

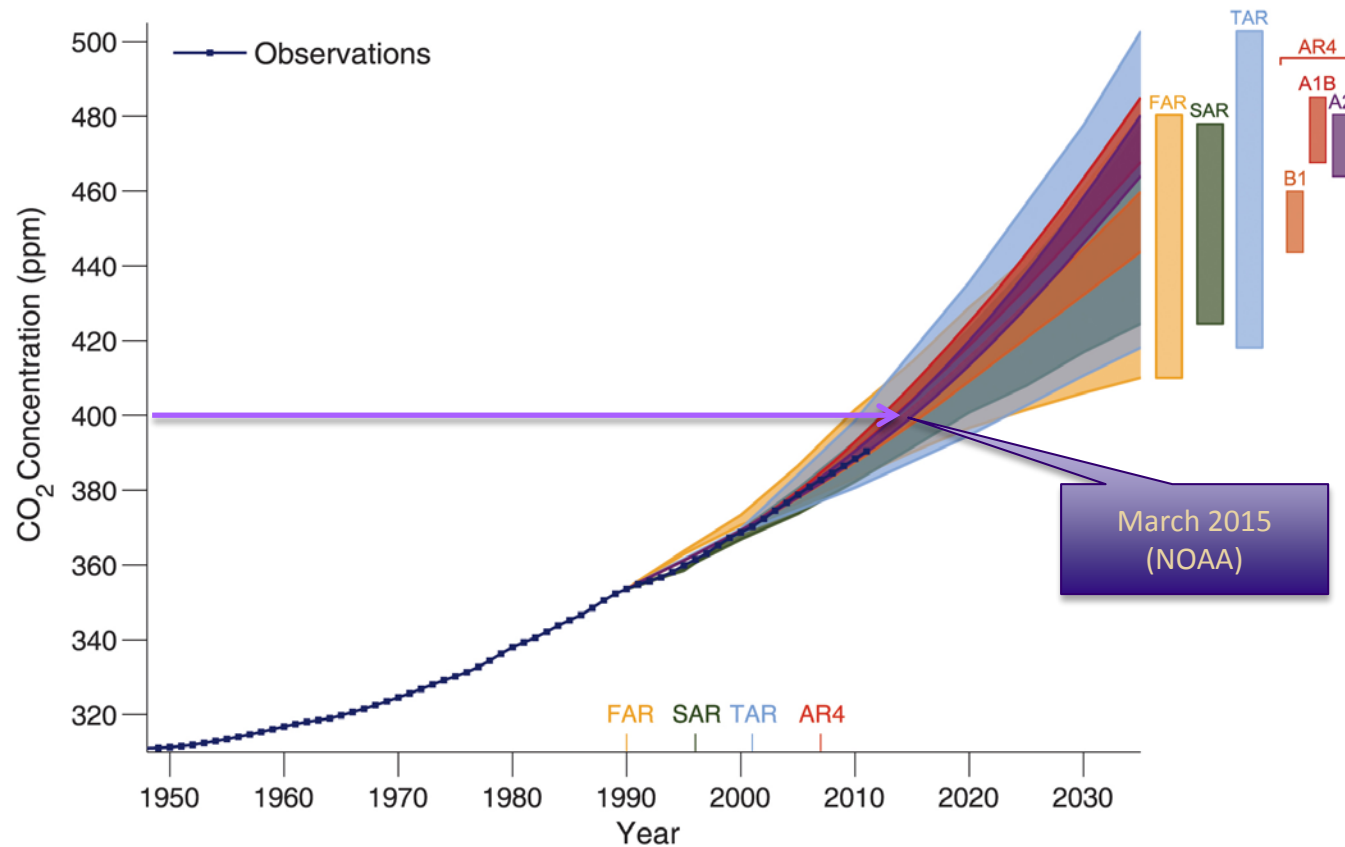
UNIVERSITY *of* WASHINGTON

THE FEASIBILITY OF PLUG-LOAD MONITORING AND ENERGY-SAVING INTERVENTIONS IN RESIDENTIAL AND OFFICE BUILDINGS ON THE UNIVERSITY OF WASHINGTON CAMPUS

Heta K. Kosonen (MSc), Amy. A. Kim (PhD)



WE NEED TO CHANGE THE WAY WE CONSUME ENERGY.

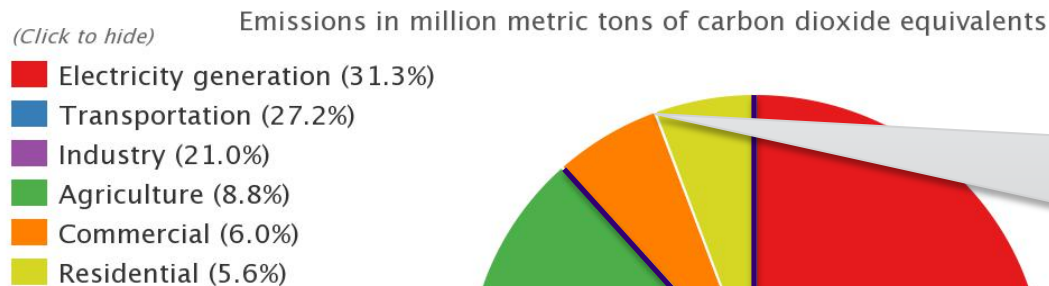


Source: IPCC, 2014. 5th assessment report.



SUSTAINABILITY INITIATIVES AT WORKPLACES OFFER A SUBSTANTIAL OPPORTUNITY TO REDUCE GHG EMISSIONS.

U.S. Greenhouse Gas Emissions by Economic Sector, 2013

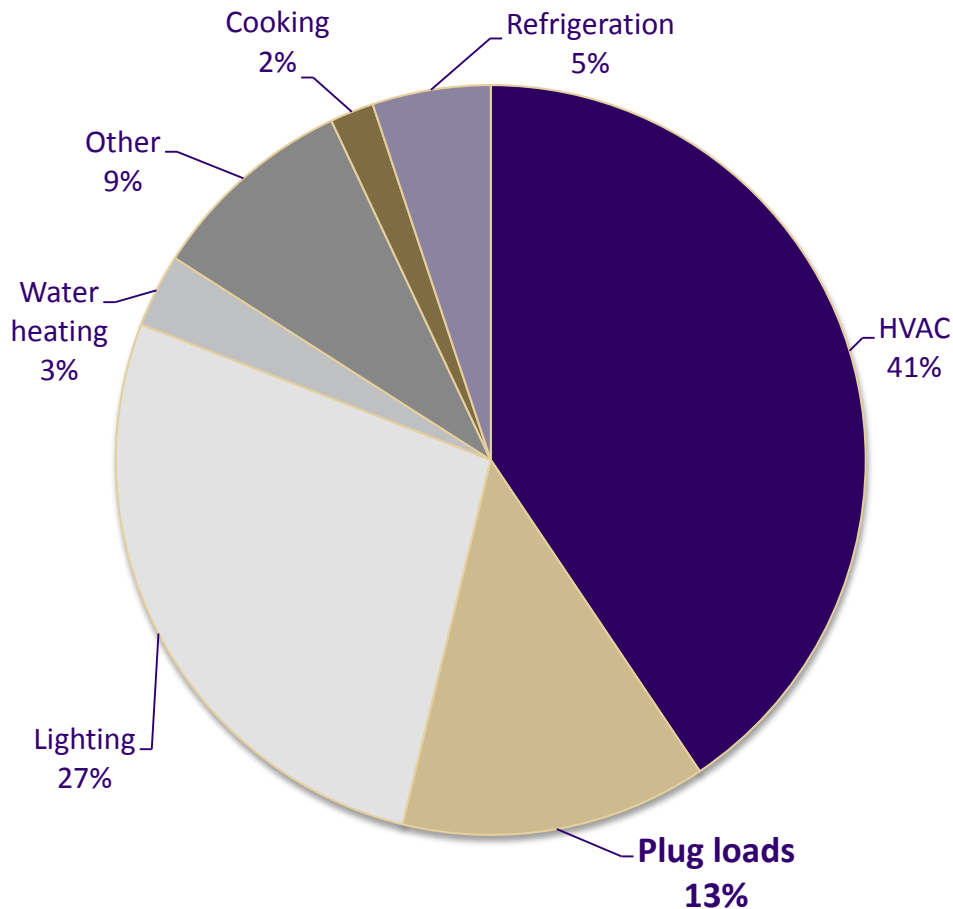


The building sector is responsible for **39.7%** of the **total annual energy consumption** in the U.S. (EIA 2014).

Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013.
<http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>

W

THE SAVINGS POTENTIAL LIES IN PLUG LOADS



Plug load

Electronic devices not responsible for zone heating and cooling, water heating, or lighting.

- Office information technology (IT) equipment
- Personal appliances (e.g. coffee machines, table fans, and personal space heaters)



WHAT WE KNOW ABOUT PLUG LOAD INTERVENTIONS

“Energy-saving potential of behavioral change is comparable to, and even higher than, that of technological solutions”

Masoso & Grobler 2010, Schweiker & Shukuya 2010

“Occupants control or impact up to 50 percent of a building’s energy use and that changing occupant behavior patterns gives the most effective reductions in energy use”

Kamilaris et al. 2014

“Occupant energy use can be impacted and controlled by giving occupants regular feedback on their energy usage patterns.”

Jain et al. 2012, Jeong et al. 2014, Gulbinas et al. 2014, Hargreaves et al. 2010, Hargreaves et al. 2013, Pereira et al. 2013, Froehlich et al. 2010, Vine et al. 2013

“Frequent feedback is generally effective and correlates negatively with the energy consumption rate.”

Faruqui et al. 2010, Siero et al. 1996, Vassileva et al. 2012, Murtagh et al. 2013



WHAT WE STILL NEED TO FIGURE OUT



What are the ingredients of a successful energy intervention?

What are the main challenges and barriers related to plug load interventions?

What happens in the long run?

Who maintains and operates the monitoring systems?

What do we do with the data?

How do we keep occupants engaged?

W

PLUG LOAD CONTROL AT THE UNIVERSITY OF WASHINGTON



Residential hall study Winter 2014

- 10 weeks of monitoring
- Technology vs. educational intervention
- Results showed no reductions in average energy use



PLUG LOAD CONTROL AT THE UNIVERSITY OF WASHINGTON

Faculty office study Summer 2014



- Identify key issues related to plug load reductions on campus
- Characterize load profiles
- Assess the feasibility of plug load interventions in academic offices
- Pre-study for a larger scale energy intervention

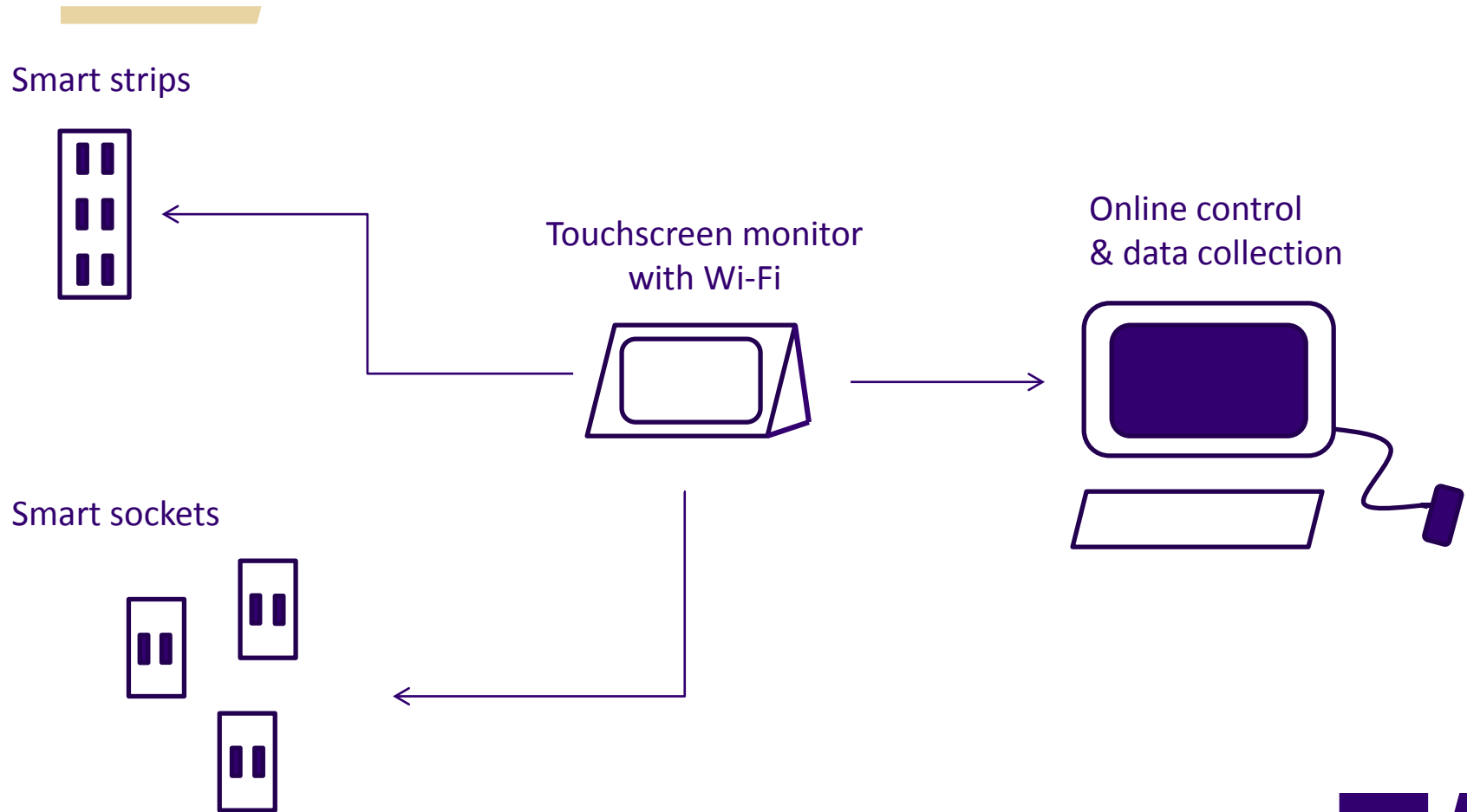


UNIVERSITY *of* WASHINGTON

METHODS



MONITORING SYSTEM



INSTALLATION AND EDUCATION



1. Appliance inventory

2. Setting appliance statuses

- Always on, on-off

3. System installation

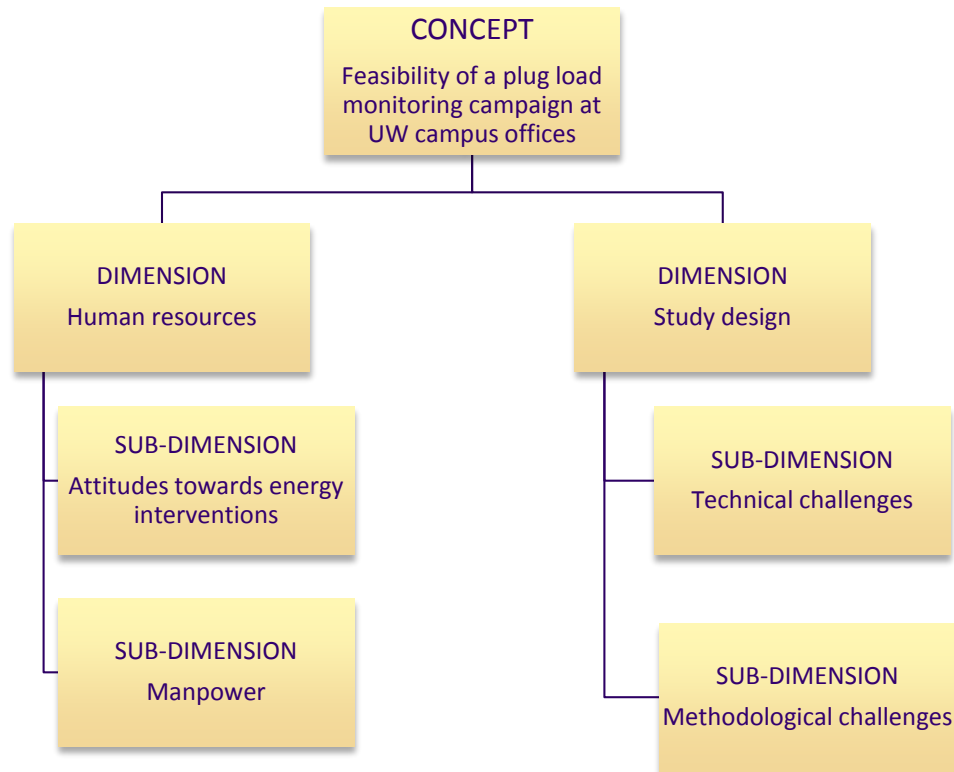
- Smart sockets and strips, monitor

4. Guidance on system control

- Introduction to short-cut commands



ADMINISTRATOR SURVEY



- Personal interviews and e-mail questionnaires.
- Participants university employees who had been involved in the residence hall plug load study in 2014
- A set of 14 questions was created on the basis of the following research topics



UNIVERSITY *of* WASHINGTON

WHAT WE LEARNED



1. ENERGY DATA COLLECTION IS NOT WITHOUT ITS CHALLENGES.

- > Installation process took approximately 30 to 45 minutes per office.
 - Little equipment maintenance was required over the 9-week study period.
- > Occasional network problems throughout the monitoring period.
 - **Frequent disruptions in data collection** and strong bias in the individual electricity consumption data.
 - **Additional workload** to University's IT specialists



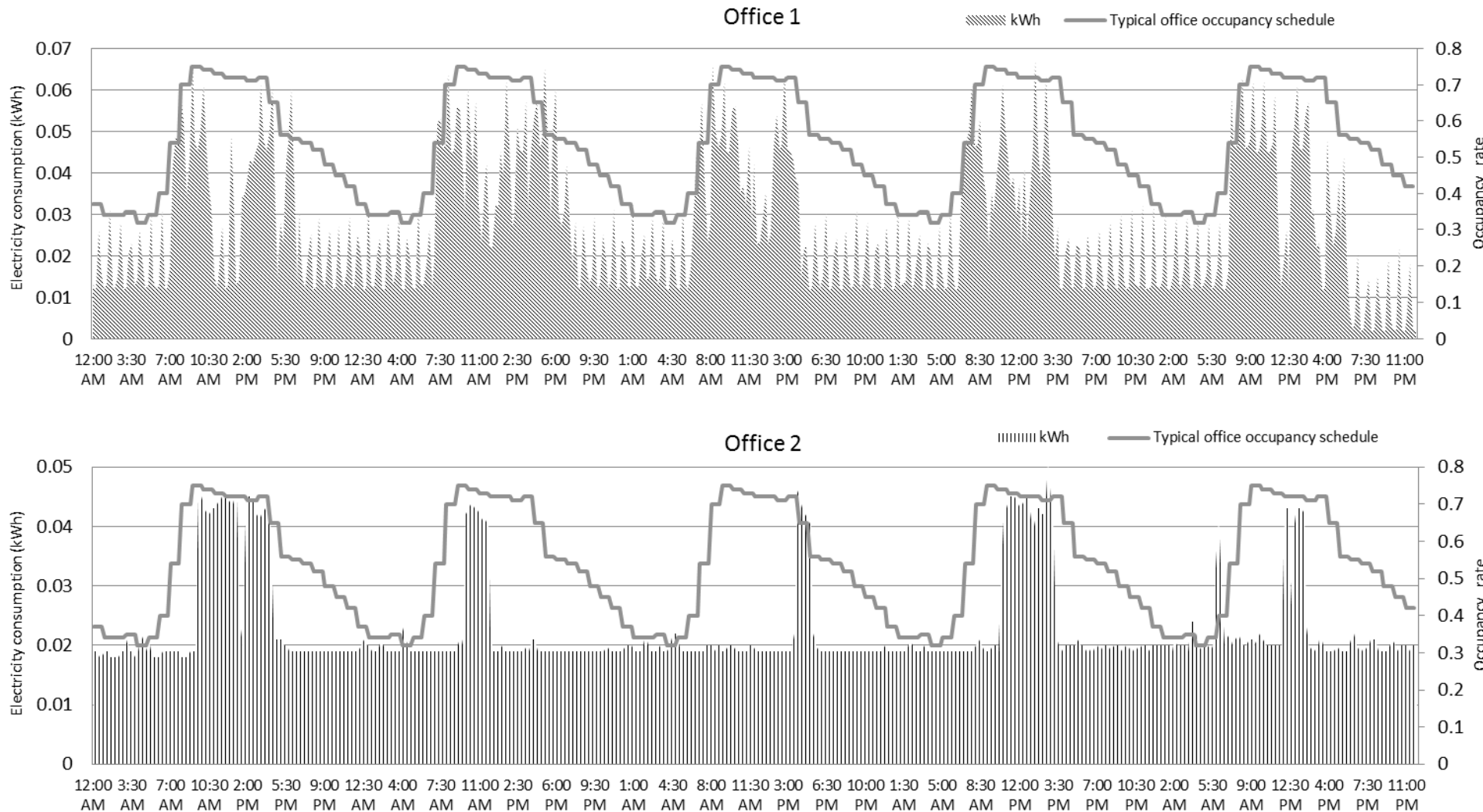
2. ENERGY CONSUMPTION VARIES HIGHLY WITHIN SIMILAR WORK STATIONS.

Appliance	Office 1	Office 2	Office 3	Office 4
Desktop computer	●	●	●	●
Monitor 1	●	●	●	●
Monitor 2		●	○	
Fan	●	○	●	
Phone charger	●	○	○	
Phone	○	●	○	
Lamp	●			
Printer	●	○	○	●
Refrigerator	●			
Microwave	○		○	
Radio	●			
Touchscreen monitor	○	○	●	○
Bass		●		
TOTAL	11	9	9	4

○ In the office ● Monitored



3. (ACADEMIC) EMPLOYEES DO NOT FOLLOW TRADITIONAL OCCUPANCY SCHEDULES.



4. THE PRESENCE OF PLUG LOAD MONITORING EQUIPMENT ALONE DOES NOT AFFECT CONSUMPTION.

- Not everyone is interested
 - Only one occupant actively used control options
 - Findings support the results presented in prior studies
- Consumption patterns of the occupants stayed unchanged during the monitoring period
 - Occupants who did not use plug load control in the beginning of the study did not develop interest in using it later in the study
 - Occupant who used control option kept using it until the end of the study



5. LONG-TERM ENGAGEMENT IS A KEY CHALLENGE IN ENERGY BEHAVIOR INTERVENTIONS.

- “everyday life gets in the way”
 - All interviewees mentioned problems with occupant engagement & hoped for more data on long-term impacts of energy interventions



NEXT STEPS

- Research on office occupant behavior in high performance buildings
- 9-month energy intervention campaign starting on the UW campus
 - Plug load monitoring
 - Behavior interventions
- Focus on long-term occupant engagement & data management
 - Effectiveness of different forms of consumption feedback
 - Simultaneous application of various intervention methods



UNIVERSITY *of* WASHINGTON

THANK YOU.

Heta Kosonen
PhD Student
CEE department
hetak@uw.edu



Amy A. Kim
Assistant Professor
CEE department
amyakim@uw.edu

