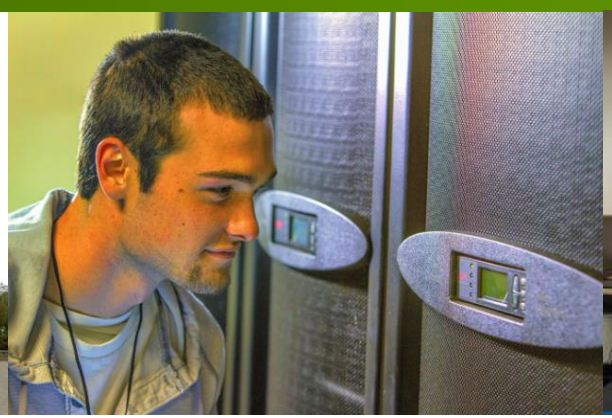
Plug Loads: Challenges and Opportunities

Michael J. Klopfer, PhD

California Plug Load Research Center

California Institute for Telecommunications and Information Technology

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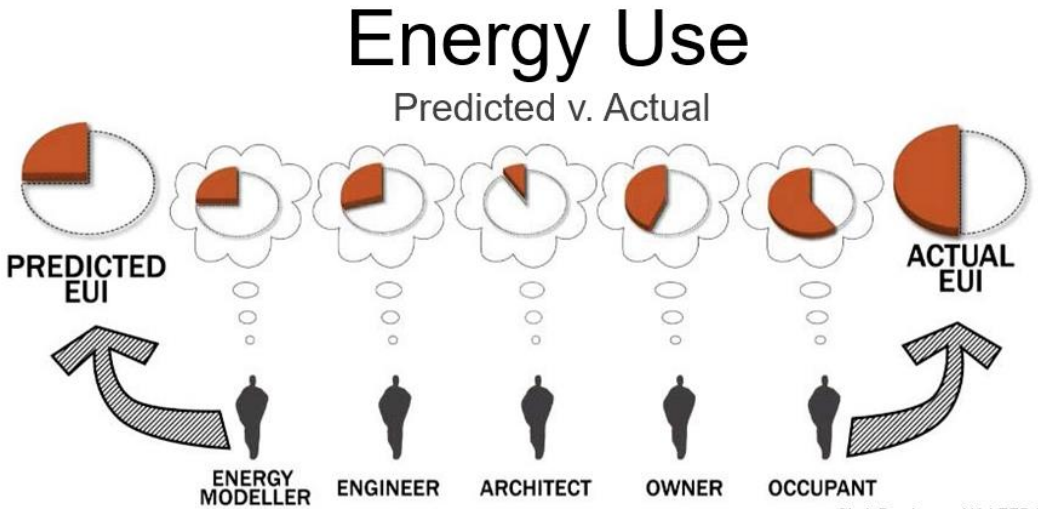
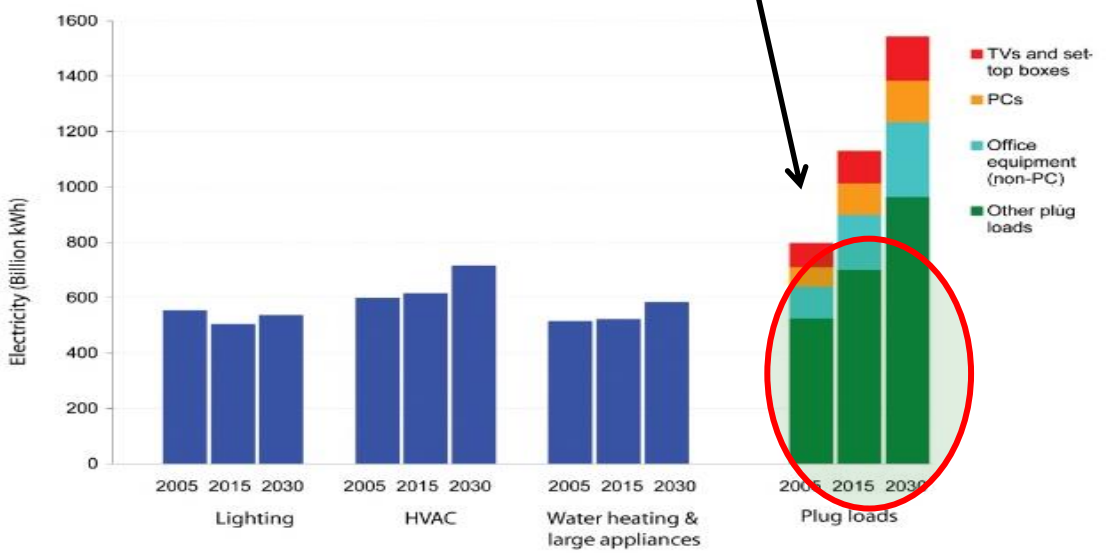
Why investigate plug loads?



What are the challenges in accurately modeling residential plug loads?

What are plug loads becoming 'more' of a problem?

What are the contributors to this "other" category, and how can this issue be addressed?



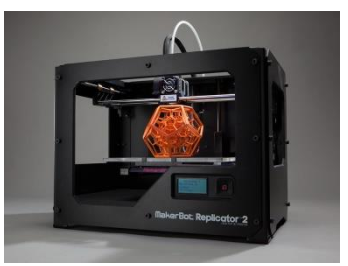
Source: Graph created by Ecova with data from EIA 2008 Annual Energy Outlook

Factors in plug load increase

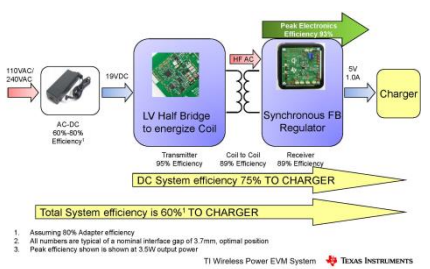
- **Home medical care and mobility**

- **Rise of overlooked devices**

- **Overhead associated with automation control?**

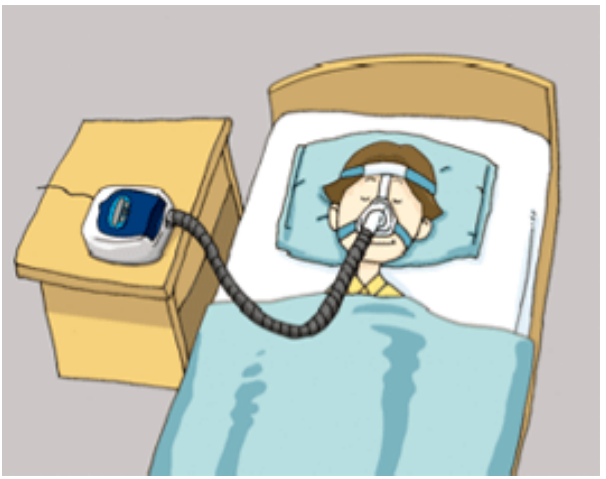


- **Changing habits/lifestyles**



Energy and respiratory disease

	Rate (hrs/day)	Energy/day (kWh)	Energy/yr (kWh)	Pop.
CPAP	8	0.4-0.8	146 - 292 kWh	25M
O_2 Concentrator	24	8.64 - 16.56	3153.6 - 6044.4 kWh	1,425,431 CA



Chronic respiratory disease is one of numerous diseases on the rise, specially with an aging population.

Smart devices for energy savings

Classic IoT Installation:

- **Increased vampire load**
- **New Infrastructure load**
- **Potentially very large savings potential**

Occupancy Sensor Installation:

- **Low vampire load (potentially under 1mW)**
- **Simple configuration, low intelligence**

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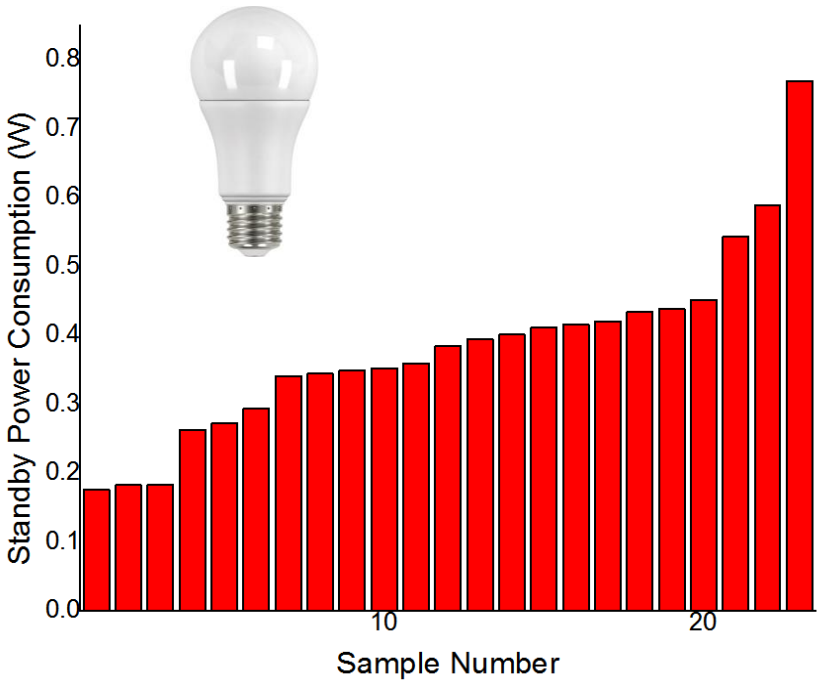
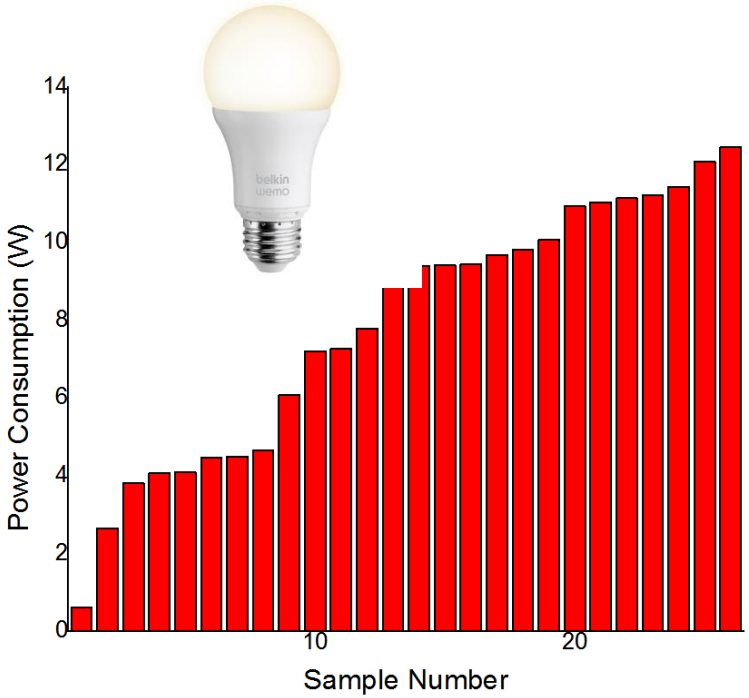
Case Study: Connected LED Light Bulb

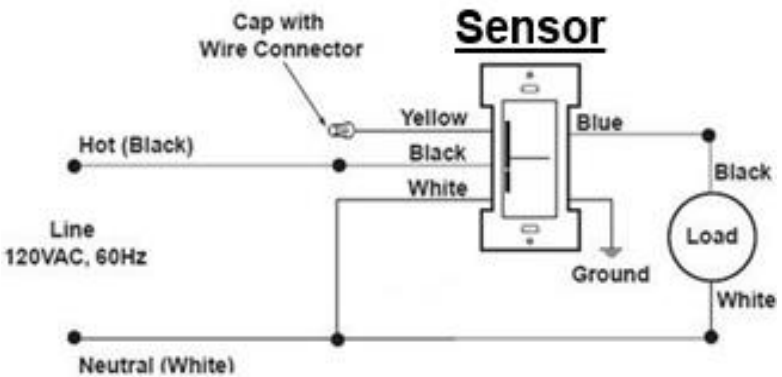


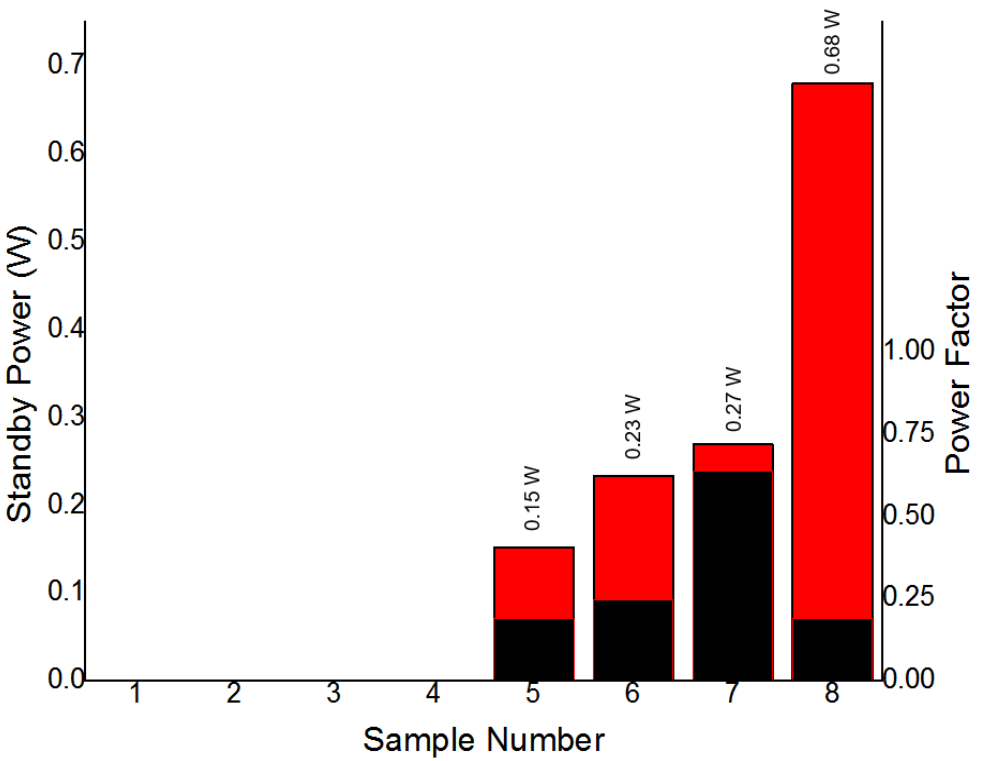
Smart bulb vampire (standby) power usage
Average = 0.38 W



Smart bulb ON power usage
Average = 7.86 W

Motion sensors for control



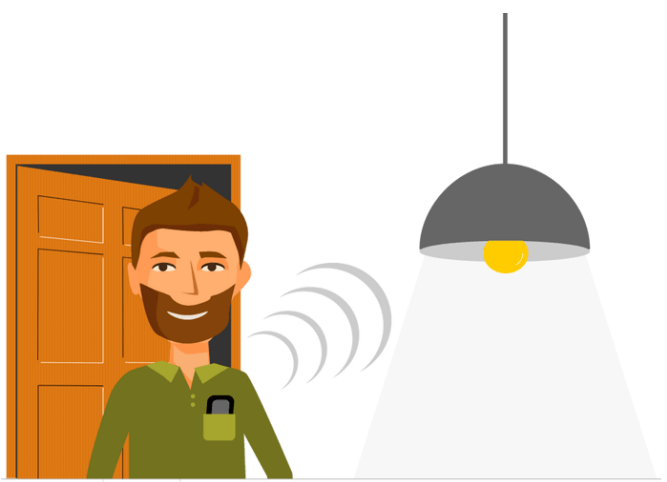


Vampire load considerations

	Standby Power	On Power	Usage	kWh Usage
Regular LED Lightbulb	0 W	9.62 W	4 Hours/Day in ON state (normal)	**14.0 kWh/yr**
IOT Smart LED Lightbulb	0.38 W	10 W (9.62W+0.38W)	2.8 Hours/Day in ON State (~30% reduction)	**13.1 kWh/yr**

Equivalent Bulb (or plug load luminary) without IoT Technology

Smart Bulb (or plug load luminary) with IoT Technology resulting in 30% usage reduction



Only 6.4% decrease in energy usage with 30% reduction in ON time state due to IoT energy overhead at device level only

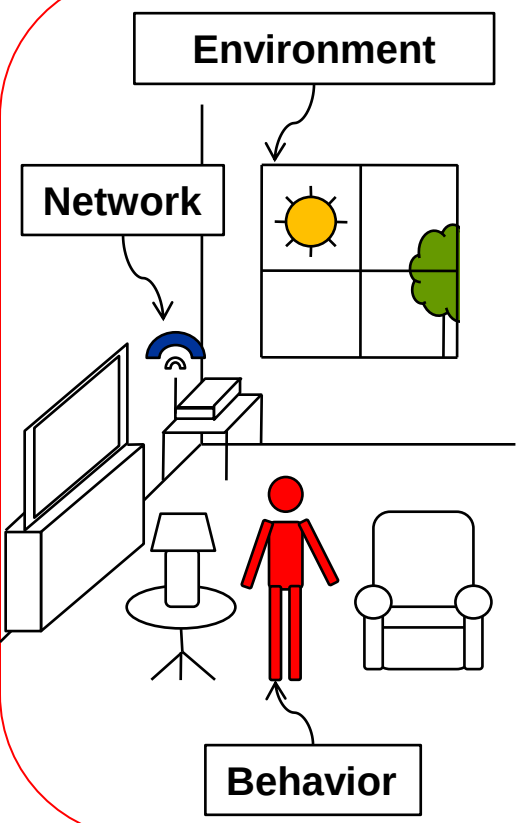
Behavior Based Savings Opportunities

Electricity Usage Context

Sensing

PEF Management

Plug Load Devices and Functional States



Optical

Acoustic

Tactile

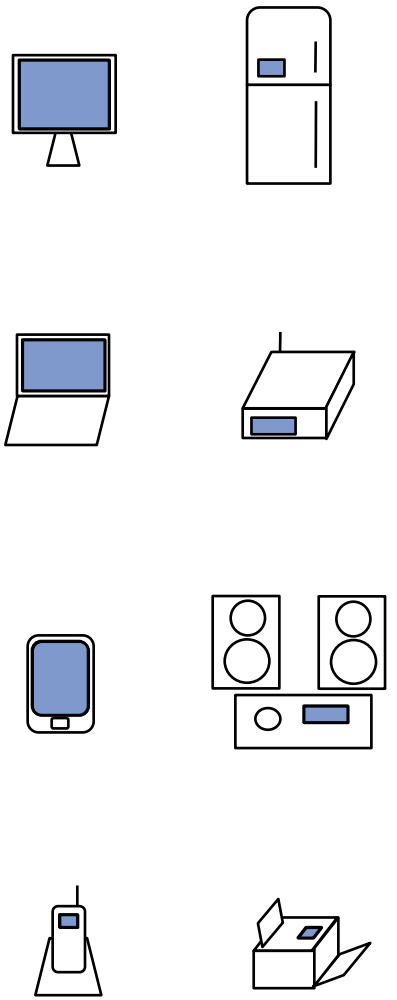
Electronic

…

User Inputs

Sensor Inputs

Pattern record



CalPlug 5W5S Demo

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Energy savings in the classroom

Projector and document camera on during breaks?

Proper PC power management?

Proper HVAC and lighting controls?

Printers and small network equipment?

Using natural light?

Student Plug Loads?

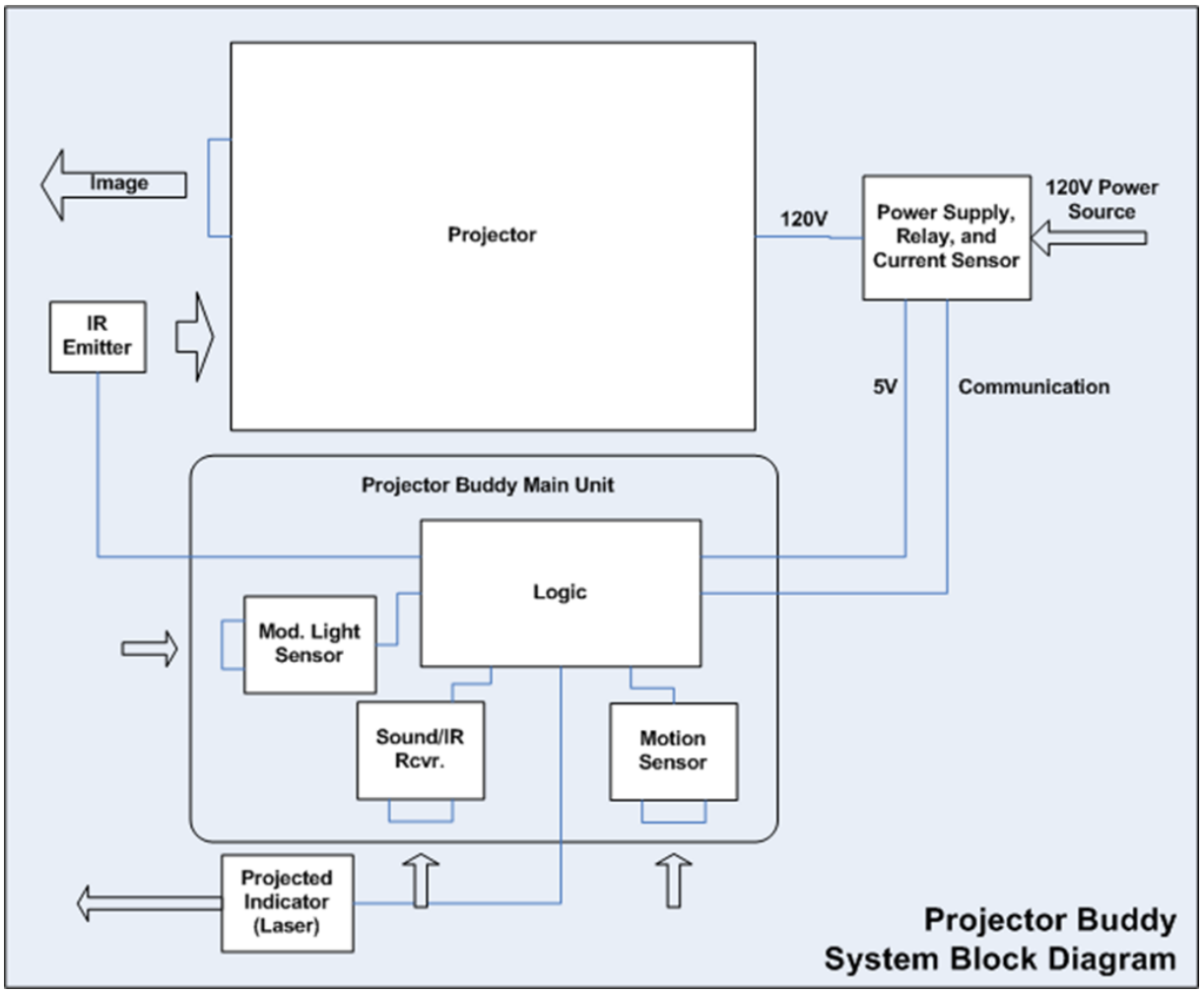
Task lighting?

Under – desk heater?

Classroom pets?

The overlooked teacher's computer

Projector Buddy: A Tool for Classroom Energy Management



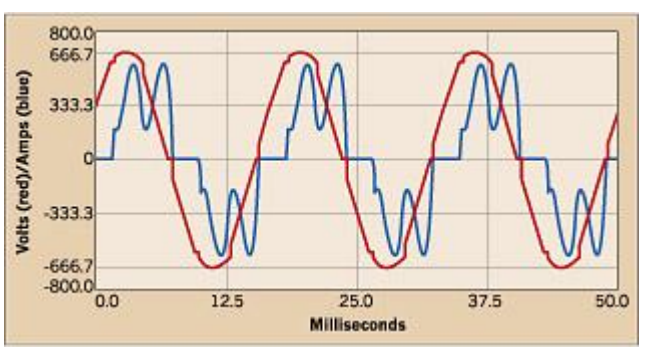
Commitment to training the leaders of tomorrow

- **Projector Buddy: Classroom Energy Management**

- **Smart EV Charger**

- **Secure WiFi controller for large residential loads (dual speed pool pumps)**

- **PLSim – rapid plug load simulation**



- **SparkyStrip – load desegregation**

Thank You!