February 19, 2018

Emerging & Commercial Ready Energy Efficiency Technologies for Businesses

PRESENTED BY

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Agenda

Emerging technologies

Commercial electric technologies

Office plug load strategies

Commercial gas technologies

Value of Emerging Technologies to Energy Efficiency Programs and Business Customers

Science Fiction to Reality


IDEAS / RESEARCH
TECHNOLOGY TRANSFER
(THE BRIDGE)
NEW PRODUCTS
NEW TECHNOLOGY SOURCES
Universities
Laboratories or research and development divisions with private-sector companies
Commercializing the technology adds value so it will have social and economic impact
The process of transferring new technologies from the laboratory to the maketplace
COMMERCIALIZATION
Conceptual system viability proven
Prototype matching the final configuration
Pre-manufacturing or pre-deployment testing and/or field testing

Emerging Technologies

Phase 1 Emerging Technology Screening - Sources

- ASHRAE research project (Max Tech, RP1651)
- Bonneville Power Administration’s (BPA) Emerging Technologies Program – E3T
- Department of Defense Environmental Security Technology Certification Program (DoD ESTCP)
- The Emerging Technologies Coordinating Council
- Department of Energy High Impact Technology Catalyst
- General Services Administration Green Proving Ground (GPG) Program
- Seventhwave research projects
- Gas Technology Institute’s Technology Snapshots (GTI ETP Collaborative)
- Direct dialogue with selected manufacturers

Phase 1 Emerging Technology Screening - Criteria

Technology readiness: Is the technology in development, deployed in some markets or does it need validation?

Savings potential: Could there be widespread adoption in buildings because of savings potential? Is the incremental savings from a technology worth program investment?

Cost Effectiveness: Will it pass a TRC test? The answer to this question may be subjective as cost data for emerging technologies is often incomplete or unavailable.

Other Considerations:

Barriers to adoption: Are there other barriers that will make technology adoption too risky?

The end-use function served: Does the technology have broad applicability (and therefore savings potential)?

Emerging Technologies - Highlights

Interior Low-e Storm Windows

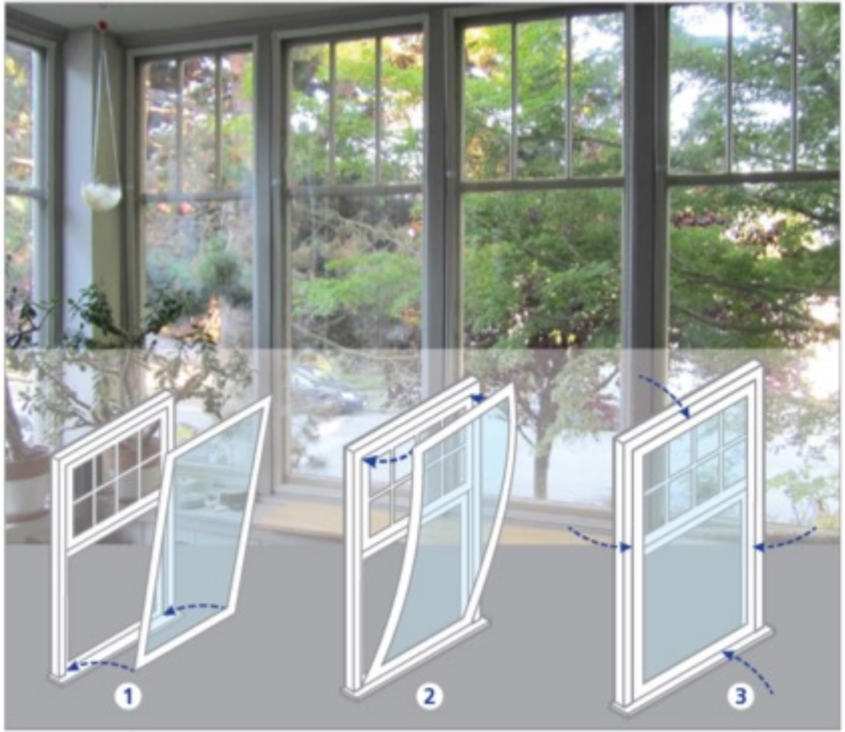


Photo: factory-made interior removable storm windows. Building America Solution Center, Pacific Northwest Laboratory (https://basc.pnnl.gov/images/factory-made-interior-removable-storm-windows)

Electricity savings: 0.06 kWh/ft^2
Gas savings: 0.05 therm/ft^2

Cost savings: \$0.08/ft^2

2017 Simple payback: 5 years

Barriers: cost, maintenance

Measure life: 15 years

Dynamic Air Flow Balancing

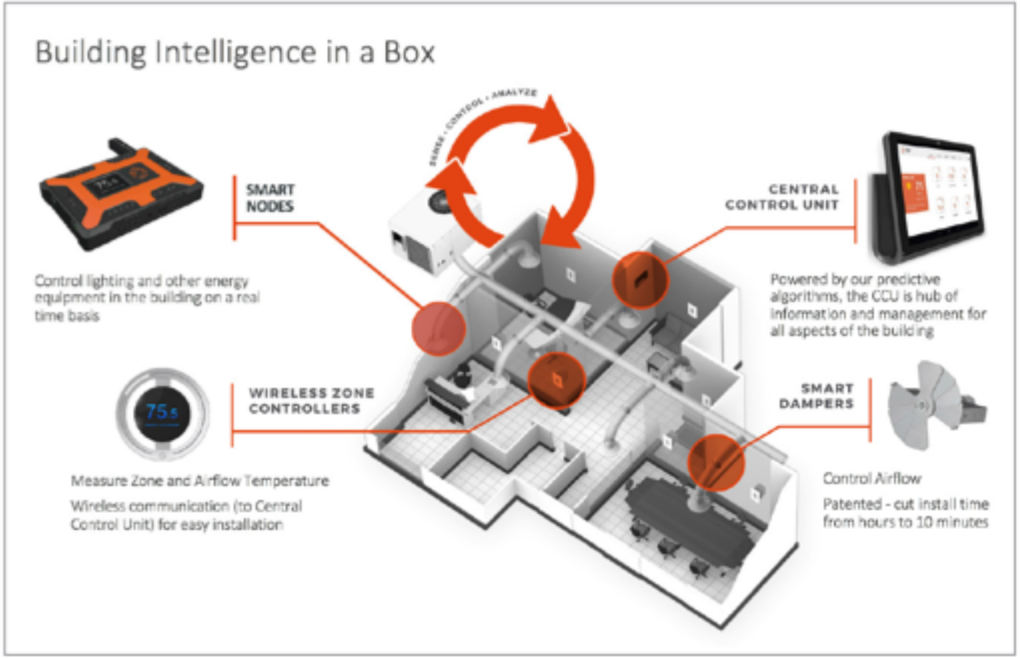


Photo courtesy of 75F

Electricity savings: 0.4 kWh/ft^2

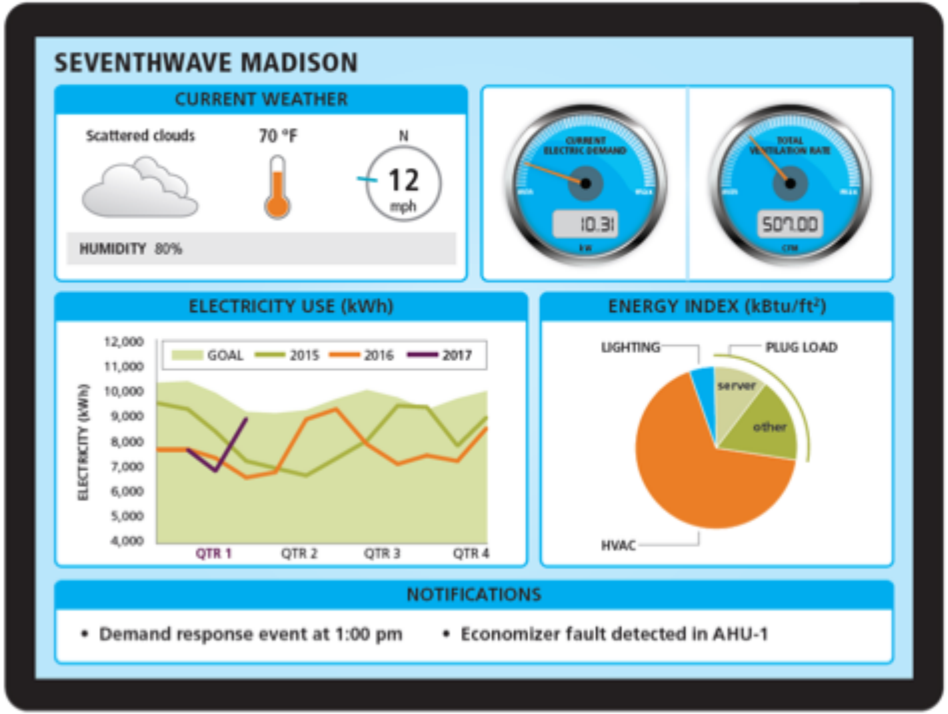
Gas savings: 0.10 therm/ft^2

Cost savings: \$0.12/ft^2

Barriers: cost, distribution

Measure life: 15 years

Advanced Energy Information Systems



Electricity savings: 0.47 kWh/ft^2

Gas savings: 0.03 therm/ft^2

Cost savings: \$0.07/ft^2

2017 Simple payback: 4 years

Barriers: training, IT barriers

Measure life: 7 years

LED Retrofit with Integrated Lighting Controls

Photo courtesy of Cree

Electricity savings: 0.89 kWh/ft^2

Cost savings: $0.08/$ft^2$

2017 Simple payback: 10 years

Barriers: cost

Measure life: 15 years

Networked Home Automation

Electricity savings: 0.15 kWh/ft^2

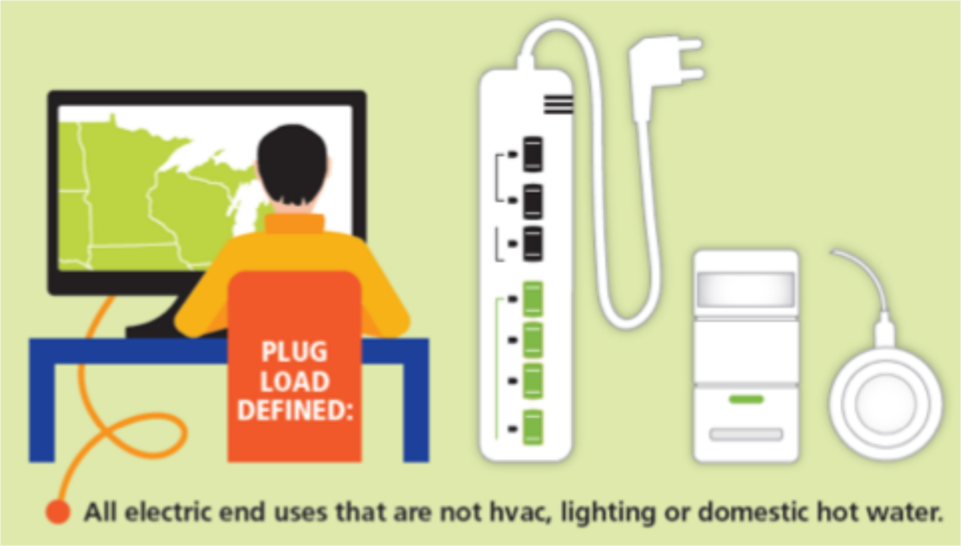
Cost savings: \$0.02/ft^2

2017 Simple payback: 7 years

Barriers: complexity, training

Measure life: 8 years

Advanced Power Strips



Electricity savings: 0.12 kWh/ft^2

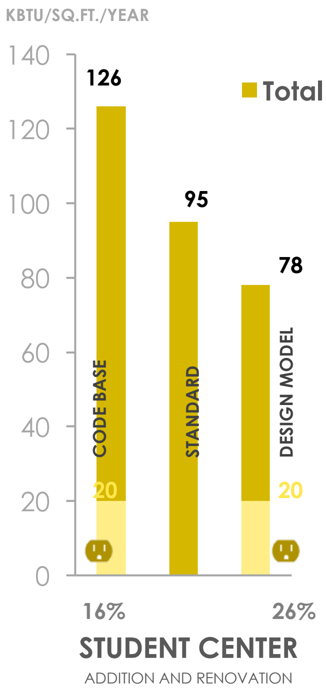
Cost savings: $0.01/$ft^2$

2017 Simple payback: 3 years

Barriers: IT pushback; persistence

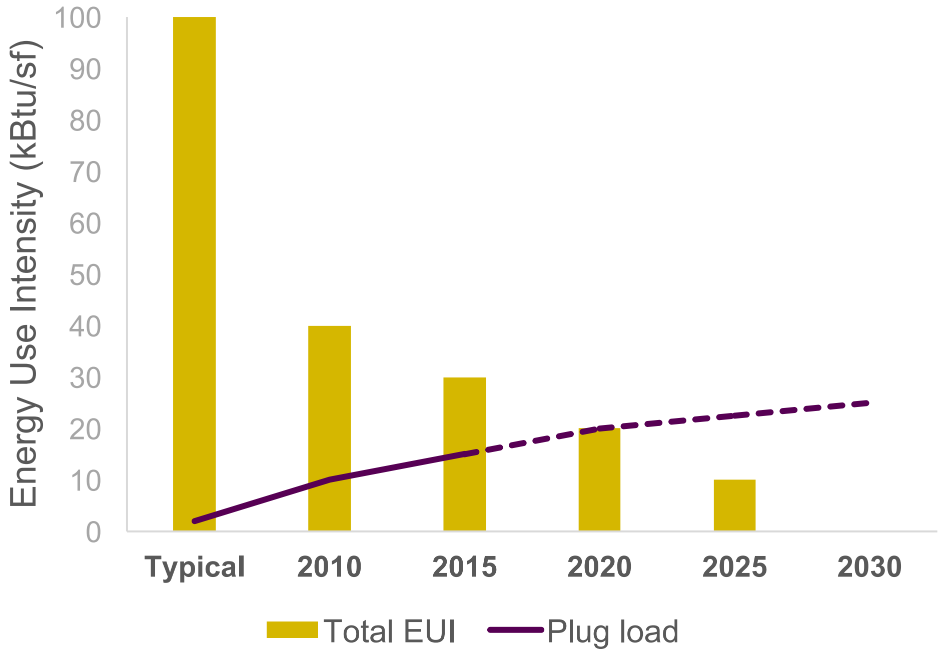
Measure life: 4 years

WHAT IS A PLUG LOAD?



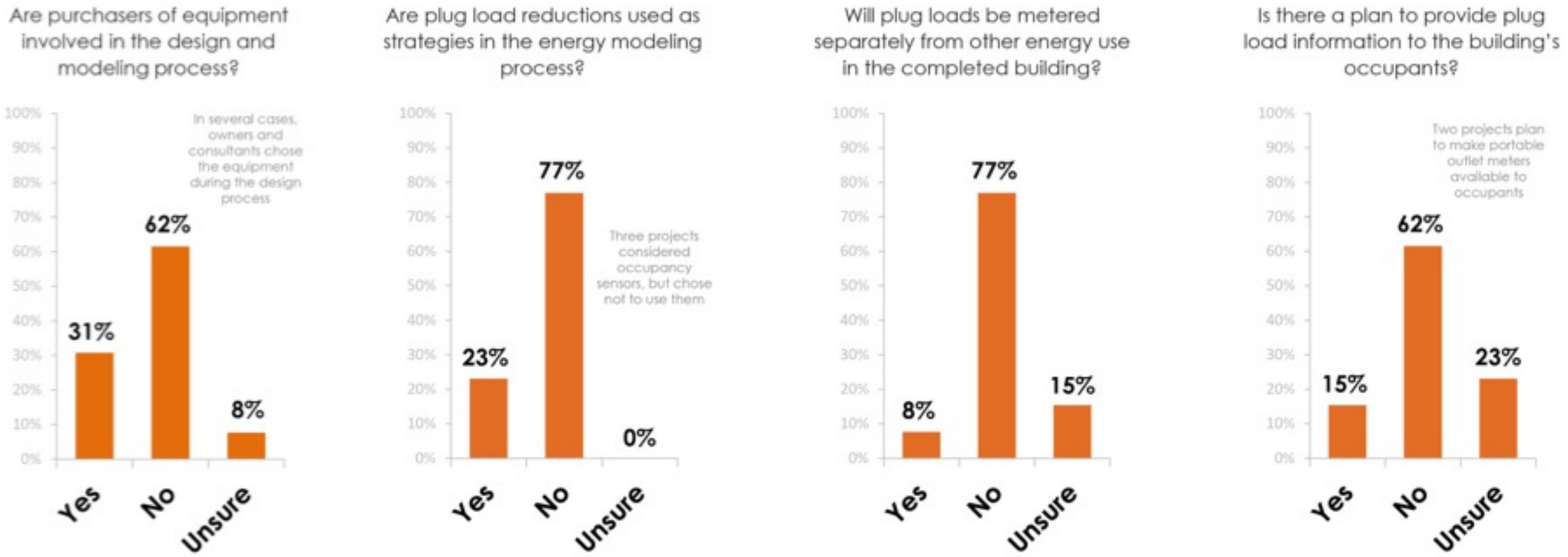
All energy consumed by appliances, office equipment, and anything else that is not a part of the facility's primary HVAC, lighting, water heating or conveyance (elevators, escalators, etc.) systems. This includes just about anything that is actually plugged into an outlet.

WHAT’S THE PROBLEM?



While plug loads are increasing, overall energy use intensity needs to decrease.

HISTORIC APPROACH TO PLUG LOADS



MINNESOTA ENERGY CODE

ASHRAE 90.1-2010 Prescriptive Path requires 50% of electrical outlets in offices and computer classrooms must be on automatic control so they can be switched off when the room is unoccupied

RESEARCH STUDIES

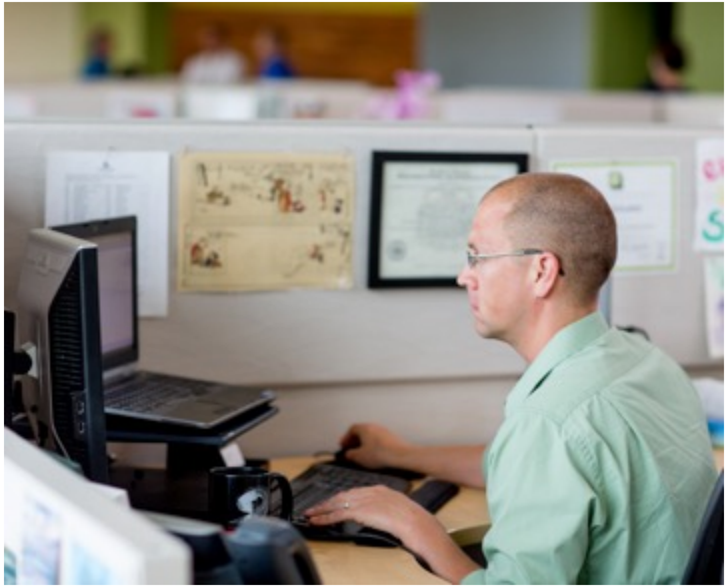
- Impacts of Office Plug Load Reduction Strategies | October 2016
- Small Embedded Data Center Program Pilot | June 2017
- Using Network Switches to Operate and Control Lighting and Plug Loads in Commercial Building | October 2020

PLUG LOAD REDUCTIONS

This project was supported in part by:

Minnesota Conservation Applied Research and Development (CARD) Grant

MINNESOTA DEPARTMENT OF COMMERCE
DIVISION OF ENERGY RESOURCES



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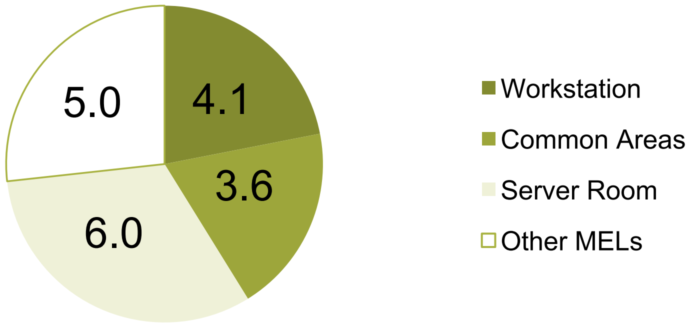
CREDIT: Samsung

PLUG LOAD ENERGY IN A TYPICAL OFFICE

CONTROLLABLE PLUG LOADS

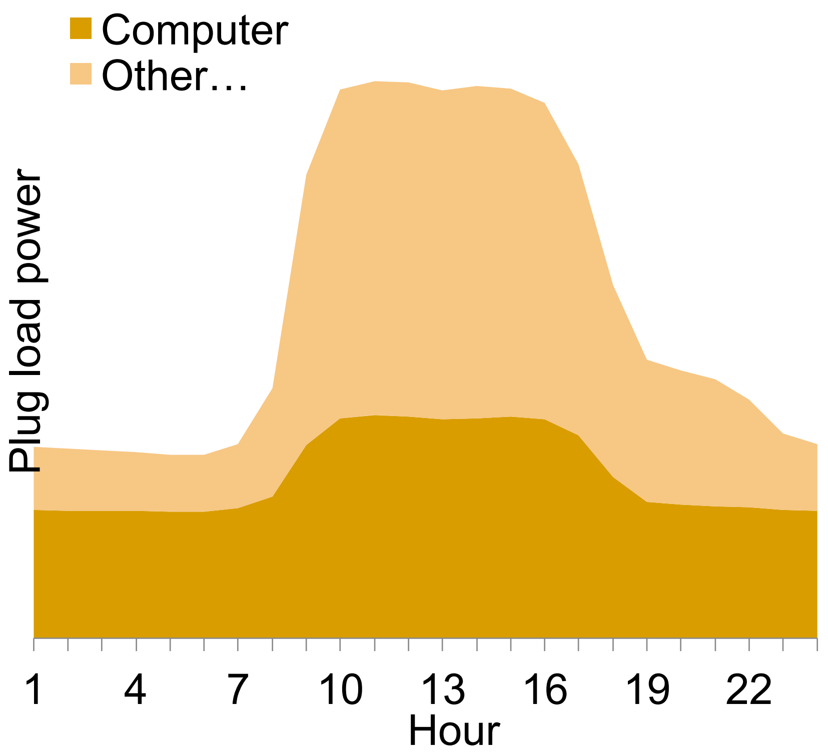
- Over 40% of typical office plug load is controllable
- Workstations make up 53% of controllable load
- Common area is the rest
  - Office equipment 30%
  - Break room 16%

Plug Load EUI ≈ 19 kBtu/sq.ft.

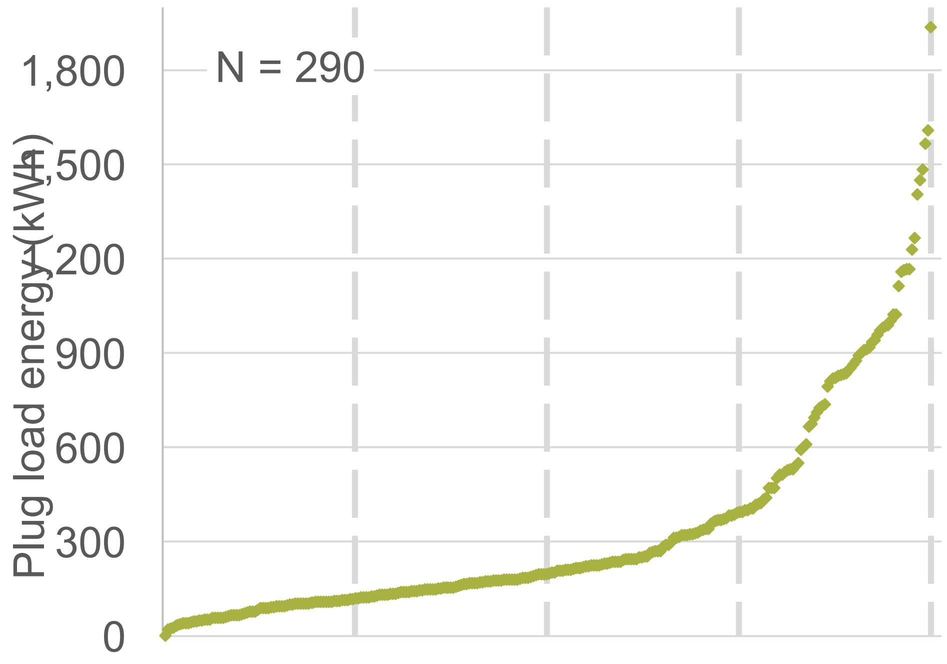


TYPICAL LOADS

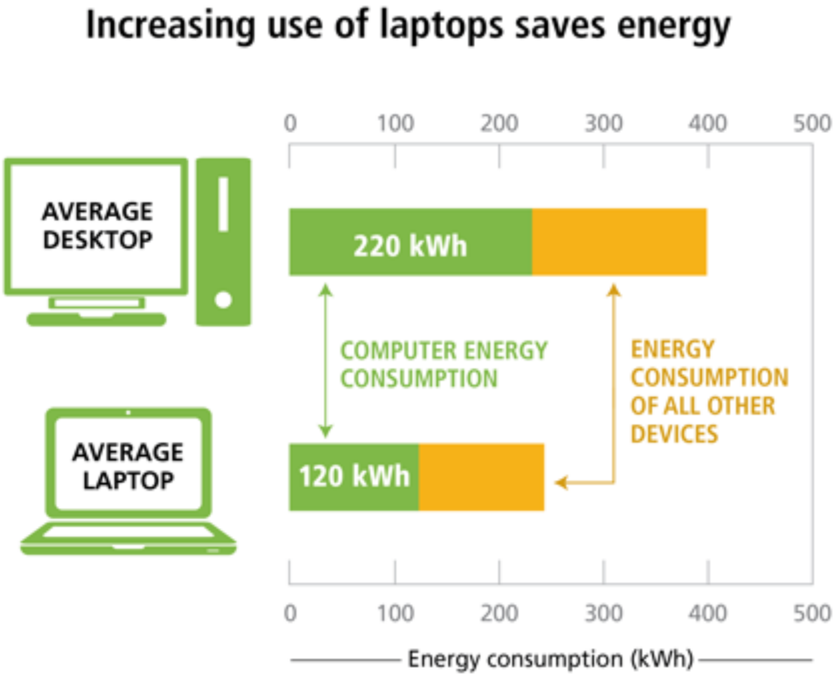
By day…



…and for the year.



TYPICAL LOADS - TRENDS



ENERGY SAVING STRATEGIES

Advanced power strips:

- APS – Occupancy sensor
- APS – Foot pedal

Computer power management

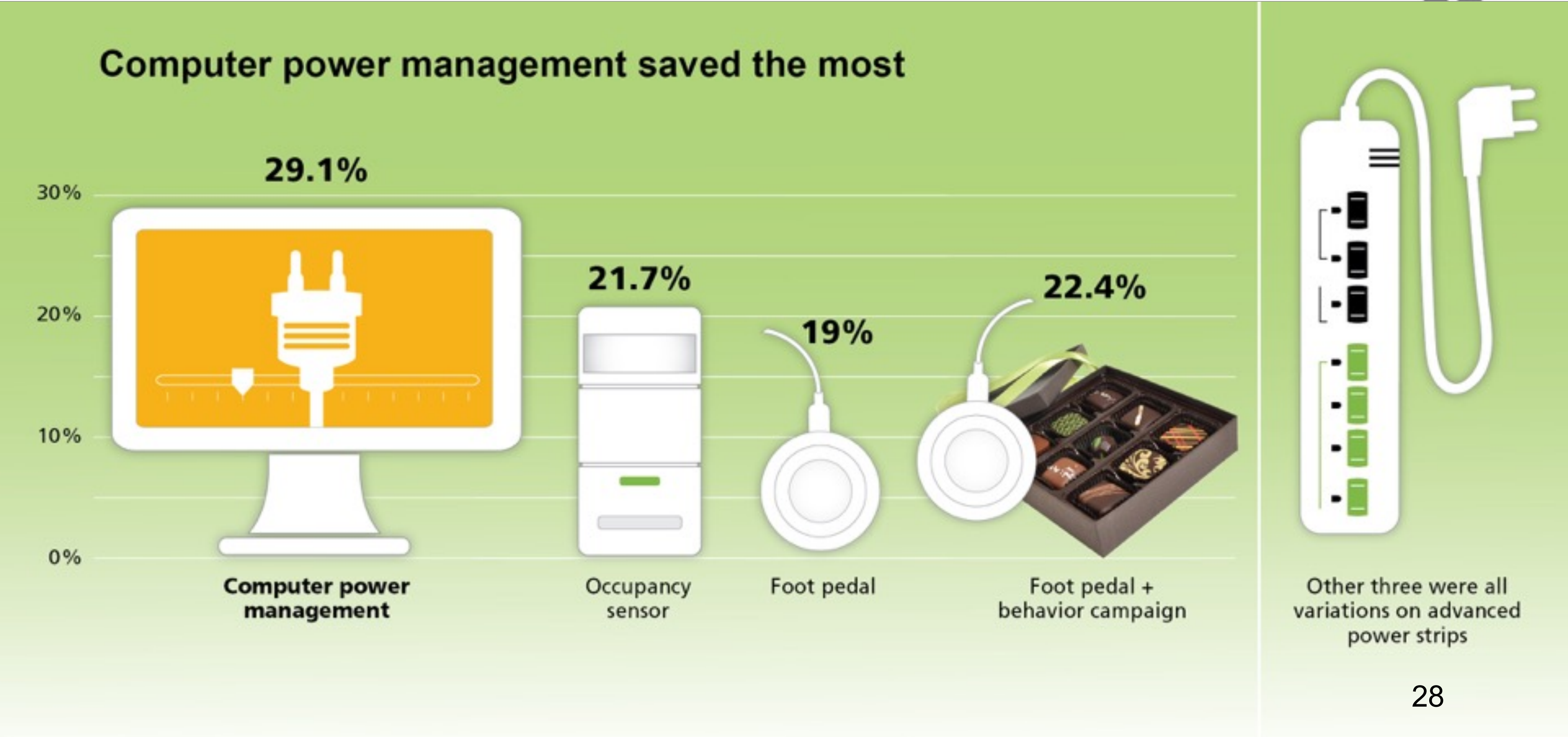
Behavior campaign + APS

Common area equipment: Basic timer

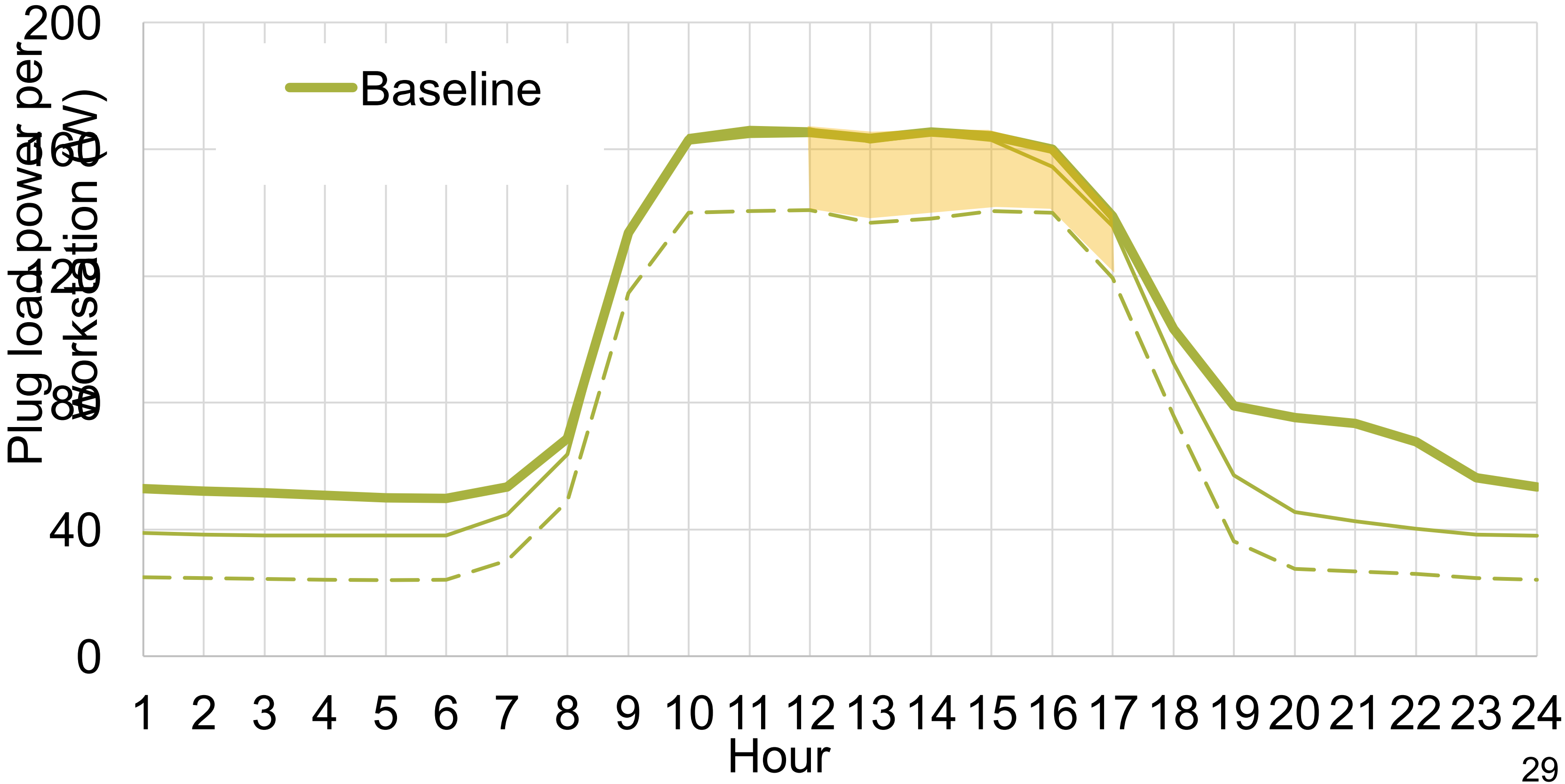
ENERGY STAR recommendations

CREDIT: Tricklestar

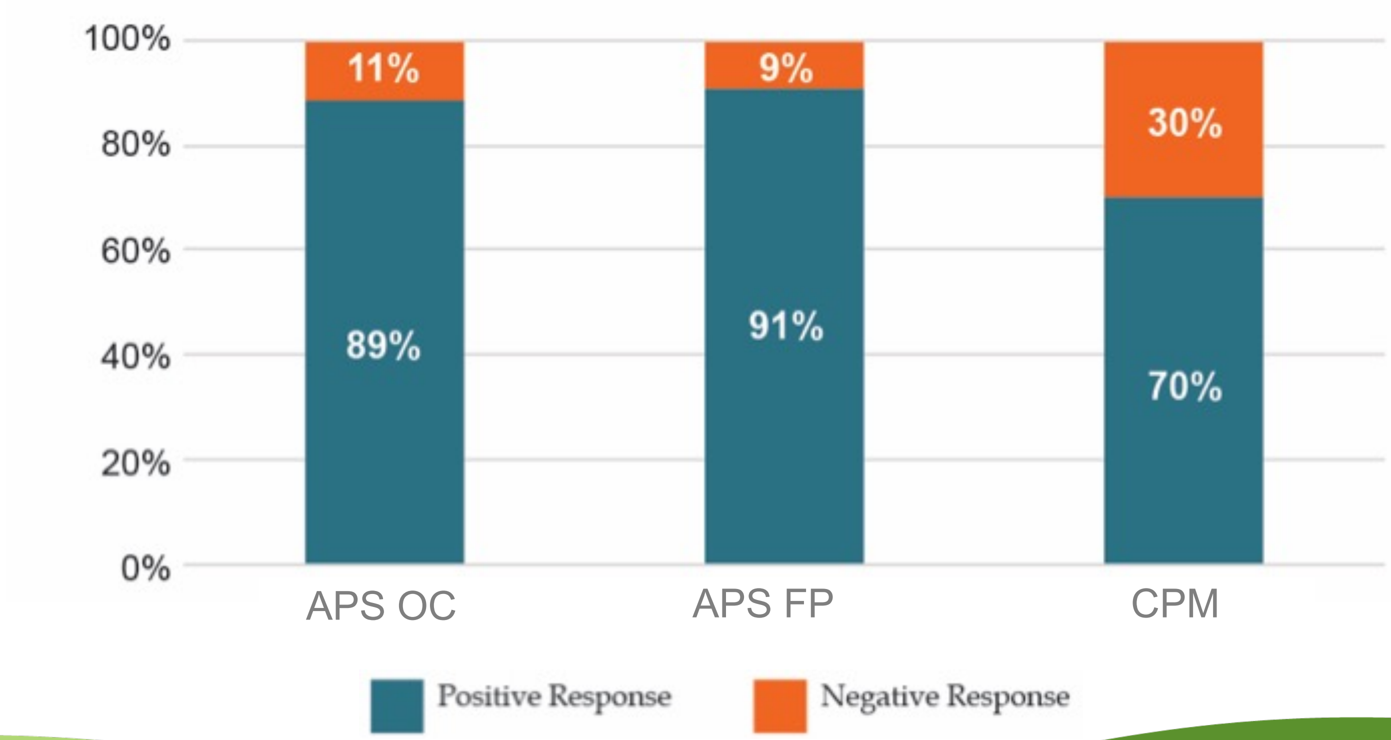
WORKSTATION SAVINGS



PEAK DEMAND IMPACT



PARTICIPANT FEEDBACK



COMMON AREA EQUIPMENT

Evaluate needs!

	Annual energy usage
	kWh
Desktop printers	170
Medium-sized MFDs	352
Coffeemakers	548
Televisions	67
Water coolers	386

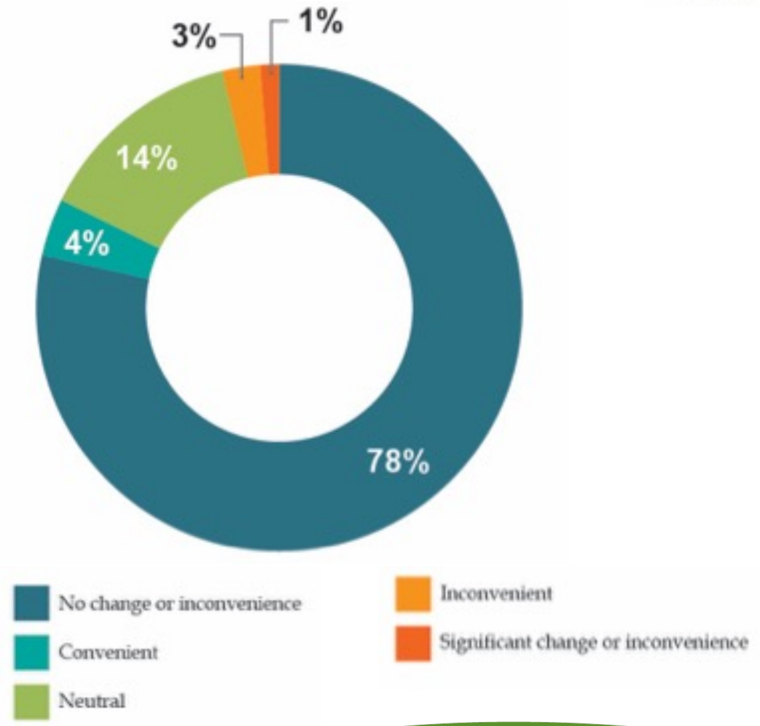
PHOTO CREDIT: Wikimedia commons

PARTICIPANT FEEDBACK

Common area equipment timers:

96% of respondents indicated that they did not notice any change/inconvenience

Most issues were related to equipment that is not designed for hard shutdown (MFDs, video conferencing equipment, etc.)



BEHAVIOR CAMPAIGN + APS

CHECK THE CLOSET

PHOTO CREDIT: Samsung

KEY TAKE-AWAYS

- Though some loads are moving out of the workstation, significant savings remains
- Relatively simple solutions are available to save 30% or more
- Energy efficiency advocates should make an ally in IT
- There is value in discussing behavior
- There is value in targeting plug load during design

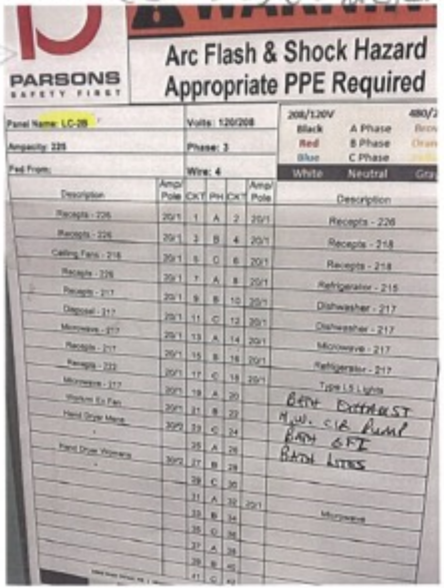
PLUG LOAD CASE STUDY
LHB OFFICE

PROCESS

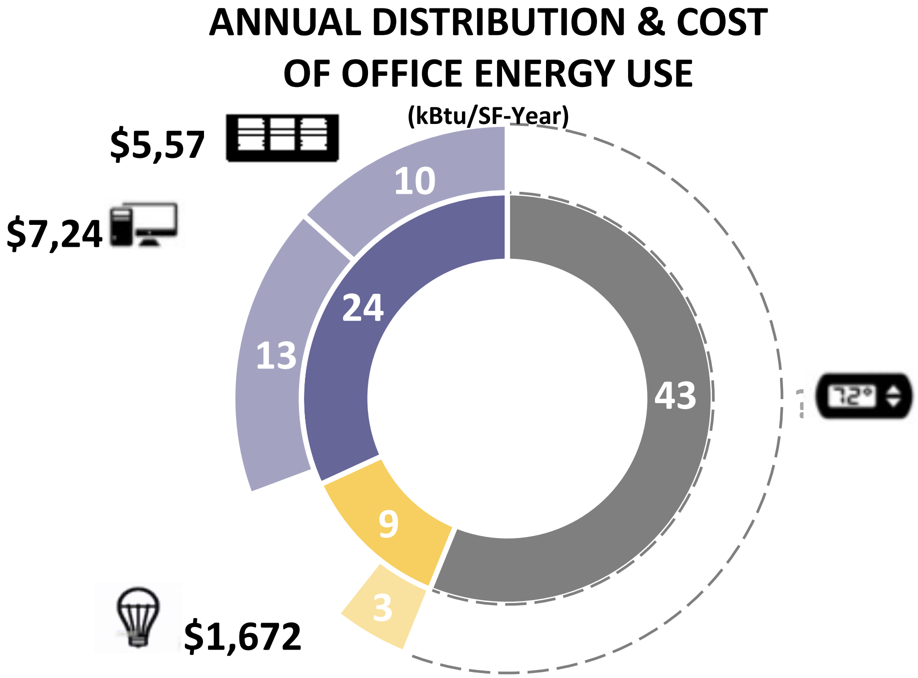
- Create an Energy Management Team
- Submeter plug loads to create a baseline
- Set goals
- Take action and record as “Events” in B3 Benchmarking
- Track results

SUBMETERS

(LC-2A) FURNITURE PLUG LOADS (LC-2B) (SHARE METER)



BASELINE



NATIONAL AVERAGE

77 EUI

AVERAGE OFFICE (CBECS 2012)

ELECTRIC EUI 33

LHB-MSP OFFICE (2016)

ELECTRIC EUI 27

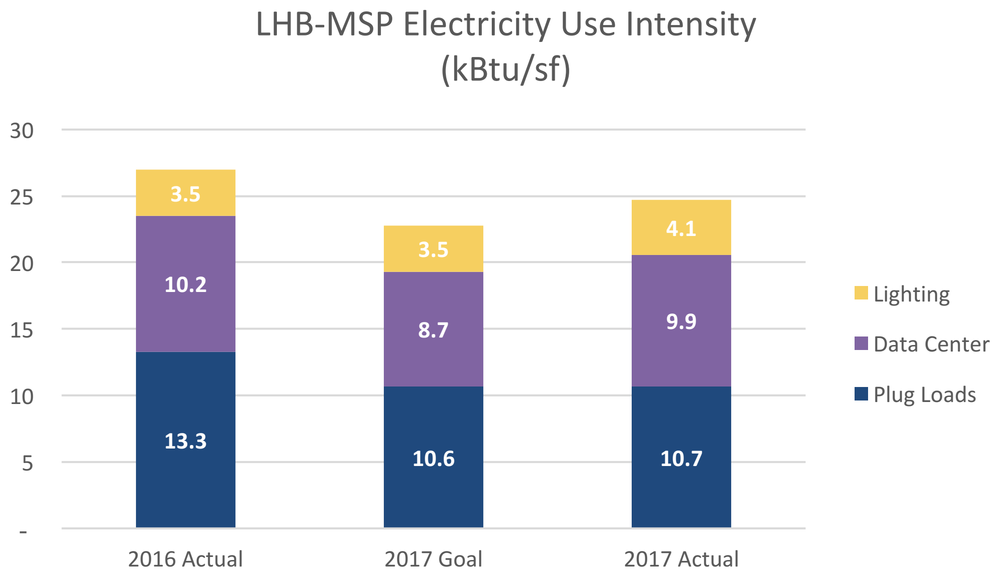
LHB-MSP Energy Update - January 2017

GOALS

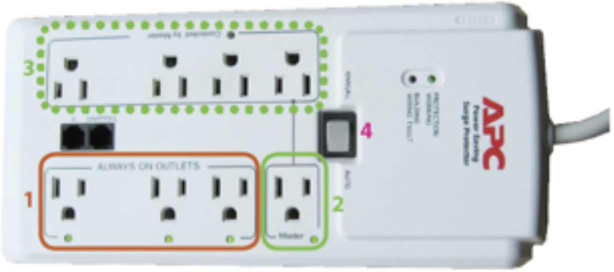
Data Center:
15% reduction

Plug loads:
20% reduction

Total Electricity:
16% reduction



ACTIONS



1. ALWAYS ON OUTLETS
Plug anything that must remain on at all times into these outlets
(Optional: CPU if you use remote desktop, headsets)

2. MASTER
Select one device at your desk to be a control. Plug this control device into the "Master" outlet.
When you turn this device off, power to the "Controlled" outlets will be turned off.
(If you use your computer when you do a "shut down" at the end of the day everything else will turn off. This device could also be your primary monitor)

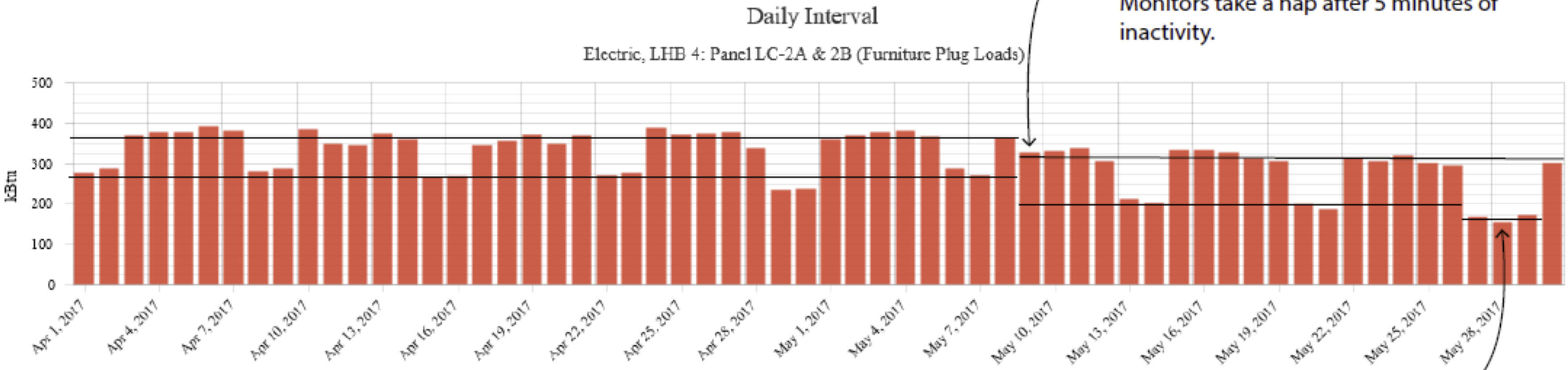
3. CONTROLLED BY MASTER
Plug anything that can be powered down in the "Controlled" outlets. When you shut down your control, or "Master" device, power to these outlets will be cut off. Think of it as "hitting the switch" on a typical power strip.
(phone chargers, computer monitors, etc.)
NOTE: DO NOT PLUG YOUR COMPUTER TOWER INTO THE CONTROLLED OUTLETS

4. SWITCH
Flip the switch to "Auto" to enable the advanced power control in your smart power strip.

- Computer power management
- Advanced power strips
- Behavior campaign
  - Updates at staff meeting
  - Education on use of advanced power strips
  - Feedback meters
  - Outreach prior to holiday weekends

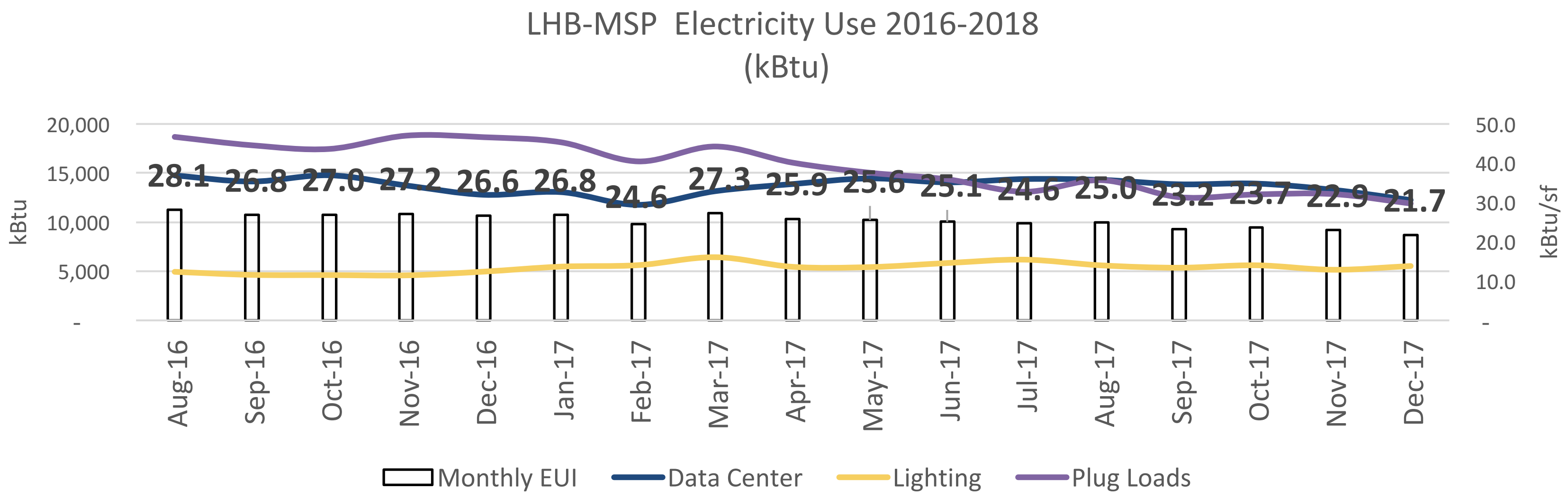
RESULTS

IT implements first phase of computer power management (CPM):
Monitors take a nap after 5 minutes of inactivity.



People turned off their computers over the Memorial Day long weekend!

RESULTS



19.8% reduction in plug loads

FOR MORE INFORMATION

Control guidance:

- Computer power management: ENERGY STAR Low Carbon IT Campaign
- Advanced power strips: Better Buildings: Myth Busting Market Barriers to APS

Design: Lobato et al, 2011

Plug load management: NBI: Plug Load Best Practices Guide

Guidance for researchers: Lanzisera et al, 2013

NEED MORE DETAIL?

Duluth Energy Conference

Advancing the Last Frontier – Reduction of Commercial Plug Loads

1:00 – 2:30 | Feb 20, 2018 | French River Room

Download the study

See a fact sheet and the full report: seventhwave.org/commercial-plug-load-study

Contact us:

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Chris Plum, Center for Energy and Environment, cplum@mncee.org

Residential Cold Climate Ductless Heat Pump

(above) Photo credit: Zia Fang, http://images.nrel.gov/viewphoto.php?imageId=6309977
(inset) Photo credit: Seventhwave

Electricity savings: 2.47 kWh/ft^2

Cost savings: \$0.32/ft^2

2017 Simple payback: 15 years

Barriers: cost, stigma?

Measure life: 18 years

LED T8 Lamp Replacement

Photo courtesy of Cree

Electricity savings: 0.48 kWh/ft^2

Cost savings: \$0.04/ft^2

2017 Simple payback: 10 years

Barriers: light quality

Measure life: 16 years

Cold Climate Variable Refrigerant Flow

Electricity savings: 1.42 kWh/ft^2

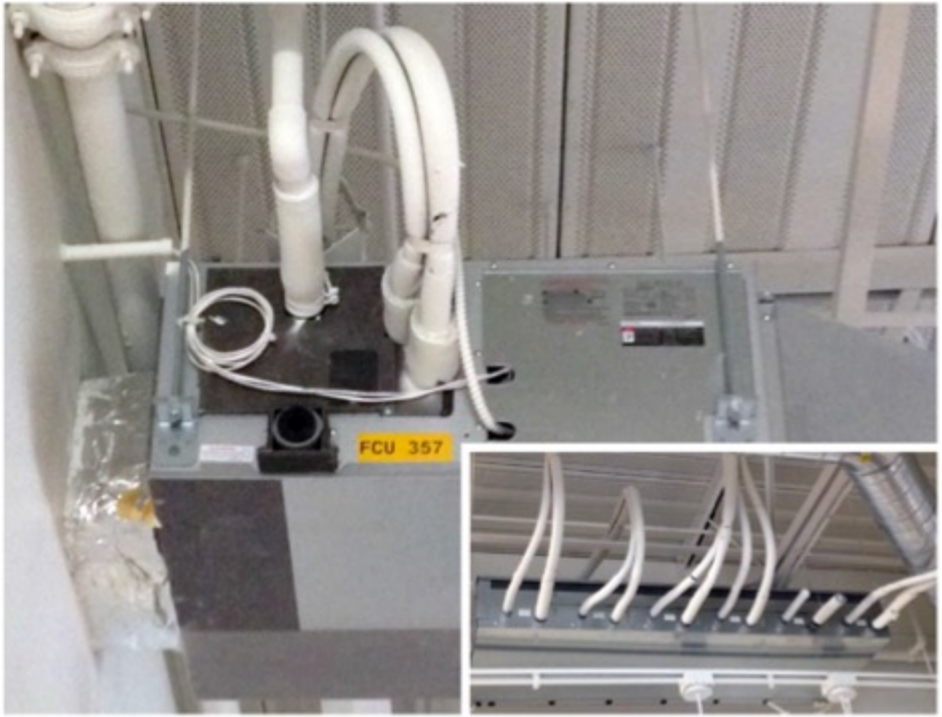
Cost savings: \$0.12/ft^2

2017 Simple payback: 10 years

Barriers: cost

Measure life: 15 years

Commercial Ductless Heat Pump / VRF



(above and inset) Photo credit: Seventhwave

Electricity savings: 1.42 kWh/ft^2

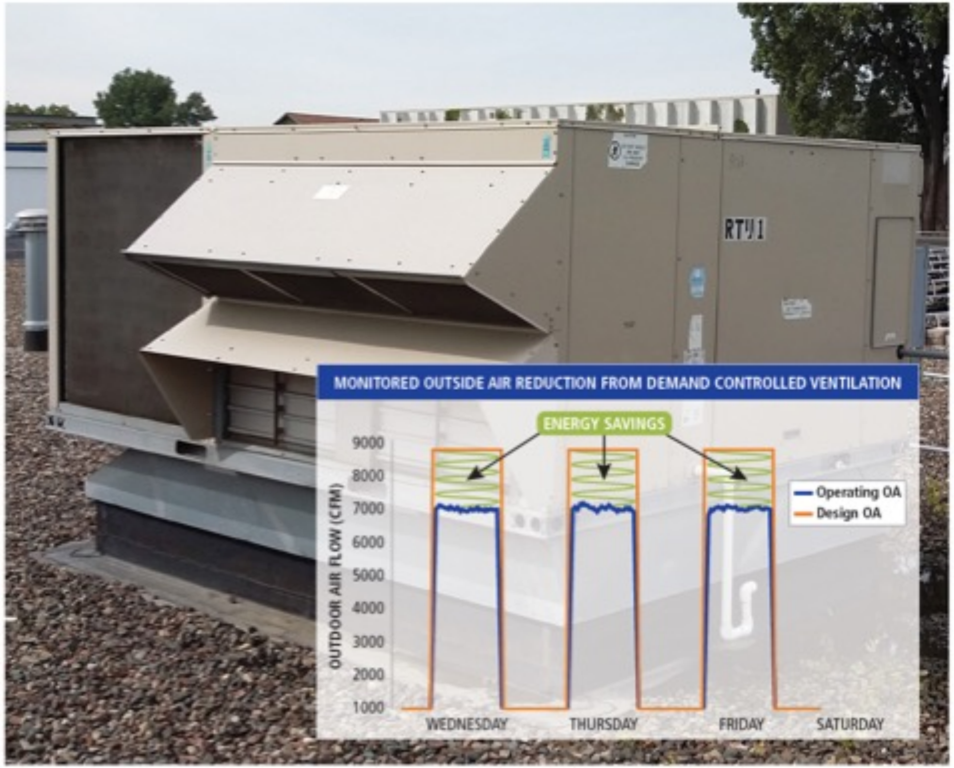
Cost savings: $0.12/ft^2

2017 Simple payback: 10 years

Barriers: low gas prices

Measure life: 15 years

Advanced Rooftop Unit Controls



Electricity savings: 1.55 kWh/ft2
Gas savings: 0.14 therm/ft2

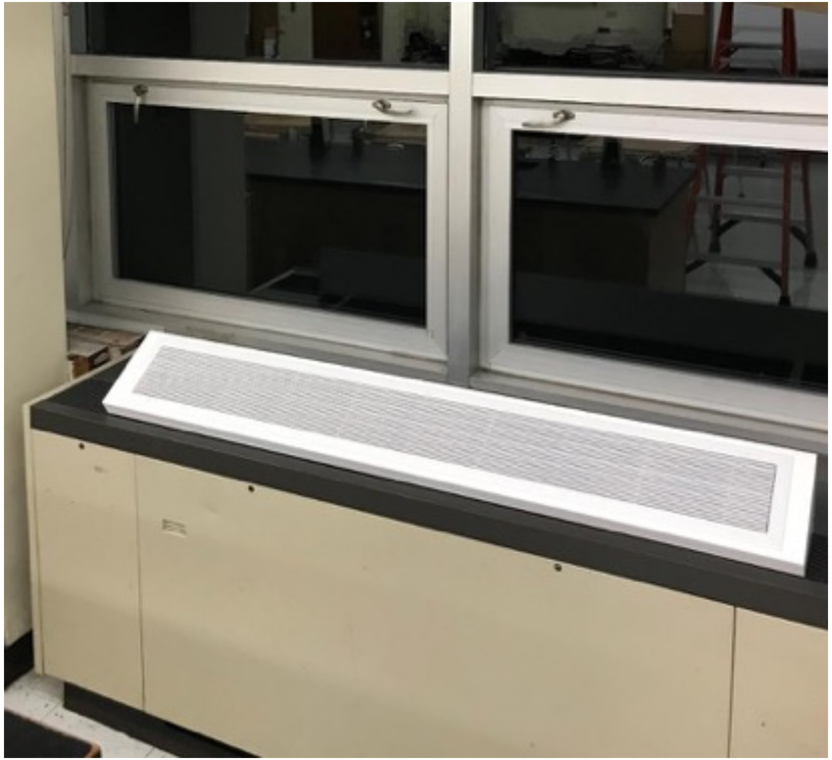
Cost savings: $0.24/ft2

2017 Simple payback: 3 years

Barriers: trade ally training, scale

Measure life: 25 years

Ventilator Exhaust Economizer Box (VEEbox)



Unit ventilators in areas of high density often heat, cool, vent.

Retrofit passive air distribution box helps eliminate stratification.

10%-15% savings being field validated with 30 sensors

$400 cost, 3 year payback

Measure life: 20 years

Hybrid Boiler Plant Design

Both condensing and non-condensing boilers

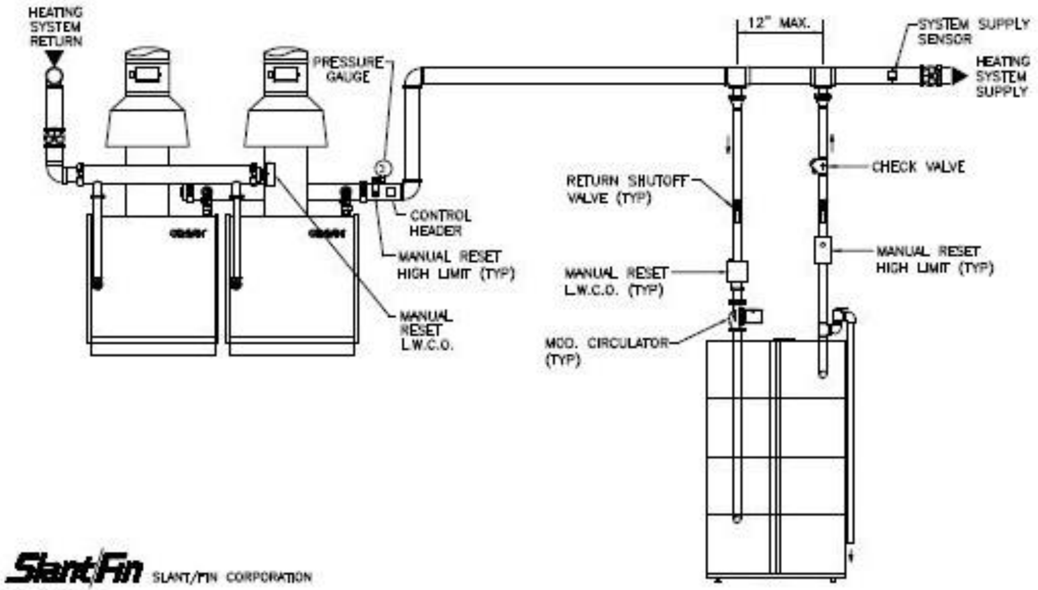


FIGURE 19
HYBRID CONDENSING / NON-CONDENSING

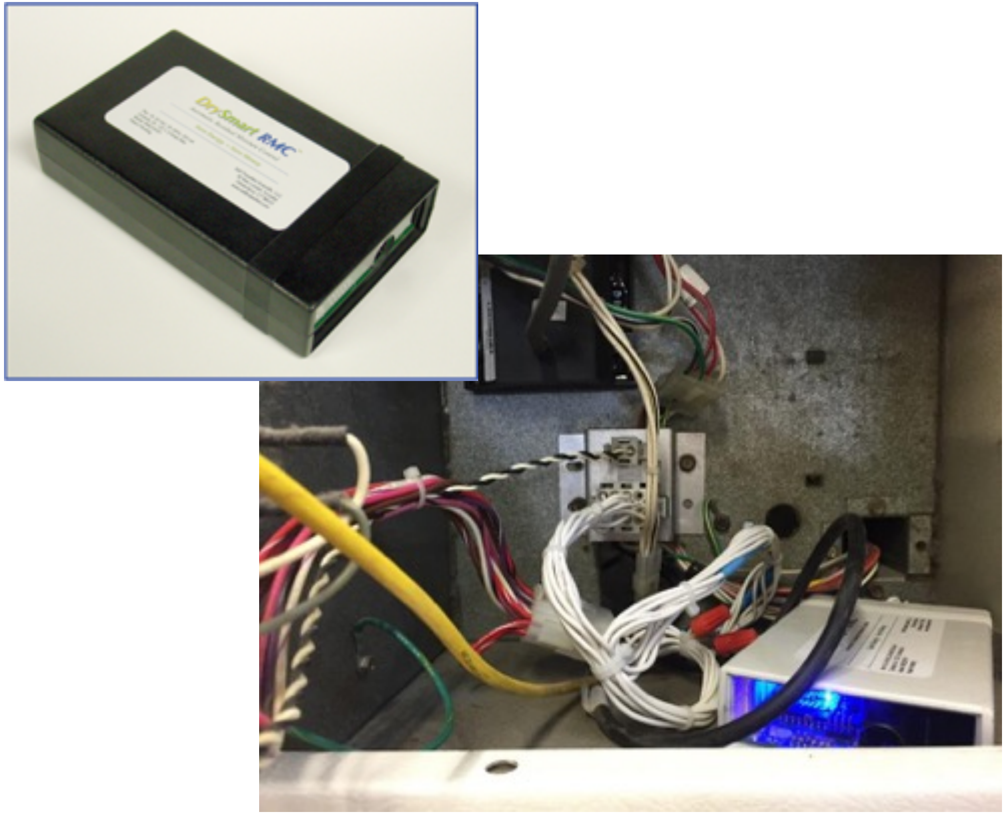
"Best of both worlds"
Condensing boiler used down to 32 degree air (<130F RWT), non-condensing for higher loads (<160F RWT)

Reduced boiler cycling and increased thermal efficiency

18-20% energy savings

4-7 year payback

Commercial Dryer Retrofit: Moisture Sensors



Determine when the load is dry and shut off the dryer before additional energy is used.

Few commercial dryers include

Easy installation, but not on mechanical timer dryers

21.7% savings field validated with sites in MN and IL

$200-500 cost, 3 year payback

Commercial Dryer Retrofit: Modulating Gas Valve

Two-stage modulating gas valve, temperature sensor, control unit

Programmable design provides maximum flexibility & savings

No manufacturer temperature or safety controls are ever by-passed

13% savings field validated with sites in MN and IL

$525 cost, 2-5 year payback depending on usage

Natural Gas Standby & Emergency Power

Resiliency

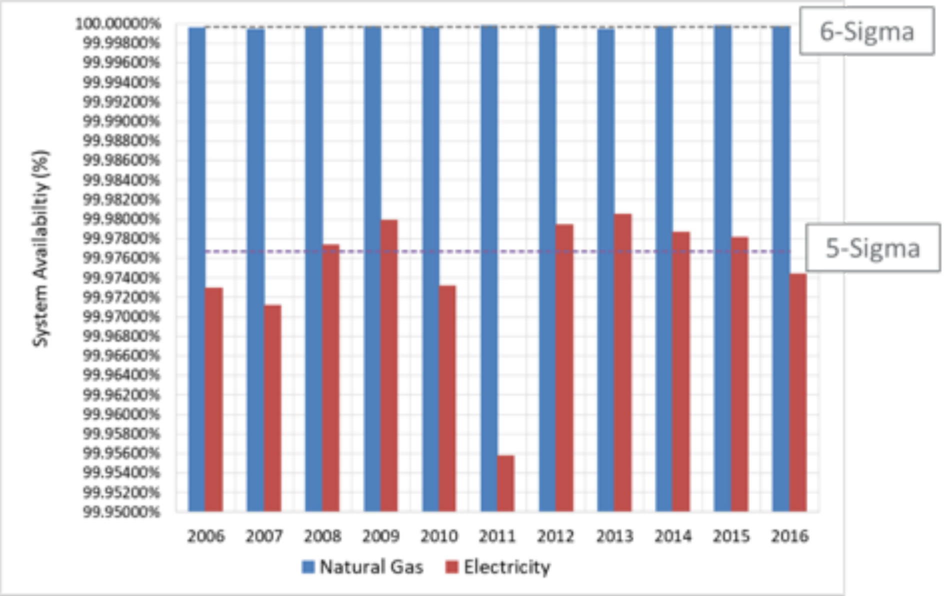
Using natural gas for demand response or diesel backup

Working with NFPA 70, AHJs, and DOD to permit pipeline natural gas as alternative to requirements for onsite diesel storage.

For more information:
http://www.generac.com/Industrial/all-about/natural-gas-fuel
http://www.generac.com/Industrial/all-about/natural-gas-fuel/natural-gas-performance

Resiliency of Natural Gas and Electric Systems

Reliability, Availability, Outage Rates



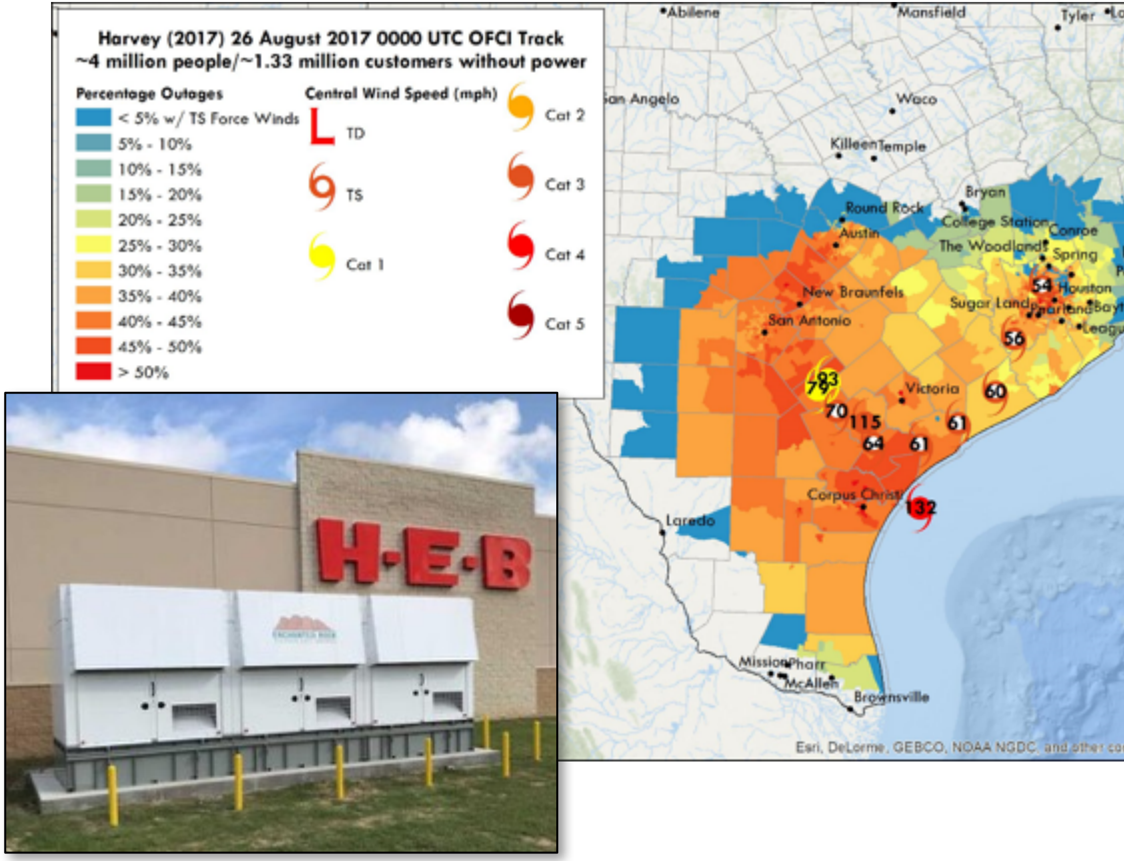
Example annual results for major California electric utility (SCE) and North American gas utility (over 15 billion customer hours/year)

“Islands” of Power after a Natural Disaster

“Microgrid System Keeps Houston Grocery Stores Open in Wake of Harvey”

Aug 29, 2017 Power Magazine

- 18 H-E-B grocery stores remained open after Hurricane Harvey flooding knocked out power in surrounding areas for days.
- Natural gas underground pipeline used as “off-site battery”.
- One store used to house first responders, as it was the only nearby facility with power.



Combined Heat and Power (CHP)

Replaces DHW, genset, and HP

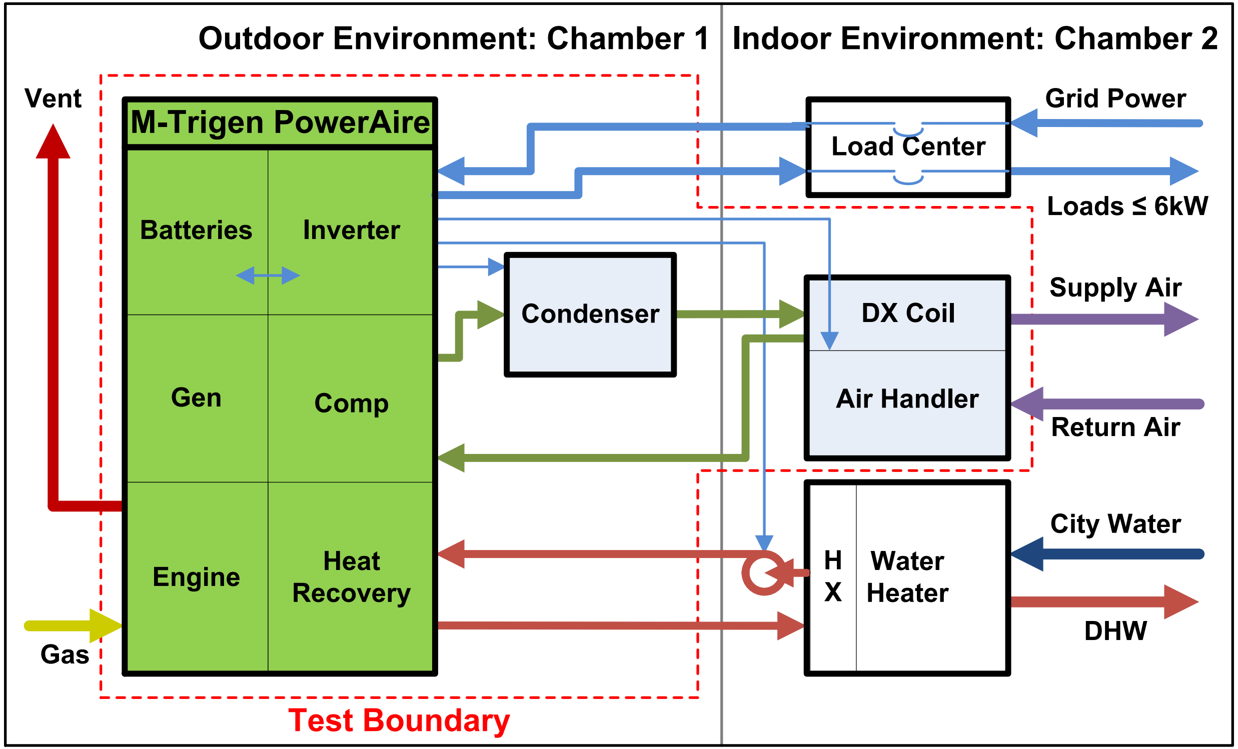
Self-powered HVAC/DHW
including HP, AHU, DHW

6kW / 5 tons / 68,000 BTUH
10kW / 15 tons / 132,000 BTUH

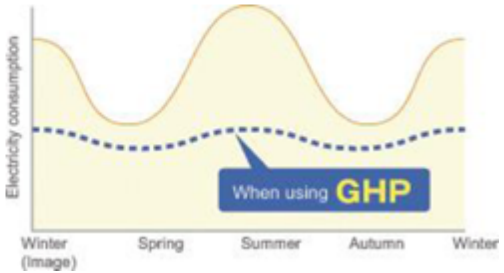
Peak demand strategy or
Microgrid component

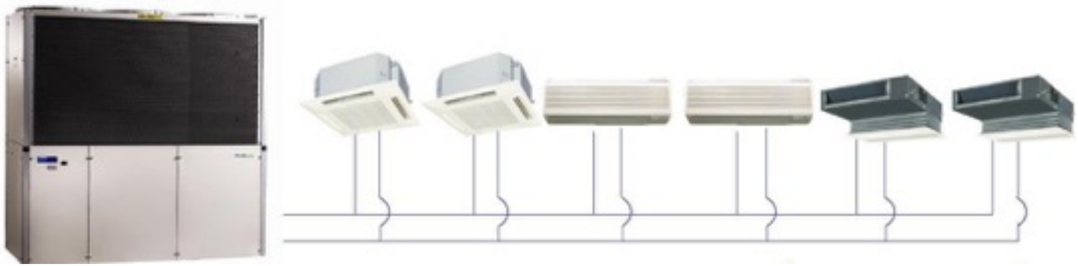
Economic benefits are site-specific
Natural gas or propane

System Block Diagram (6kW Unit)



Natural Gas Engine Heat Pumps (GEHP)





GEHP employ similar technology to ASHP; same Daikin VRF fan coils.

Engine heat recovery increases heating capacity at low temps (cold climates)

Peak electric demand reduction (up to 50%)

Lower energy costs; lifecycle cost savings

Some utilities offer $1,500 per ton

Discussion

Thank you

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