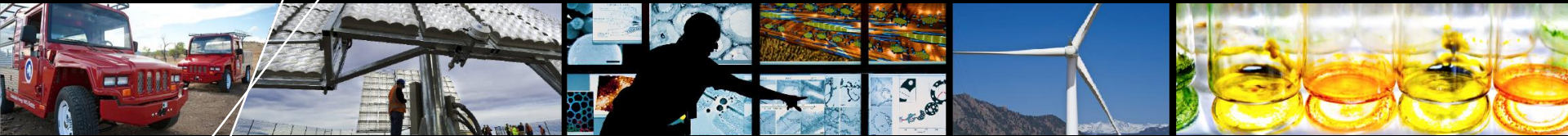


# The Past, Present, and Future of Plug Load Strategies



**Rois Langner**

*Buildings & Thermal Systems Center*

**National Renewable Energy Laboratory**

**ACEEE National Symposium for  
Market Transformation**

**March 21, 2016**

# Agenda

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- Introduction
- Controlling Plug Loads in Commercial Buildings
  - What can we do now?
  - How to get tenant buy-in?
  - What's coming next?
- Summary

# DOE's Better Buildings Alliance



Members work with the U.S. Department of Energy's (DOE's) network of research and technical experts to develop and deploy innovative, cost-effective, energy savings solutions.

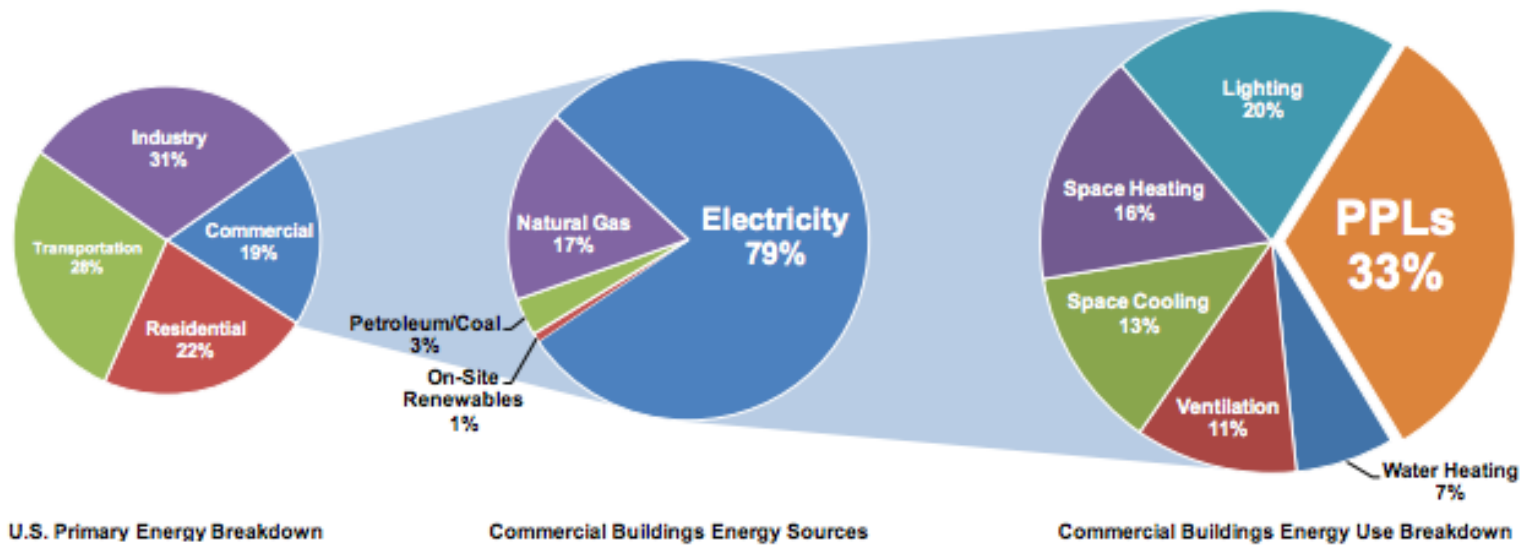


Figure 1. PPLs account for 33% of the total energy consumed by commercial buildings. Graph by Chad Lobato, NREL; Data source: DOE (2010)

# BBA PPL Membership

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

EERE Home | Programs & Offices | Consumer Information



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## BETTER BUILDINGS ALLIANCE

Sectors

Activities

Events

About

Join

Owners and Operators

Affiliates

HOME » TECHNOLOGY SOLUTIONS TEAMS » PLUG & PROCESS LOADS

### Activities

#### Technology Solutions Teams

Lighting & Electrical

Space Conditioning

[Plug & Process Loads](#)

Food Service

Refrigeration

### Plug & Process Loads

Plug and Process Loads (PPL) consume about one third of primary energy in U.S. commercial buildings. PPLs cover a wide variety of electronic, computer, refrigeration, and cooking devices, including equipment essential to information processing, medical treatment, and food service businesses. Each of these categories contains hundreds of types of devices.

PPLs account for an increasingly large percentage of commercial building energy use. The primary energy use associated with PPLs is projected to grow from 30% to 35% of total commercial building energy use between 2010 and 2025, due to an increase in the number of plug-in devices and the energy intensity of those devices. Due to the wide range of commercial building types, uses, sizes, and vintages found in the United States, PPL

<https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads>

# Why Plug & Process Loads (PPLs)?

**PPLs account for an increasingly large percentage of a building's energy use**

Reduce PPL energy use by:

- Assessing PPL energy consumption
- Selecting appropriate control strategies
- Exploring efficient PPL design solutions
- Identifying utility incentives
- Institutionalizing policies and procedures for PPL energy reduction



**Figure 5.** Diagram of an example low-energy workstation.  
*Illustration by Matthew Luckwitz, NREL*

# Available PPL Resources

- Fact Sheets
- Technical Reports
- Presentations
- Case Studies
- Technical Specifications
- How-To Graphics
- List of Utility Incentives

**ADVANCED POWER STRIPS (APS)**  
**HOW TO USE IN AN OFFICE SETTING**

Each APS has three outlet types for equipment with various electricity needs:

- Primary Outlet**  
COMPUTER, LAPTOP  
The primary outlet acts as the "control" or "master" outlet because it turns off the power to secondary outlets when the device connected to it is turned off. The primary outlet typically powers your computer's central processing unit because most other devices connected to the power strip at an office desk depend on your computer for their functionality. For example, you need to turn on your computer to use your monitor and to print documents.
- Secondary Outlet**  
MONITOR, PRINTER, DESK LAMP  
The secondary outlets act as the "controlled" outlets and typically power peripheral devices, such as your computer monitor(s), desk lamp, and printer. When the device connected to the primary outlet is turned off, the power will automatically be shut off to the device connected to the secondary outlets. For example, turning off your computer automatically shuts off the power to your monitor or printer. The amount of energy you save with an advanced power strip depends on the energy usage of the devices connected to the secondary outlets.
- Always-On Outlet**  
LANDLINE PHONE, FAX, MINI FRIDGE  
The always-on outlets are not controlled by the primary outlet. Important office desk devices, such as landline phones and fax machines, that are plugged into the always-on outlet will receive constant power regardless of the primary outlet device.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

**DECISION GUIDE**

Healthcare Solutions

PRODUCT TYPE	Healthcare	Office	Retail	Manufacturing	Commercial	Government	Education	Healthcare
Advanced Power Strips (APS)	\$	SS	SS	SS	SS	SS	SS	SS
Upgrade Equipment with Low Energy or ENERGY STAR Certified Equipment	\$	SS	SS	SS	SS	SS	SS	SS
Use Built-In Low Power States	\$	SS	SS	SS	SS	SS	SS	SS
Design Strategies for Constructing Plug-and-Process Loads (PPLs)	\$	SS	SS	SS	SS	SS	SS	SS
Integrate PPL Controls with Other Building Systems	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS
Additional Submetering and Control Solutions	SSS	SSS	SSS	SSS	SSS	SSS	SSS	SSS

Click here to view the legend

**Available resources for PPL controls:**

- Healthcare Energy Audits Manual
- Healthcare Energy Audits Manual - Appendix A
- Advanced Energy Design Guide for Large Hospitals and Healthcare Facilities: Achieving 50% Energy Savings
- Advanced Energy Design Guide for Large Hospitals and Healthcare Facilities: Achieving 50% Energy Savings
- Advanced Energy Design Guide for Healthcare Facilities

Learn more at [energy.gov/betterbuildings](http://energy.gov/betterbuildings)

**Better Buildings**  
U.S. DEPARTMENT OF ENERGY

**Technical Specification for Advanced Power Strips**  
Version 1.0  
December 30, 2014

U.S. DEPARTMENT OF ENERGY

Strategies

Rooms and Kitchens

Vending Machines

Drinking Fountains

Phones

Figure 5. Diagram of an example low-energy workstation. Illustration by Matthew Luckwicz, NREL.

## Featured Publications:

- [Assessing and Reducing PPLs in Office and Retail Buildings](#)
- [Technical Specification for Advanced Power Strips](#)
- [How To Use Advanced Power Strips in an Office Setting](#)
- [Utility Incentives for Advanced Power Strips](#)
- [Decision Guides for PPL Controls](#)

**What can we do now?**

# PPL Solutions – What can we do now?

- Messaging, or Turn it Off! Campaigns
- Use Built-In Low Power States for Equipment
- Advanced Power Strips
- Upgrade Equipment with Low-Energy or ENERGY STAR<sup>®</sup>-Certified Equipment
- Design Strategies for Consolidating PPLs
- Integrated PPL Controls with Other Building Systems
- Submetering and Control Options



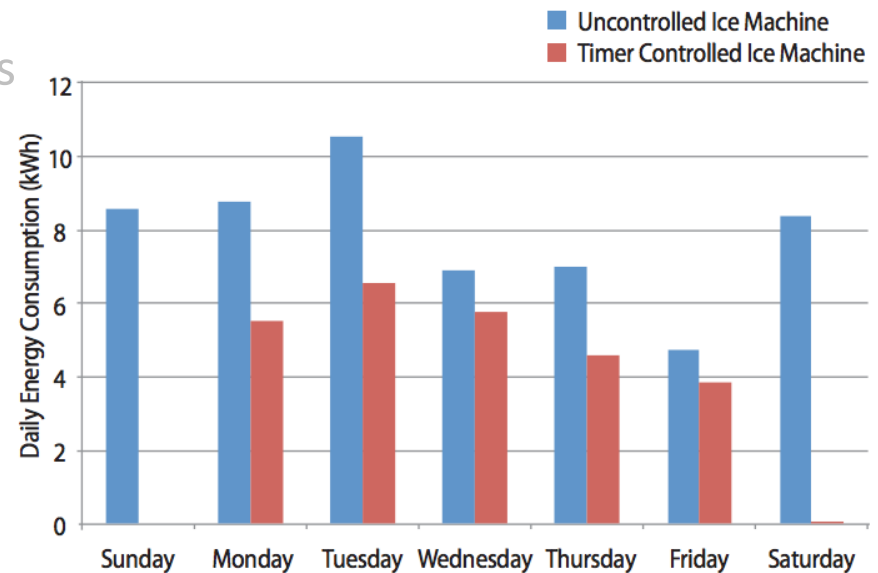
Illustration by Marjorie Schott, NREL





# Low Cost Solutions

- Messaging, or Turn it Off! Campaigns
- Use Built-In Low Power States for Equipment
- Advanced Power Strips
- Upgrade Equipment with Low-Energy or ENERGY STAR<sup>®</sup>-Certified Equipment
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**Figure 3.** Ice machine daily load profile. *Graph by Chad Lobato, NREL*

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- List of [Utility Incentives](#) for Advanced Power Strips



## Technical Specification for Advanced Power Strips

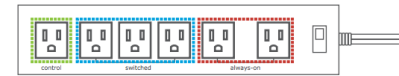
Version 1.0

December 30, 2014



### ADVANCED POWER STRIPS (APS)

#### HOW TO USE IN AN OFFICE SETTING



Each APS has three outlet types for equipment with various electricity needs:

 <b>Primary Outlet</b> COMPUTER/LAPTOP <p>The primary outlet acts as the "control" or "master" outlet because it turns off the power to secondary outlets when the device connected to it is turned off. The primary outlet typically powers your computer's central processing unit because most other devices connected to the power strip at an office desk depend on your computer for their functionality. For example, you need to turn on your computer to use your monitor and to print documents.</p>	 <b>Secondary Outlet</b> MONITOR, PRINTER, DESK LAMP <p>The secondary outlets act as the "controlled" outlets and typically power peripheral devices, such as your computer monitor(s), desk lamp, and printer. When the device connected to the primary outlet is turned off, the power will automatically be shut off to the device connected to the secondary outlets. For example, turning off your computer automatically shuts off the power to your monitor or printer. The amount of energy you save with an advanced power strip depends on the energy usage of the devices connected to the secondary outlets.</p>	 <b>Always-On Outlet</b> LANDLINE PHONE, FAX, MINI FRIDGE <p>The always-on outlets are not controlled by the primary outlet. Important office desk devices, such as landline phones and fax machines, that are plugged into the always-on outlet will receive constant power regardless of the primary outlet device.</p>
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Learn more about plug and process loads: [www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads](http://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads).

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Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

NREL/PD-5500-63800 • March 2015

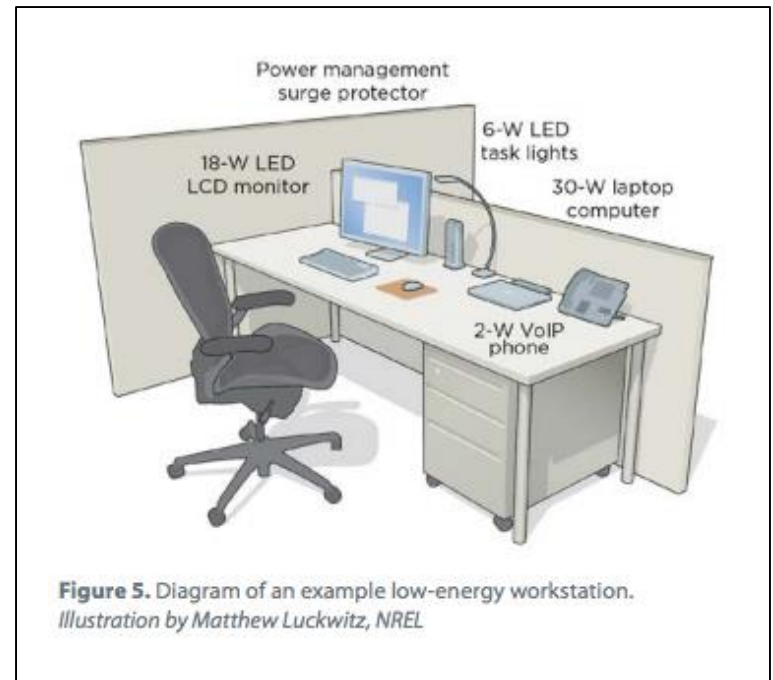
# GPG Plug Load Control Study

- **Opportunity:** 20-25% of building electricity consumption goes to plug loads.
- **What Was Done:** In 2012, NREL tested the effectiveness of three plug load reduction strategies in eight federal office buildings throughout GSA's Mid-Atlantic Region.
- **Technology:** Tested strategies included 1) schedule-based control, 2) load-sensing, and 3) a combination of the two. Schedule-based control was found to be most effective.
- **Energy Savings:** 26% energy reduction at workstations with advanced computer management already in place, 50% energy reduction in kitchens and printer rooms.
- **Cost-Effectiveness:** 2 year payback.
- **Available Online:** <http://gsa.gov/portal/content/164611>



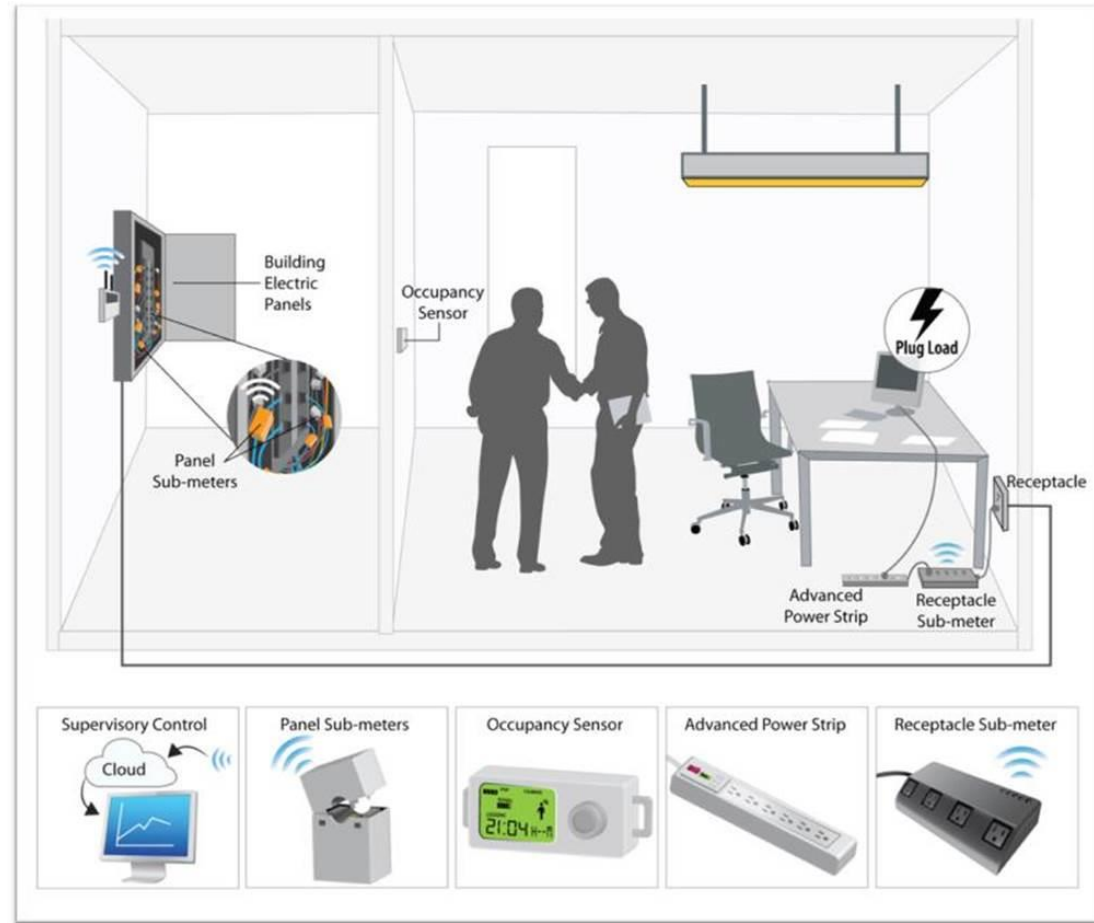
# Mid-High Cost Solutions

- Messaging, or Turn it Off! Campaigns
- Use Built-In Low Power States for Equipment
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- Integrated PPL Controls with Other Building Systems
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# Tenant Engagement

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**How to get tenant buy-in?**

# Tenant Engagement

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- Messaging, or Turn it Off!  
Campaigns
- Interactive dashboards
- Incentive programs
- Engagement activities

# Tenant Engagement

- Messaging, or Turn it Off! Campaigns
- Interactive dashboards
- Incentive programs
- Engagement activities



Page 2 of 2

### Flip the Switch: I Will if You Will

#### PLUG LOADS: FLIPPING THE SWITCH ON ENERGY WASTE

At Shorenstein, we are committed to reducing our environmental footprint. As corporate partners in the U.S. Department of Energy's Better Buildings Challenge, we pledged to cut energy use in our buildings 20% by 2020. We're over half way there, and we're hoping that you will join us to help reach this goal and Flip the Switch.

#### YOUR ACTIONS MATTER

- ◆ To a large extent, the way we use electric devices determines how much energy they consume.
- ◆ You can reduce your computer's energy costs up to 70% by enabling **lower-power settings**.
- ◆ You can cut overall electricity demand in your office by 5% simply by **turning off devices when not in use**.

#### THE PLUG LOAD ENERGY PIE

#### QUICK FACTS ON PLUG LOADS

- ◆ A plug load is the energy draw from an electric device plugged into an outlet, such as a computer, printer, or TV.
- ◆ Plug loads are the **fastest growing energy uses** in the U.S., largely due to the proliferation of computing equipment.
- ◆ In office buildings, plug loads account for up to **50% of all electricity consumed**.
- ◆ A computer operating 24 hours-a-day for one year uses as much electricity as the average U.S. home does in 3 weeks and emits more than half a ton of carbon dioxide.
- ◆ **Vampire loads** are the energy draws from electric devices that are turned "off" that's right – even if you have turned off an electric device, it can still consume electricity, up to 10% of its active-mode consumption!

Image: courtesy www.earthhour.org

#### OK, I'M READY TO TAKE ACTION

Opportunities to reduce plug loads in office buildings abound, but we recommend starting with your computer, monitor, printer, and copy machine. These devices account for over 75% of office electricity use.

- ◆ **Computer and monitor:** Enable your computer's power management settings. Use the following link to head to the [ENERGY STAR](#) website, which offers step-by-step instructions for all major operating systems.

#### Engaging low power settings only takes a couple minutes.

- ◆ You can save additional electricity by **reducing display brightness**. You might also find that a less bright monitor is easier on your eyes.
- ◆ When you leave for the day, **turn off your computer monitor...** and flip the switch on the power strip.
- ◆ **Printer and copier:** If they have low power settings, enable them, and turn them off at the end of the day. We recommend attaching these devices to power strips and switching these off – **printers and copiers can draw substantial vampire loads**.
- ◆ **Get your colleagues involved:** Sometimes it takes a leader to get the ball rolling. Once you've engaged your low power settings and located all your power strips, stop by your coworker's office and show them... there's low power in numbers!

#### DON'T STOP NOW!

We encourage you to think of other ways you can reduce energy, water, and material waste in your office. An thanks – by working together, we know that we can reach our goal.

Questions or comments? Contact your **Property Management Office**.

## NREL

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NREL/PO-5500-43800 • March 2015



# Tenant Engagement

- Messaging, or Turn it Off! Campaigns
- Interactive dashboards

NREL PIX # 500006-C



# Tenant Engagement

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- Messaging, or Turn it Off! Campaigns
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Icon made by Freepik from [www.flaticon.com](http://www.flaticon.com)

# Tenant Engagement

- Messaging, or Turn it Off! Campaigns
- Interactive dashboards
- Incentive programs
- Engagement activities

**Energy Chickens!**

Penn State Studio Lab:  
Energy Behavior Change

<http://studiolab.psu.edu/projects/energy-behavior-change>



**What's next?**

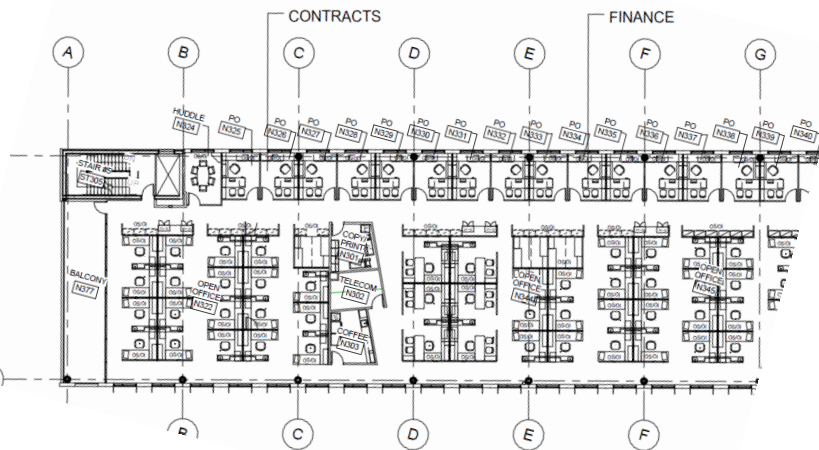
# PPL Solutions – What's coming next?

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- Designing for plug load efficiency
- Integrated plug load controls
- Office automation

# PPL Solutions – What's coming next?

- Designing for plug load efficiency
- Integrated plug load controls
- Office automation



- Maximize use of common spaces
  - Multifunction devices – 75% less printers
- Workstation
  - ENERGYSTAR as a starting point
  - Minimize individual stuff
  - Advanced Power Strips
- Design to use stairs
- Minimize distribution transformers
- Exhaust transfer air for cooling of network/switch rooms
- Opportunities to turn off parasitic office equipment
- Occupancy sensors
  - Power strips
  - Integrate into light switch or CPU activity
- Efficiency datacenter operations
- Air side economizer
- Evaporative cooling
- Waste heat recovery

# PPL Solutions – What's coming next?

- Designing for plug load efficiency
- Integrated plug load controls
- Office automation

- Space utilization
- Occupancy sensors
- Work station information
- Controls/communication protocols

# PPL Solutions – What's coming next?

- Designing for plug load efficiency
- Integrated plug load controls
- **Workstation automation**



NREL PIX # 17904

- Lights
- Plug loads
- Individual heating and cooling
- User feedback for BAS input
- Sensors for operable windows
- Controlled outlets
- Energy storage



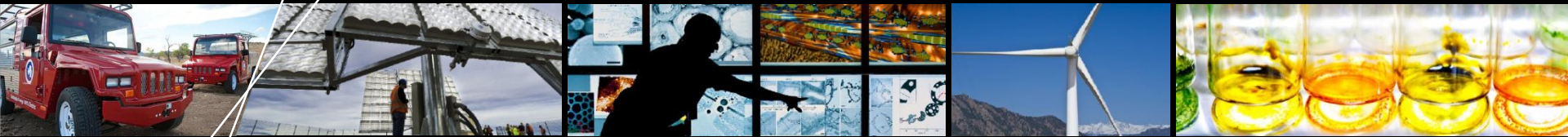
# Summary

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## In Summary:

- There's a lot that you can do **now**
- **Low-cost solutions** exist
- There are many ways to **engage with tenants** to reduce plug load energy use
- There are many ways to **design and operate** a building to reduce plug load energy use
- **New technologies** are on the horizon

**Thank you!**



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