



National Science
Foundation



CAREER: Energy Management for Smart Residential Environments through Human-in-the-loop Algorithm Design

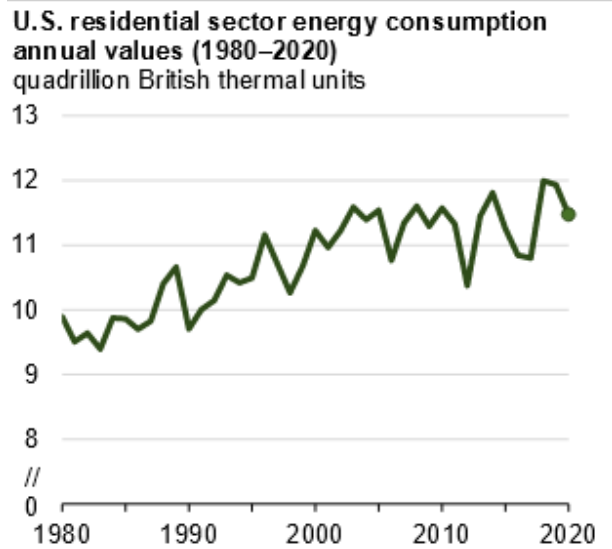
Award #1943035

Award date March 12, 2020

PI: Simone Silvestri, University of Kentucky

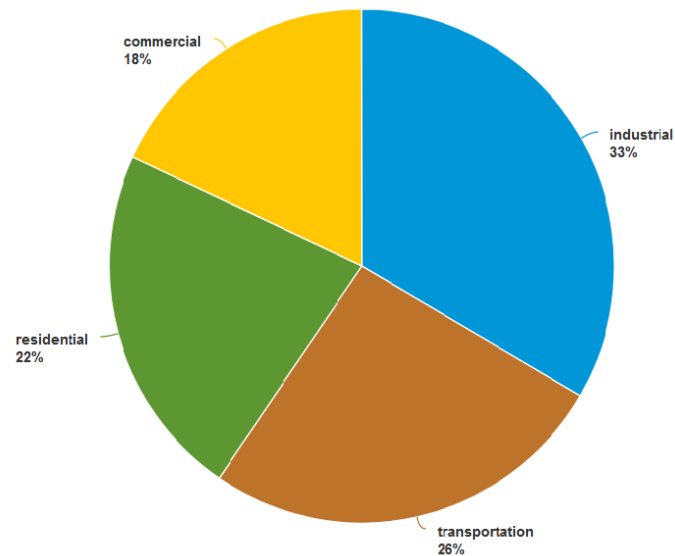
Motivation (1)

- Residential energy consumption has been constantly increasing



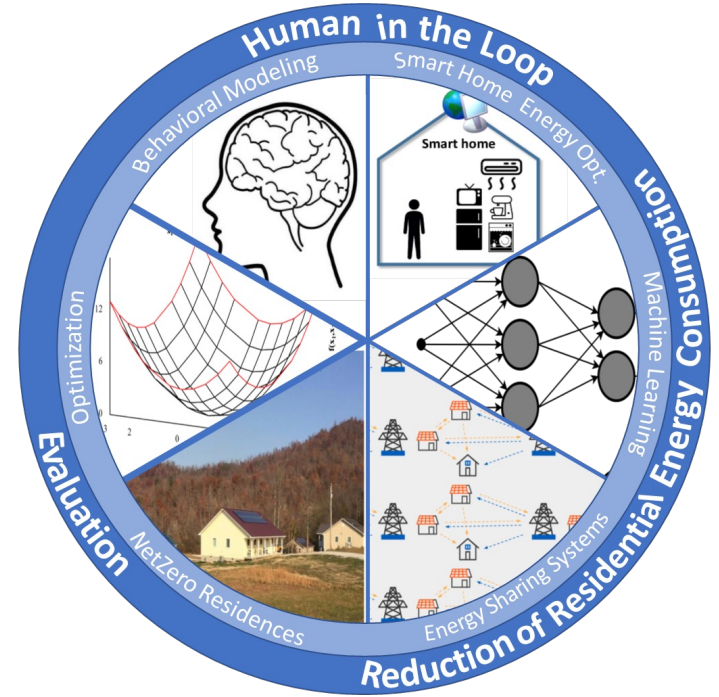
Source: U.S. Energy Information Administration, Monthly Energy Review, 2021

- It is responsible for more than 20% of the total consumption

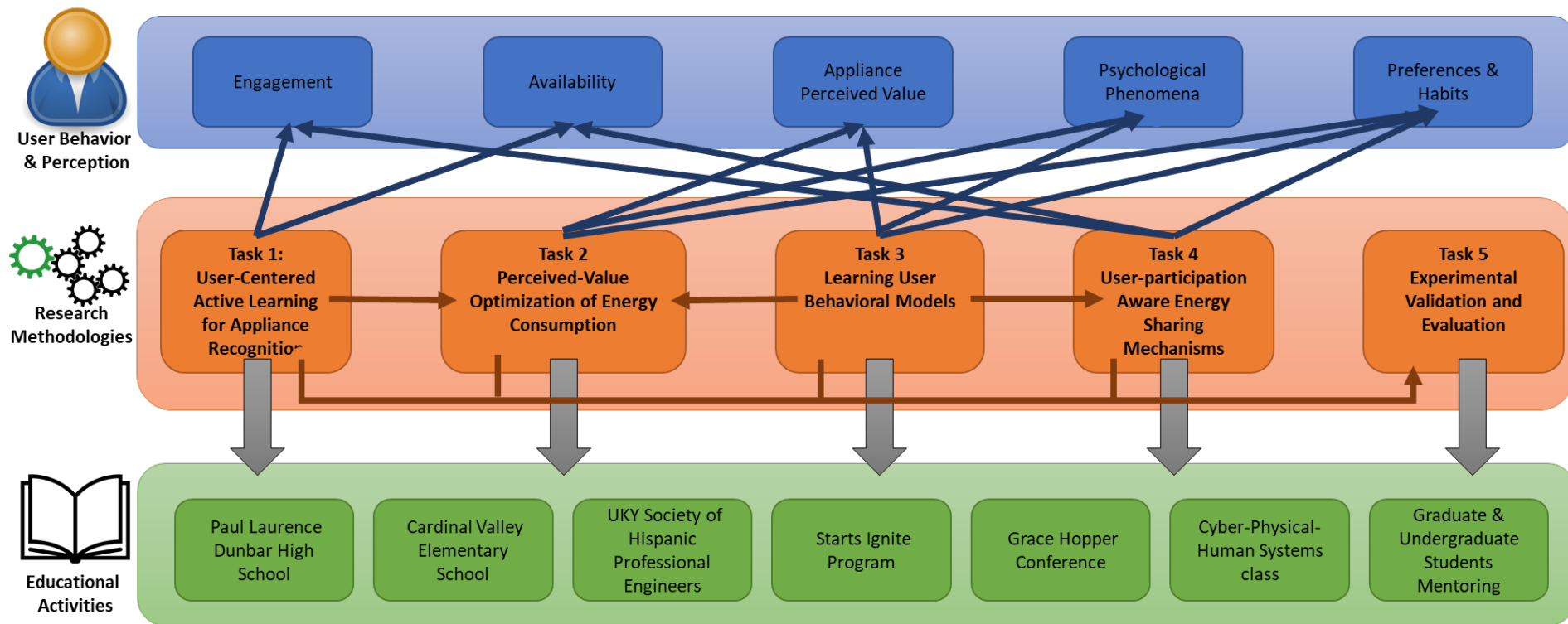


Objectives

- Overcome current limitations of energy management systems for SREs
- Explicitly include humans in the design loop
 - Behaviors
 - Perceptions
 - Psychological processes
- Design and integrate novel
 - Algorithmic
 - Machine learning
 - Optimization solutions

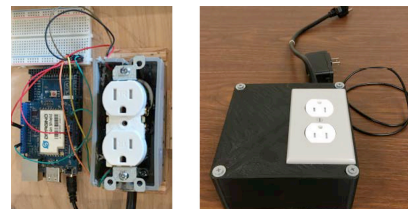
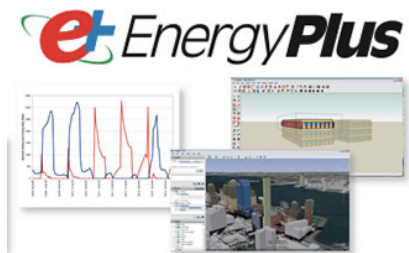


Methodologies & Education



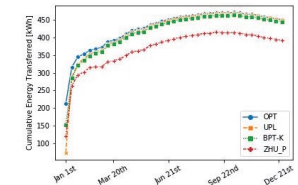
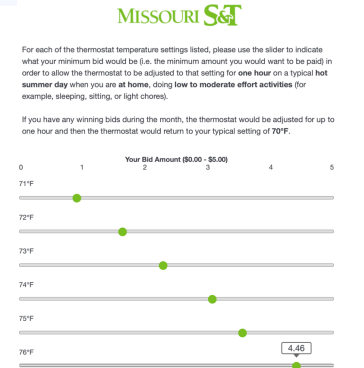
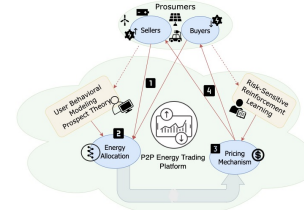
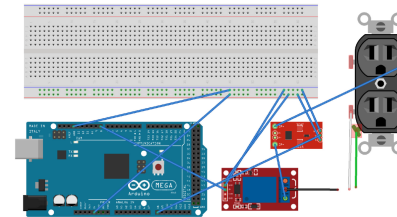
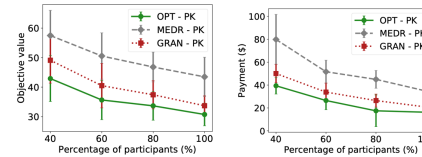
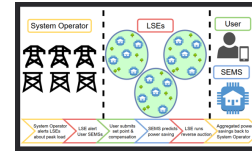
Evaluation

- Realistic simulations with Energy Plus
- Smart outlet system
- Collaboration with local energy companies
 - Power and Energy Institute of Kentucky (PEIK)
 - Tennessee Valley Authority (TVA)
 - Louisville Gas and Electric and Kentucky Utilities (LG&E-KU)
- The testbeds @ NetZero houses in Williamsburg, KY



Some recent results

- HVAC Power Conservation through Reverse Auctions and Machine Learning (IEEE PerCom 2022)
- Learning from Non-Experts: An Interactive and Adaptive Learning Approach for Appliance Recognition in Smart Homes (ACM TCPS 2022)
- A Reinforcement Learning Approach for User Preference-aware Energy Sharing Systems (IEEE TGCN 2021)
- Perceived-Value Driven Optimization of Energy Consumption in Smart Homes (ACM TIOT 2020)



Publications & Contacts

J. Codispoti, A. R. Khamesi, N. Penn, S. Silvestri, E. Shin, "Learning from Non-Experts: An Interactive and Adaptive Learning Approach for Appliance Recognition in Smart Homes" in ACM Transactions on Cyber-Physical Systems, Vol. 6, Issue 2, 2022.

A. Timilsina, S. Silvestri, "Prospect Theory-inspired Automated P2P Energy Trading with Q-learning-based Dynamic Pricing" in Proceedings of the IEEE Global Communications Conference (GLOBECOM), 2022

E. Casella, A. R. Khamesi, S. Silvestri, D. A. Baker, S. K. Das, "HVAC Power Conservation through Reverse Auctions and Machine Learning" in Proceedings of the IEEE International Conference on Pervasive Computing and Communications (PerCom), 2022

E. Casella, E. Sudduth, S. Silvestri, "Dissecting the Problem of Individual Home Power Consumption Prediction using Machine Learning" in Proceedings of the IEEE International Conference on Smart Computing (SMARTCOMP), 2022 - Work in Progress

A. Timilsina, A. R. Khamesi, V. Agate, S. Silvestri, "A Reinforcement Learning Approach for User Preference-aware Energy Sharing Systems" in IEEE Transactions on Green Communications and Networking, Special Issue on Green Internet of Things: Challenges and Future Opportunities, Vol. 5, Issue 3, 2021.

S. Bhattacharjee, V. P. K. Madhavarapu, S. Silvestri, S. K. Das, "Attack Context Embedded Data Driven Trust Diagnostics in Smart Metering Infrastructure" in ACM Transactions on Privacy and Security, Vol. 24, Issue 2, 2021

A. Khamesi, S. Silvestri, D. Baker, A. De Paola, "Perceived-Value Driven Optimization of Energy Consumption in Smart Homes" in ACM Transactions on Internet of Things, Vol. 1, Issue 2, 2020.

A. R. Khamesi, S. Silvestri, "Reverse Auction-based Demand Response Program: A Truthful Mutually Beneficial Mechanism" in Proceedings of the International Conference on Mobile Ad Hoc and Sensor Systems (MASS), 2020

A. R. Khamesi, R. Musmeci, S. Silvestri, D. A. Baker, "Reproducibility of Survey Results: A New Method to Quantify Similarity of Human Subject Pools" in Proceedings of the IEEE Global Communications Conference (GLOBECOM), 2020

E. Shin, A. R. Khamesi, Z. Bahr, S. Silvestri, D. A. Baker, "A User-Centered Active Learning Approach for Appliance Recognition" in Proceedings of the IEEE International Conference on Smart Computing (SMARTCOMP), 2020

thank you!