Interacting with technologies:

Here's a video …

When a lousy interface interferes with energy-saving behaviours

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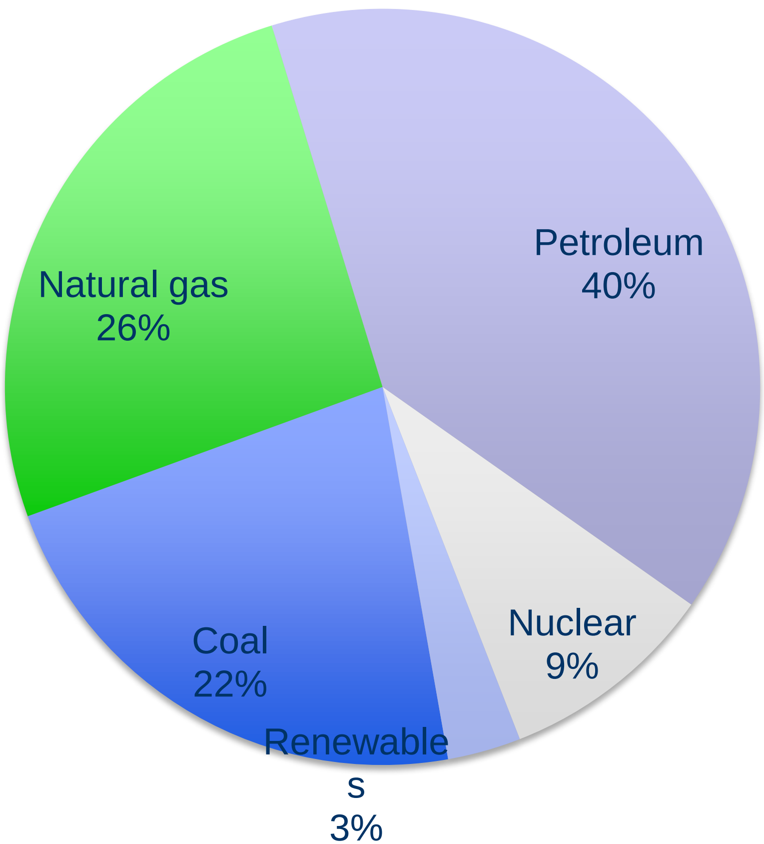
1. When a lousy interface interferes with energy-saving behaviours
2. Japan's 6 GW lunch break
3. Energy impacts of Earth Hour

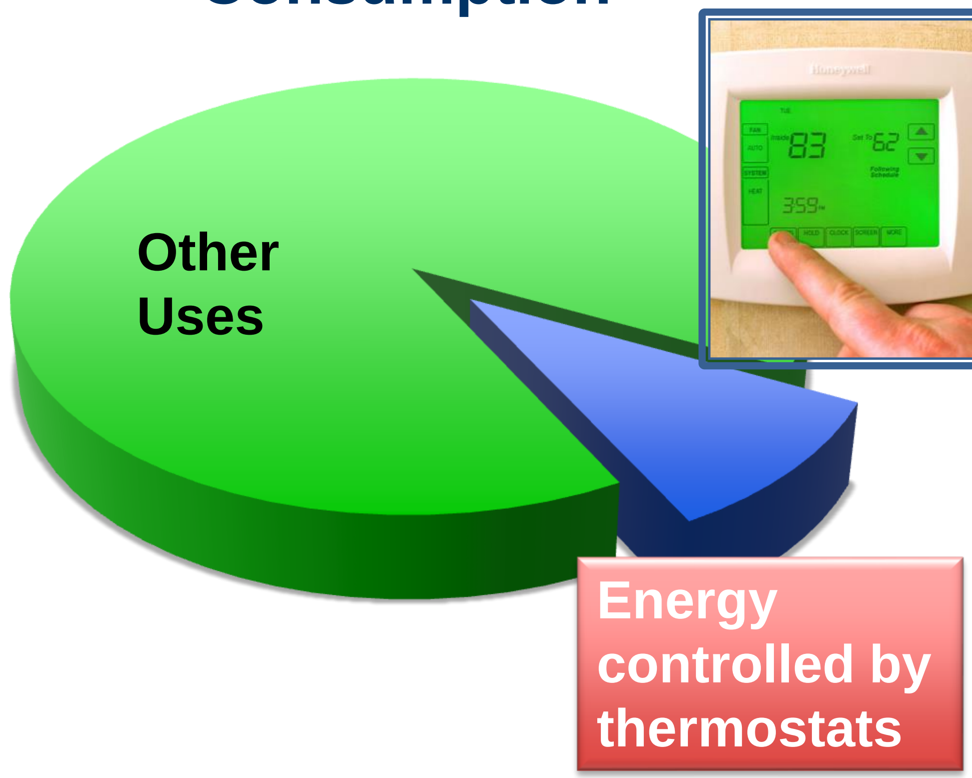
Thermostats are Important!

Residential thermostats in the USA control the same amount of energy as generated by all nuclear power plants in the USA

USA Energy Supply



USA Total Energy Consumption



History: Programmable Thermostats

1995: ENERGY STAR created specification for programmable, "energy-saving" thermostats

2008: ENERGY STAR terminated the specification.

It concluded that homes with programmable thermostats were using more energy than homes with manual thermostats and poor usability was the principal cause

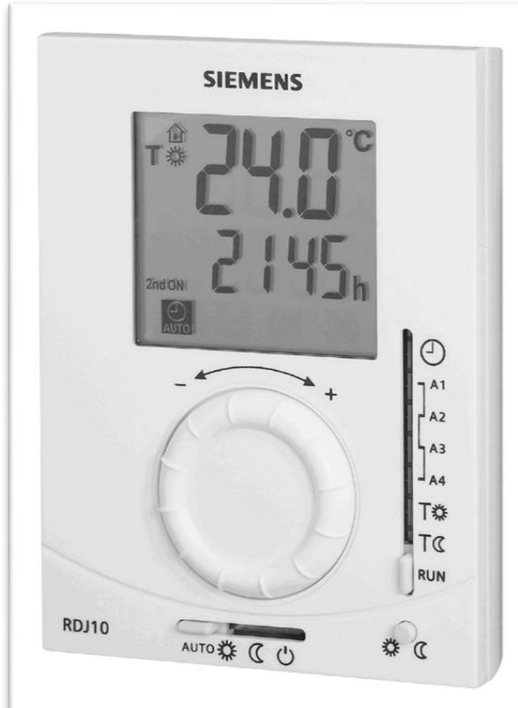
- Programming features disabled in 50% of homes
- 20% have wrong time

➔ Manufacturers needed to "fix" the usability problem before ENERGY STAR would revive the endorsement program for thermostats.

Premise: Improving the usability of thermostats will *facilitate* energy-saving behavior

Poor Usability is a Barrier to Energy Efficiency

- A complex interface prevents or discourages energy-saving behavior
- People don’t understand how to program the thermostats to get energy savings



No standardized procedure to measure usability

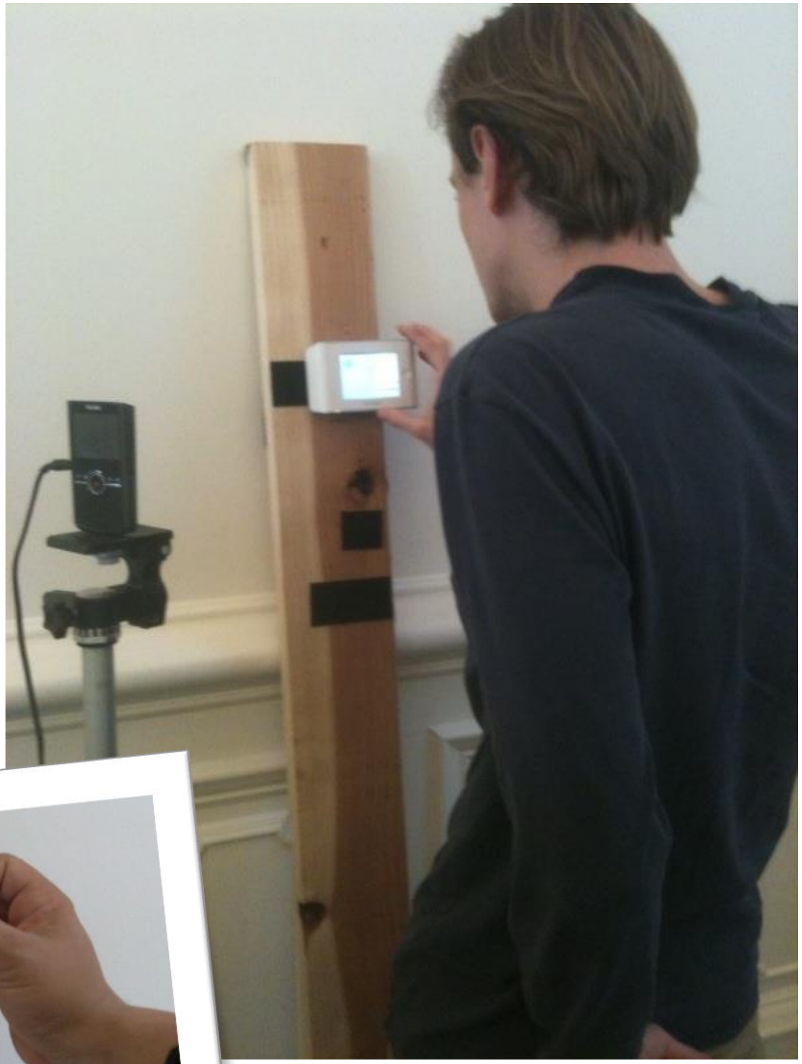
- ENERGY STAR needed a method of measuring usability
- No test procedure existed
- Our task: develop a procedure to measure the user friendliness of thermostats

Perry, D., C. Aragon, A. Meier, T. Peffer, and M. Pritoni. 2011. "Making Energy Savings Easier: Usability Metrics for Thermostats." *Journal of Usability Studies* 6 (4): 226–44.

We Tested Thermostat Usability

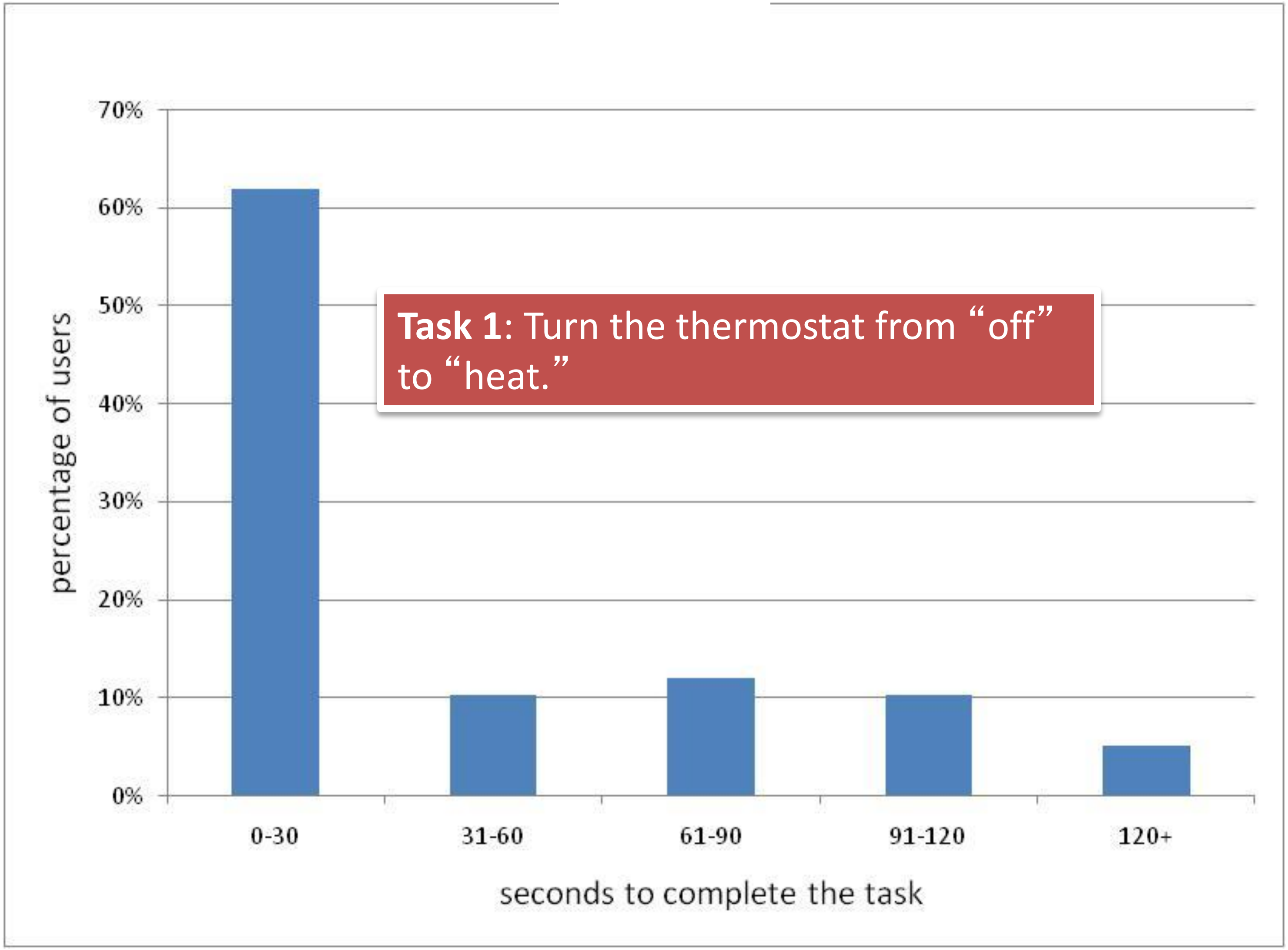
We measured people's ability to perform essential tasks on the thermostat

- 5 thermostat interfaces
- 31 participants
- 2 interfaces per person
- 6 tasks for each test
- 62 tests total

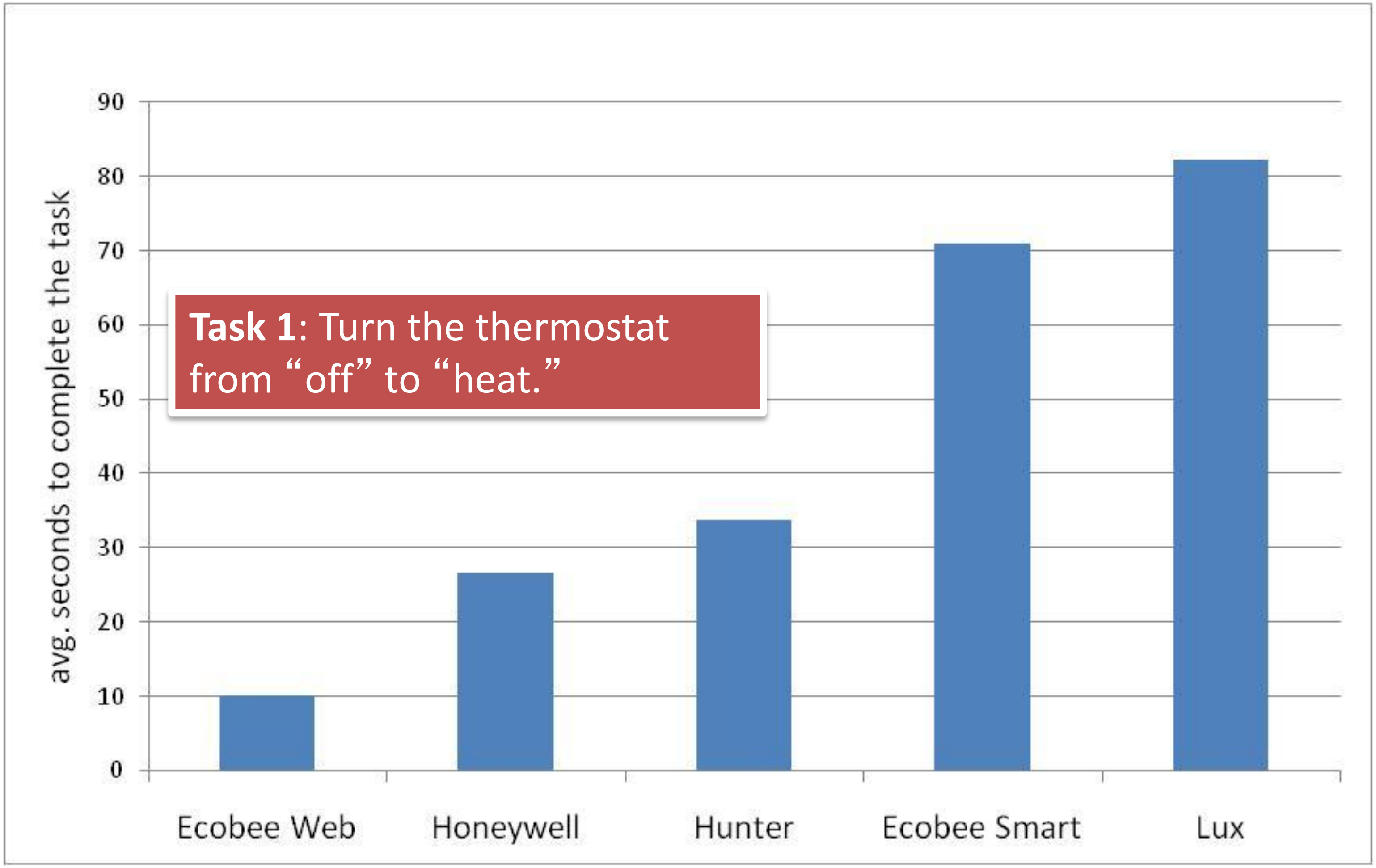


Here's another video …

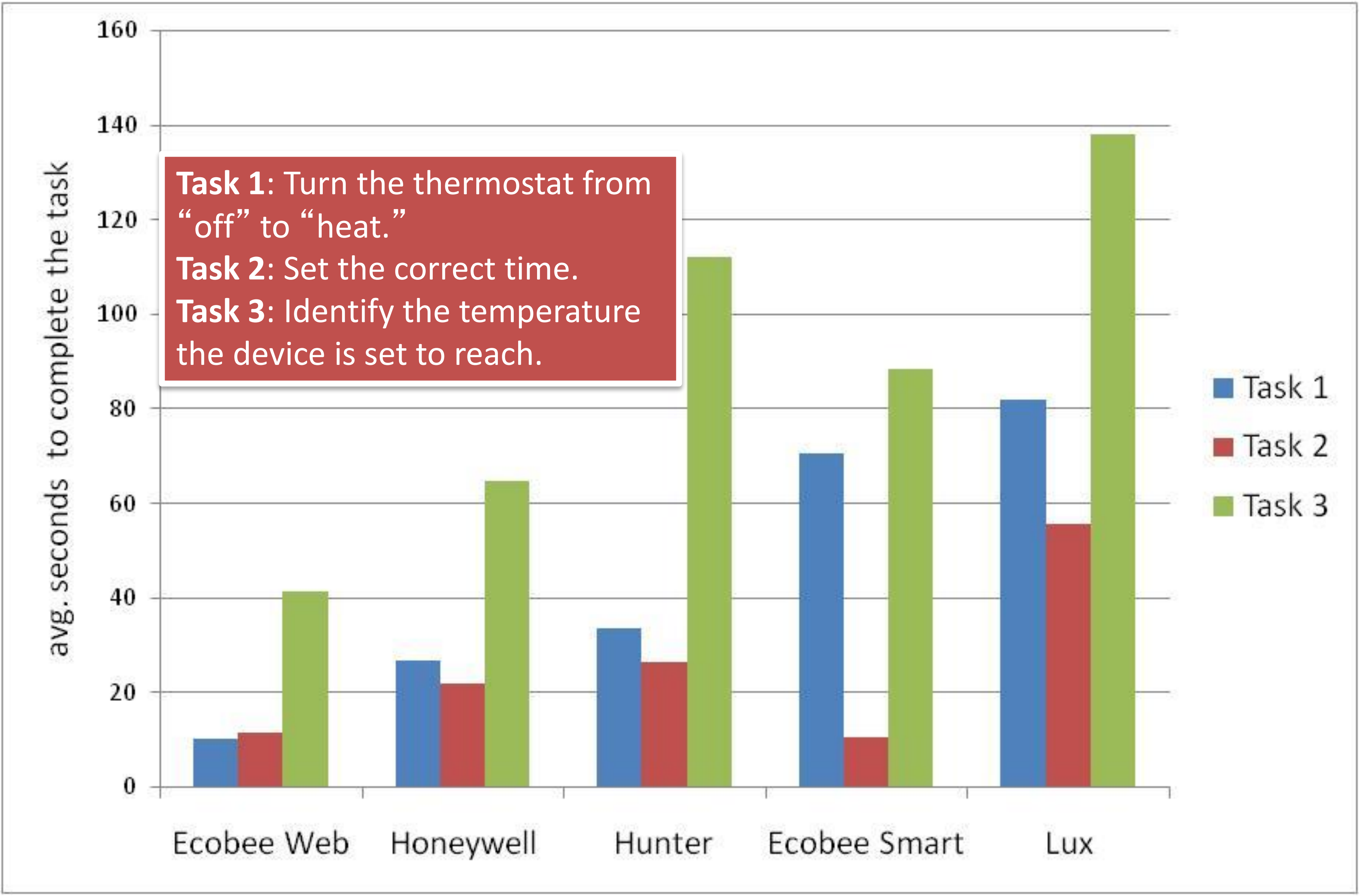
Distribution of Times for Subjects to Complete Task 1



Average Time to Complete Task by Model



Time to Complete Tasks by Model



Defining a Metric for Usability

- Relies on actions that are easy to observe, measure, and are unambiguous
- Captures essence of device’s usability
- Closed-end scale, e.g. values between 0 and 1 to allow combination of task metrics and creation of a usability “score”

Converting Task Time & Success into a Metric *"Combined Completion Coefficient"*

$$M_i = 2c\left(1 - \frac{e^x}{1+e^x}\right)$$

Where,

$$c = \begin{pmatrix} 0, & \text{if subject failed to complete task} \\ 1, & \text{if subject completed task} \end{pmatrix}$$

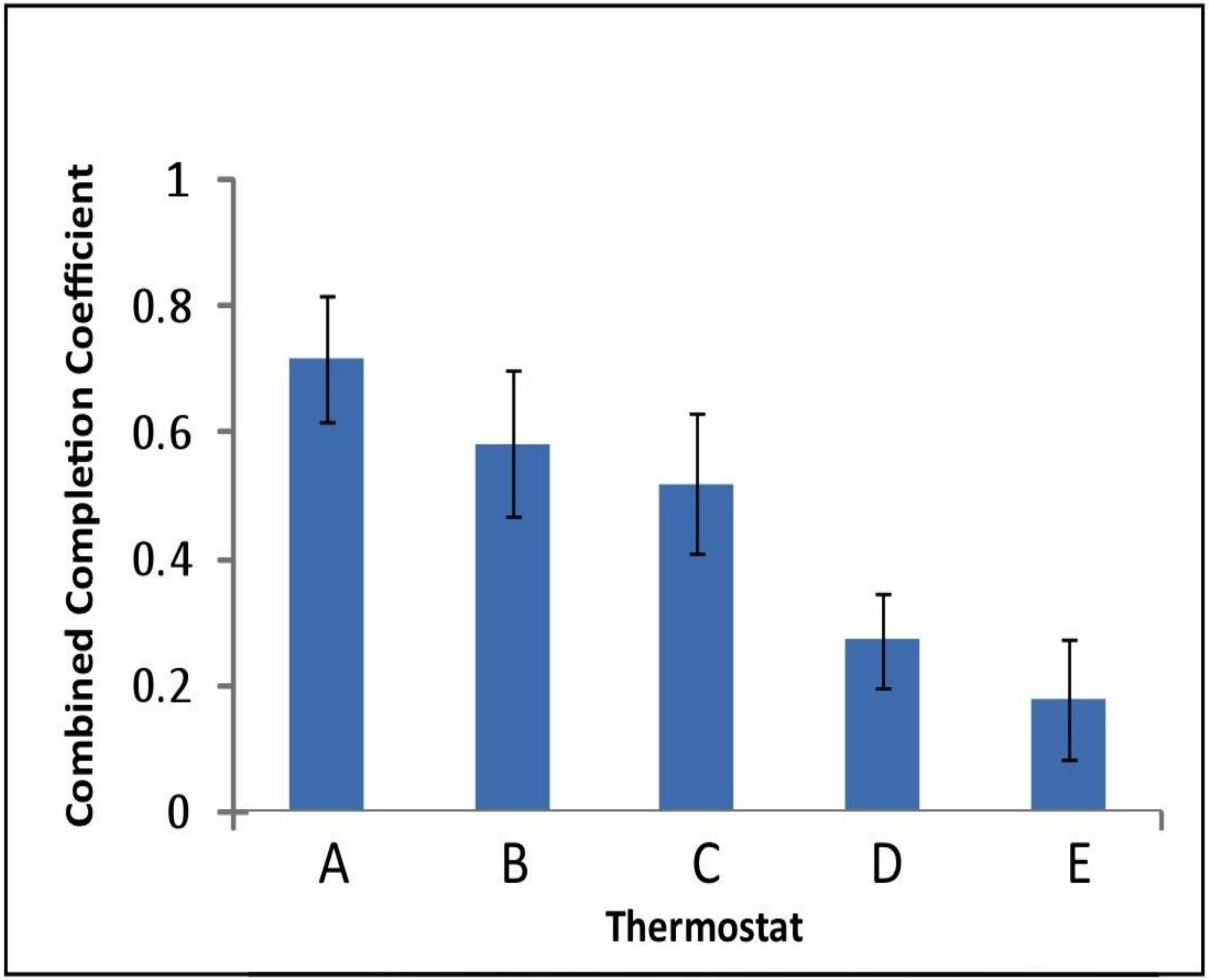
$$x = \frac{t}{k}$$

$t =$ time for subject to complete task (in seconds)

$\mathrm{k} =$ an empirically-derived constant weighting value of failures to complete

Note that M_i will always be between 0 and 1.

Combined Completion Coefficient based on 3 tasks – A Usability "Score"



Conclusions

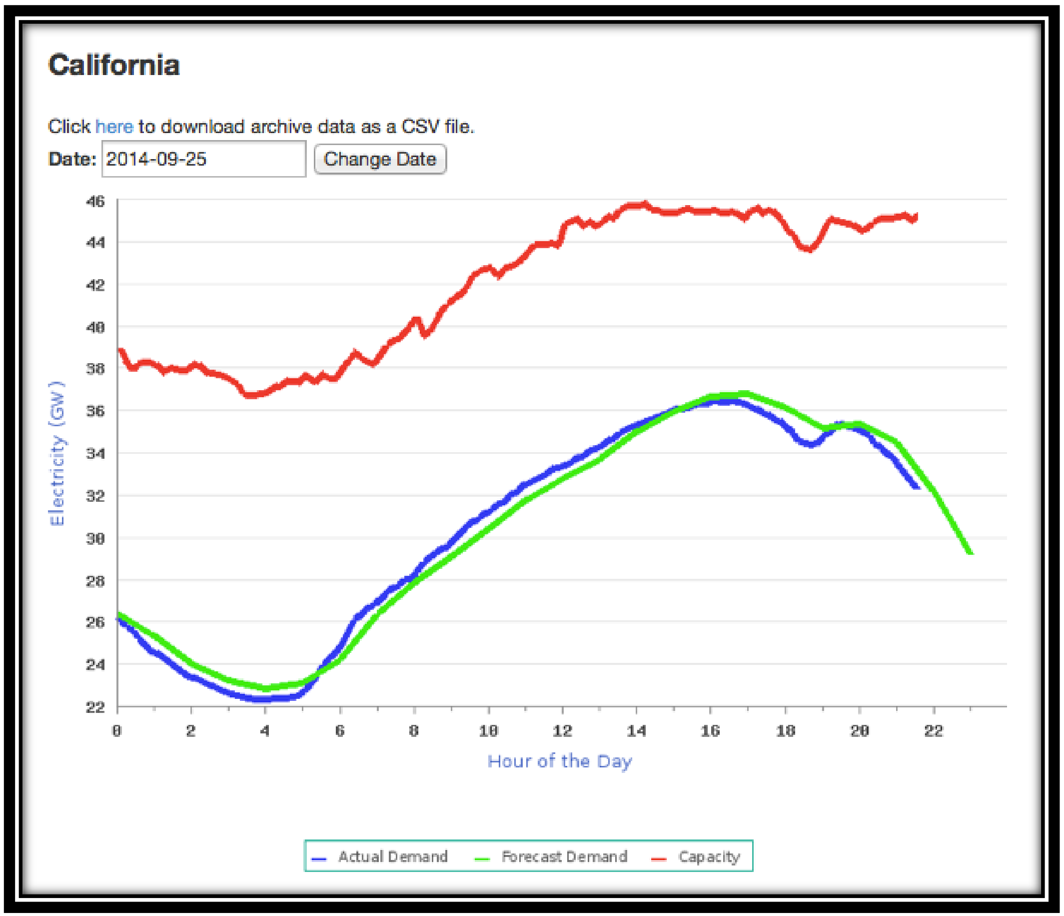
Premise: Improving the usability of thermostats will *facilitate* energy-saving behavior

- Many homes fail to use features of programmable thermostats
  - ~50% of programmable thermostats set to long-term hold
  - ~20% do not have the correct time
- We created and demonstrated a methodology to quantify usability
  - Applies to other user interfaces
- Understanding the interactions between people and technologies are crucial to explaining behavior

JAPAN’S 6 GW LUNCH BREAK

California’s Grid Status Today

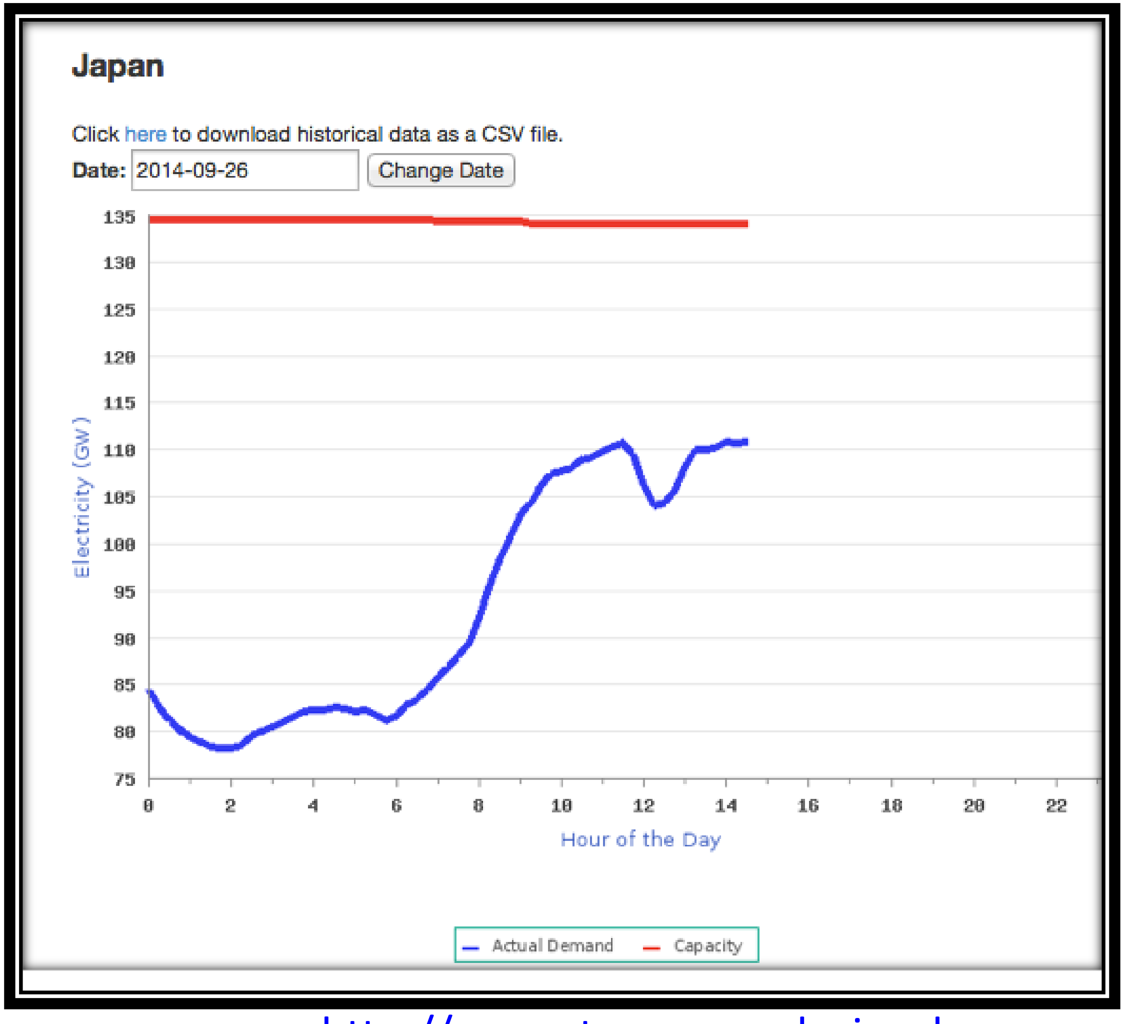
California's electricity supply and demand in real-time (based on CAISO data)



http://currentenergy.ucdavis.edu

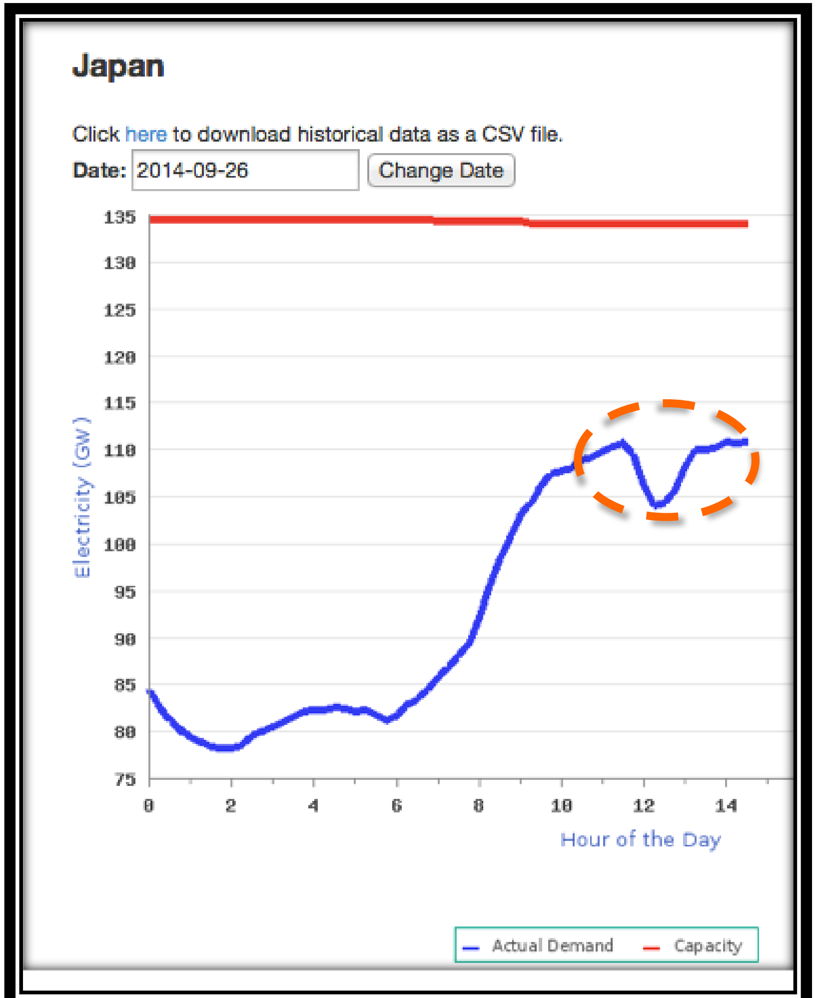
Japan’s Grid Status

Japan's Supply and Demand for electricity in real-time (50 & 60 Hz)



http://currentenergy.ucdavis.edu

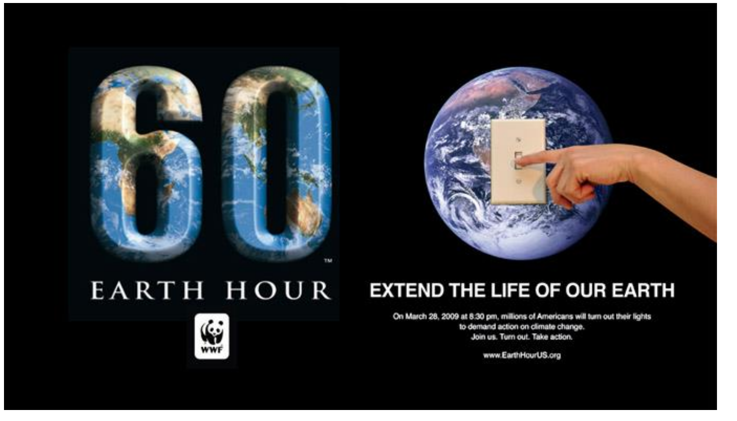
What Happens at Lunchtime?



- Japanese office workers switch off lights, computers, & ACs before they leave for lunch
- This behavior does not occur in America!
- How do we transfer this behavior to other countries?
- How do we extend this behavior beyond lunch time?

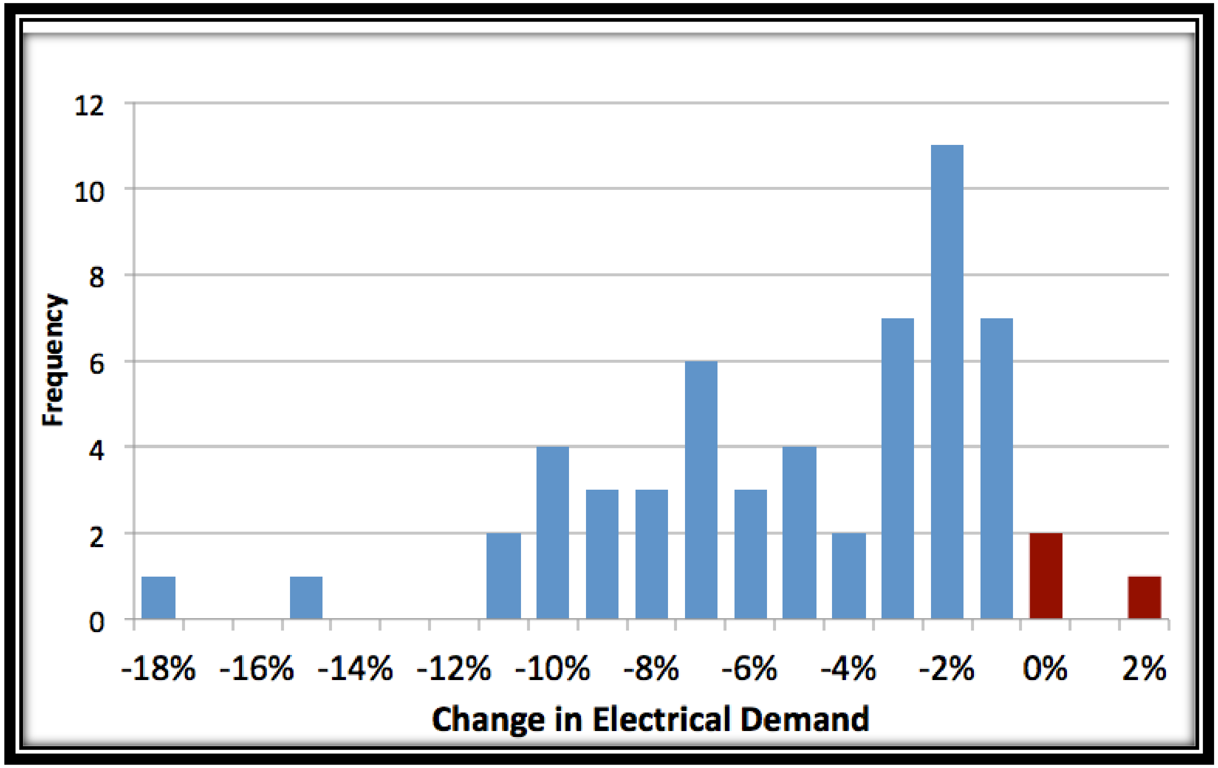
Earth Hour

- Worldwide effort to show concern for environment by making a symbolic reduction in electricity use
- A coordinated effort to avoid electricity use for 1 hour



A Temporary Change in Behavior Lowers Electricity Demand

- Many people tried saving energy for the first time
- Will next action be longer? More enduring?
- Behavior also included buying more efficient lights, etc.



Observed Reduction in Electricity Use During Earth Hour

Olexsak, Sarah J., and Alan Meier. 2014. "The Electricity Impacts of Earth Hour: An International Comparative Analysis of Energy-Saving Behavior." *Energy Research & Social Science* 2 (June): 159–82.

Conclusions

Actions to enable behavior to assist in lowering energy use:

1. Understand how Japan cuts demand 6 GW during lunch
2. Design user interfaces to promote energy-saving behavior
   – Could Ecodesign incorporate usability requirements?
3. Employ symbolic actions as the first step towards larger, more durable energy savings

The relationship between human behavior and energy use is complicated, but it is an essential part of achieving a low-energy society