the School of Architecture, the College of Engineering and Computer Science and the School of Law. Research is supported by grants from the National Science Foundation (NSF), the Alfred P. Sloan Foundation, Syracuse University, and the Syracuse University Center of Excellence (COE). Its mission is to advance scholarly knowledge and provide practical insights on the adoption and impacts of smart grid technologies for industry, government and education through research, training of graduate and undergraduate students, and broad dissemination of research findings.

II. PERSONNEL

Director: Jason Dedrick, School of Information Studies

Affiliated faculty and researchers at Syracuse University

Jeffrey Stanton, School of Information Studies

Murali Venkatesh, School of Information Studies

Peter Wilcoxon, Maxwell School of Citizenship and Public Affairs

Keli Perrin, Institute for National Security and Counterterrorism, School of Law

Elizabeth Krietemeyer, School of Architecture

Sara Eftekharnejad, College of Engineering and Computer Science

Bing Dong, College of Engineering and Computer Science

External Affiliates

Steve Chapin, Lawrence Livermore National Laboratory, CA

Tarek Rakha, Georgia Institute of Technology, GA

Cynthia Frantz, Oberlin College and Conservatory, OH

Pecan Street Inc., Austin TX.

Graduate Students

Ehsan Sabaghian, School of Information Studies, Ph.D. Candidate

Stephanie Haller, School of Architecture, Masters Student

Zheng Bo, Maxwell School of Citizenship and Public Policy, Masters Student

Yang He, College of Engineering and Computer Science, Masters Student

III. CURRENT ACTIVITIES

A. New Proposal

NSF Smart & Connected Communities. SCC-IRG Track 1: Energizing the Community: Interactive Platforms for Connected, Collective and Coordinated Energy Actions. (Under review) Requested Amount: \$2,347,634

PI-Jason Dedrick, Co-PIs: Elizabeth Krietemeyer, Sara Eftekharnjad, Syracuse University, Tarek Rakha, Georgia Tech, Cynthia Frantz, Oberlin College, Senior Investigator, Bing Dong, Syracuse University.

The rapid growth of renewable energy creates challenges in managing the electric grid due to fluctuations in wind and solar power, which require keeping expensive reserve capacity or managing demand. We hypothesize that collective action by communities will lead to better results than existing demand response programs that target individual energy users only. We propose a smart and connected approach called Community Energy, which connects residents and stakeholders through innovative technologies to act collectively and match electricity use with the supply of renewable energy. The proposed research builds on an earlier planning grant by building and testing a Community Energy project in Austin, TX. The objectives are to change the community's energy culture and behavior to achieve greater use of renewable energy, enhance grid resilience, and create measurable value for the electric utility and the community. The project implements innovative technical and social methods to achieve those goals. The community will be engaged deeply in co-design of the energy feedback application and community elements of the program. The program engages the local utility to identify potential benefits to the grid and quantify the benefits of those changes through an innovative test bed technology.

B. Continuing Projects

1. Community Energy

Supported by an award from the National Science Foundation--NSF Award # CNS-1737550 SCC-Planning: Community Energy: Technical and Social Challenges and Integrative Solutions. \$99,965.

PI-Jason Dedrick; Co-PIs-Elizabeth Krietemeyer, Syracuse University; Tarek Rakha, Georgia Tech

The goals of this project are to bring together residents and stakeholders in the Mueller community of Austin, TX, to create knowledge and tools to develop a Community Energy program that will serve as a model for other communities. The main activities carried are (1) initial design of an energy dashboard (2) a workshop with residents and meetings with key stakeholders (3) analysis of electricity usage and solar generation patterns in the Mueller community (4) A survey of Mueller residents.

The project has developed new knowledge on the factors that influence participation in community energy programs, and how those programs can be designed to achieve economic, social and environmental goals. The planning activities have forged community connections and laid the groundwork for the full-scale Community Energy program submitted in 2019 (above).

Publications:

Rakha, T., El Kontar R., Krietemeyer, E. and Dedrick, J. "Sustainable Urban Community Eco-Feedback through Simulation-enabled Performance Dashboards." Building Simulation 2019. Sept 2-4, Rome.
Dedrick, J., Krietemeyer, E., Rakha, T and Sabaghian, E. "Community Energy: Technical and Social Challenges and Integrative Solutions". Industry Studies Association Annual Conference, Nashville, TN, May 31, 2019.

2. Campus Lighting for safety and sustainability

Supported by a grant from the Syracuse University Campus as a Laboratory for Sustainability program. Campus Light Mapping: Analysis and Visualization of Sustainable Smart Lighting for Reducing GHG Emissions and Improving Campus Safety. \$13,510.

PI-Elizabeth Krietemeyer, co-PI, Jason Dedrick

The objectives of this research are to collect, analyze, and map empirical data of existing nighttime illumination and daytime solar radiation across Syracuse University's campus and its surrounding areas using Geospatial Information System (GIS) and architectural energy simulation tools. These mappings would be used to 1) locate zones of excessive or inadequate electrical lighting on commonly used and desirable paths; 2) visualize areas and identify opportunities for smart and sustainable lighting design through renewable solar PV and smart sensing systems; 3) provide the campus community with a mobile mapping application that visualizes and communicates safely-lit routes and highlights areas for improving energy efficiency while encouraging more sustainable transportation behavior through smart lighting.

3. Cybersecurity Risks of Distributed Energy Markets

Supported by a grant from the National Science Foundation: SBE 1618803 Cybersecurity Risks of Dynamic, Two-Way Distributed Electricity Markets, \$344,184

PI-Jason Dedrick, co-PIs-Peter Wilcoxon, Steve Chapin

The objectives of the research are to advance knowledge of cybersecurity risks in dynamic distributed markets for electricity, and to provide insights for policymakers, regulators and businesses by answering the following questions: (1) What are the potential security and privacy risks associated with various distributed electricity market designs and rules? (2) What security measures would be required to provide an acceptable level of risk under different market designs and rules? (3) What are the trade-offs between taking measures to reduce risks and optimizing market performance?

C. Completed Projects

1. Urban Building Energy Simulation

Supported by a grant from the Syracuse University Center of Excellence (CoE): A Framework for Designing Neighborhood Energy Efficiency through Data Visualization and Calibrated Urban Building Energy Simulation (VIS-SIM). \$24,997

Principal Investigators (PIs): Jason Dedrick, Elizabeth Krietemeyer, Syracuse University, Tarek Rakha Georgia Tech.

A new generation of urban building energy models (UBEMs) are currently being developed to estimate neighborhood-scale hourly energy demand loads. The goal for such tools is to explore "what if" scenarios for various design strategies, and to prioritize the most effective solutions. The objectives of this research are to visualize the relationships between three critical and closely related subjects that are not yet integrated within existing UBEMs: 1) The functioning of the electric grid and how it can be made cleaner, more efficient and more resilient, 2) The use of energy by building functionality and the comfort of occupants, 3) The dynamics external available natural resources of solar and wind energy for matching resources with demand. Using currently acquired energy-use databases from the Pecan Street, Inc. from residential buildings in Austin, TX combined with our current visualization techniques and urban building simulation tools, a new UBEM was developed to simulate, test, and visualize future scenarios and strategies.

Publications:

- Rakha, T. and El Kontar R. (2019) "Community energy by design: a simulation-based design workflow using measured data clustering to calibrate Urban Building Energy Models (UBEMs)." EPB: Urban Analytics and City Science. DOI: 10.1177/2399808319841909.
- El Kontar, R., & Rakha, T. (2018) "Profiling Occupancy Patterns to Calibrate Urban Building Energy Models (UBEMs) Using Measured Data Clustering." Technology| Architecture+ Design, 2(2), 206-217. DOI: 10.1080/24751448.2018.1497369.
- Rakha, T., and El Kontar, R. (2018) "Calibrated Urban Systems Design: A Simulation-based Design Workflow using Measured Data Clustering to Calibrate Urban Building Energy Models (UBEMs)," In Proceedings of the 34th International Conference on Passive and Low Energy Architecture (PLEA), pp. 2 – 7, 10-12 December, Hong Kong: China.
- El Kontar, R., & Rakha, T. (2018) "Profiling Occupancy Patterns in Community-scale Residential Buildings using Data Clustering for Operational Energy Use," In Proceedings of the 2018 Building Performance Analysis Conference and SimBuild, 26-28 Sep, Chicago: USA.

2. Data Privacy and Smart Meters

Supported by the following grants:

NSF: Award # SES-1447589. EAGER: Data Privacy for Smart Meter Data: A Scenario-Based Study \$266,101

PI—Jason Dedrick, Co-PI—Jeffrey Stanton

Alfred P. Sloan Foundation: Alfred P. Sloan Foundation, Privacy Policies for Smart Meter Data: Integrating Consumer and Utility Interests, \$48,900.

PI—Jason Dedrick, Co-PI—Jeffrey Stanton

Smart electric meters capture data on household energy usage at frequent intervals and transmit that data to utility companies, who use the data to automate meter reading and billing, respond to outages and for manage grid operations. The data from smart meters are also shared with customers to monitor and control their own energy use. Data collected over time can be used to forecast demand, understand customer behavior and develop new services or pricing plans.

Smart meter data also can be used to identify the use of specific appliances by their unique electronic load signature and infer household activities from that data. This raises a number of legal issues, such as who owns the data, whether utilities can share it with third parties, under what conditions authorities can access the data, and how data is protected from hackers. The collection and use of these data raise customer privacy concerns that in turn may slow the adoption of smart meter technology by utilities.

The goals of the project were to (1) understand the attitudes and concerns of utility consumers with regard to smart meter data privacy, (2) identify how utility companies currently protect data privacy and how well their policies and practices correspond to the privacy concerns of consumers utilities, (3) help utilities develop privacy policies that are consistent with their own business and regulatory requirements and also responsive to the privacy preferences of consumers.

Publications:

- Ranmarine-Rieks, A., Dedrick, J., Stanton, J. (under review) Risks, Benefits, and Control of Information: Two Studies of Smart Meter Privacy. Journal of the Association for Information Science and Technology, Special issue on Information Privacy in the Digital Age.

Dedrick, J., Ranmarine-Rieks, A., Stanton, J. (2018) "Consumer perceptions of smart meter data privacy", *Industry Studies Association Annual Conference*. Seattle, WA, May 30.
Dedrick, J. "Electric utilities' use of big data," The 2016 Grid of the Future Symposium, Philadelphia.

3. Adoption of Smart Grid Technologies

Supported by a grant from the National Science Foundation. NSF Grant: SES-1231192. by Electrical Utilities: Factors Influencing Organizational Innovation in a Regulated Environment, \$331,190

PI- Jason Dedrick, Co-PIs - Jeffery Stanton, Murali Venkatesh

Electrical utilities in the U.S. face a challenging future, marked by the need to modernize an inefficient, deteriorating infrastructure and public resistance to location of new generation and transmission facilities. There is great interest in adopting smart grid technologies to improve the quality, reliability and efficiency of electricity supply, enable greater use of distributed alternative energy sources and reduce the need for new transmission lines. The smart grid allows utilities to better manage supply and demand, while giving customers real-time usage information and the ability to adjust consumption in response to pricing. Yet this innovation presents major organizational and technical challenges to utilities, which operate in a highly-regulated environment and are subject to pressure from a number of interest groups. As a result, utilities have been slow to commit to widespread adoption.

The objectives of the research are to advance knowledge and provide insights to business and government decision makers by answering following questions: (1) What internal and external factors determine the motivation and willingness of utility companies to develop and deploy smart grid innovations? (2) How do organizations in a regulated environment respond to innovation opportunities and challenges? (3) What policy changes would be required to overcome obstacles to the adoption of socially desirable innovations?

Publications:

- Dedrick, J., Venkatesh, M., Stanton, J., Zheng, Y., and Ramnarine-Rieks, A. (2015). Adoption of Smart Grid Technologies by Electrical Utilities: Factors Influencing Organizational Innovation in a Regulated Environment. *Electronic Markets*, 1-13.
- Dedrick, J. and Zheng, Y. (2015). *Adoption of Smart Grid Technologies: Results of a Survey of U.S. Electric Utilities*. 2015 Grid of the Future Symposium. Chicago, IL.
- Dedrick, J., Stanton, J., and Venkatesh, M. (2013). *Critical Policy Issues for Smart Grid Adoption by Utilities*. October 21. Grid of the Future Symposium. Boston.
- Dedrick, J. and Zheng, Y. (2015). *Learning strategies in smart grid adoption: an exploratory study in the U.S. Electric Utility Industry*. iConference 2015. Newport Beach, CA.
- Dedrick, J. (2014). *Policy and Regulatory Factors Influencing Smart Grid Adoption*. Industry Studies Association Annual Conference. Portland, OR.
- Dedrick, J., Venkatesh, M., and Stanton, J. (2014). *Smart Grid Adoption by U.S. Utilities: Policy Drivers and Barriers*. *Smart Grids and the Social Sciences Workshop, Trondheim, Norway, April 11*. Smart Grids and the Social Sciences Workshop. Trondheim, Norway.
- Dedrick, J. and Zheng, Y. (2013). *Smart Grid Adoption in a Regulated Industry: Comparative Case Studies of Electric Utilities*. Industry Studies Association Annual Conference. Kansas City, MO.

IV. Dissertations

Completed

- *Knowledge Requirements, Gaps and Learning Practices in Smart Grid Adoption; an Exploratory Study in U. S. Electric Utility Industry | **You Zheng, Advisor: Jason Dedrick***

Ongoing

- *Integration of Smart Grid Technologies by Electrical Utilities; Patterns, Motivations, Challenges, Success Factors, Practices and Influence of the Field | **Ehsan Sabaghian, Advisor: Jason Dedrick***

V. Datasets

For last 5 years, the Center has maintained a very large dataset on household energy use acquired via Pecan St. Inc. in Austin, TX. It includes data at one minute intervals for over 1,000 households in three states, including data for each electrical appliance or circuit. The dataset has been kept updated and cleaned and is used in research projects, grant proposals and iSchool class projects.