Assessing and Reducing Plug and Process Loads in Commercial Office and Retail Buildings

CBEA Webinar
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Key Questions

• What are plug and process loads (PPLs)?

• Why are PPLs so hard to control?

• How can I use NREL’s guides to reduce PPLs in my building?
What are plug and process loads?

**Definition:** PPLs are building loads that are unrelated to general lighting, heating, ventilation, cooling, and water heating. They typically do not provide comfort to the occupants.

**Impact of Commercial PPLs:**
- 5% of U.S. primary energy (DOE *Buildings Energy Data Book 2010*)

**PPL Challenges:**
- PPLs are not viewed as an integral building system.
- No single decision maker specifies all efficiency strategies.
- PPLs are not addressed by building codes.
Plug Loads: Important Definitions

- **In Use**
- **Parasitic Load**
- **De-Energized**
How did we get here?

**Office PPLs:**
- The design and construction of NREL’s Research Support Facility (RSF) sparked in-depth office PPL research.
- As designed, more than 50% of the RSF’s annual energy is from PPLs.
- Existing NREL PPL practices would have exceeded the whole-building energy use goals.
  - A 50% reduction in PPL energy use was required.
- NREL developed PPL energy use reduction strategies and retrofits from office PPL research.

**Retail PPLs:**
- NREL has worked with Commercial Building Partnership members and performed plug load audits in various retail spaces.
- NREL has performed extensive retail PPL metering studies.
- NREL developed PPL energy use reduction strategies and retrofits from retail PPL research.
Examples of Plug Loads in Office Buildings

- Break rooms and kitchens
  - Refrigerators
  - Small kitchen appliances
  - Vending machines
  - Drinking fountains
- Workstations
  - Computers
  - Monitors
  - Task lights
  - Phones
  - Printers, copiers, scanners, and fax machines
- Vertical transport
  - Elevators
  - Escalators
- Small-scale food service areas
- Conference rooms
- Server rooms/data centers
- Telecom rooms
Examples of Plug Loads in Retail Buildings

- Point of sale
  - Cash register
  - Demagnetizer
  - Barcode scanner
  - Conveyor belt
- Vending machines
- Refrigerators
- Self-service kiosks
- Electronics section
  - Televisions
  - Radios
  - Computers
  - Clocks
  - Video game consoles
- Office equipment
  - Computers
  - Monitors
  - Task lights
  - Phones
  - Printers, scanners, copiers, and fax machines
Things That Affect Energy Use of Plug Loads

Manufacturer dependent:
• In-use power draw
• Parasitic power draw
• Built-in low power functionality
• Built-in automatic on/off functionality
• Built-in battery backup
• Power requirements: voltage and amperage
• Power cycling limitations
• Time to be ready to use from an “off” state
• Availability of energy-efficient replacements
• Device functions

Use dependent:
• Location
• User
• Use pattern
• Implementation
• Device control
Why are plug loads so hard to control?

Manufacturer dependent:
• Built-in low power or automatic on/off functionality
  • Built-in functionality can be inconsistent, unreliable, or not included.
• Power requirements: voltage and amperage
  • Off-the-shelf solutions may not be available for higher power devices.
• Power cycling limitations
  • Some devices simply cannot be turned off because of potential damage to the device.
• Time to be ready to use from an “off” state
  • The time delay to reach a “usable” state is too great.
  • Configuration may be required when a device is turned on.
• Device functions
  • The primary function may be for the health and safety of building occupants and thus the device cannot be turned off.
Why are plug loads so hard to control?

Use dependent:
- Location
  - A given device may be used differently depending on its location.
- User
  - A given device may be used differently depending on the user.
- Use pattern
  - Device use schedules vary widely.
- Implementation
  - PPLs are often present in large numbers.
  - PPLs are very diverse.
  - PPLs can directly generate revenue.
How can I reduce plug loads in my building?

NREL How-To Brochures:

- Assessing and Reducing Plug and Process Loads in Retail Buildings
- Assessing and Reducing Plug and Process Loads in Office Buildings

What do these include?

- 10-step process to evaluate PPLs
- Recommendations based on:
  - Space type
  - Equipment type
- Plug load savings calculator
10 Steps To Address Plug and Process Loads

1. Establish a PPL Champion
2. Benchmark Current Equipment and Operations
3. Develop a Business Case for Addressing PPLs
4. Identify Occupant’s True Needs
5. Meet Needs Efficiently
6. Turn It All Off
7. Institutionalize PPL Measures
8. Address Unique PPLs
9. Promote Occupant Awareness
10. Address PPLs (Design Team)
Step 1: Establish a PPL Champion

**Purpose:**
To initiate and help implement PPL strategies.

**Skills needed:**
- Basic understanding of:
  - Energy efficiency opportunities
  - Design strategies
- Ability to:
  - Apply cost justifications
  - Critically evaluate operations, institutional policies, and procurement processes
Step 2: Benchmark Current Equipment and Operations

- Identify and inventory PPLs.
- Establish baseline for:
  - Current equipment
  - Current operations.
- Establish basis of comparison for financial calculations.
- Understand when equipment is used.
- Identify PPL strategies that would yield the largest savings.
Step 2a: Perform a Walkthrough and Develop a Metering Plan

The champion will assess PPLs to:

- Gain an understanding of the use pattern.
- Inventory PPLs: types and quantity.
- Identify common and unique pieces of equipment.
- Work with the PPL users to determine how and why each piece of equipment is used.
- Determine if PPL is critical to health, safety, or business operations.
- Develop a metering plan.
  - Meter a subset of common equipment.
  - Meter all “unique” PPLs when possible.
Step 2b: Select a Plug Load Meter

**Meter Features:**
- Ability to measure and log one week of electrical power (Watts) data
- Sampling interval of 30 seconds
- Designed for the type of circuit to be metered (e.g., 120 Volt, 15 amp, 60 Hertz)
- Ability to accurately meter loads of 0–1800 W
- External display
- Internal clock that timestamps each data point
- Underwriters Laboratories listing
Step 2c: Meter the Plug Loads

Steps to execute the metering plan:
1. Determine whether the PPL can be de-energized.
2. Determine whether installing a meter will interrupt business operations.
3. Inform users that the metering effort is not to monitor their personal activities.
4. Set up the meter to measure electrical power.
5. Power down and unplug the device to be metered.
6. Plug the device into the meter. Plug the meter into an outlet.
7. Clear the memory on the meter and go through any other initial setup.
8. Power on the device to be metered.
9. Meter the device for a typical work week.
10. Calculate the average load during occupied and unoccupied hours.
Step 2d: Analyze Results

PPL Profile

Load (kW)

12:00 AM 12:00 AM 12:00 AM 12:00 AM 12:00 AM 12:00 AM 12:00 AM

8.0 kW during unoccupied hours

Assume store closure 10:00 p.m. to 10:00 a.m. daily

$6,789 per store per year

Credit: Michael Sheppy/NREL
Step 2d: Analyze Results

Most Common

- TVs (44)
- Demagnetizers (35)
- Cash Register Terminals (33)
- Beverage Refrigerators (29)
- Handheld Barcode Scanners (28)
- Barcode Scanner/Scales (23)
- Computer Monitors (23)
- Battery Chargers (20)
- Conveyor Belts (16)
- Fans (15)
- Security Monitors (14)
- Vending Machines (12)

Least Common

- Modems (11)
- Computers (7)

Credit: Chad Lobato/NREL

Annual Energy Cost ($/year)
Step 3: Develop a Business Case for Addressing PPLs

**Purposes:**
- Establish an initial business case by demonstrating that energy consumption and energy costs can be reduced.
- Energy cost savings alone might not always be enough to justify many PPL strategies.
  - Develop business cases not related to energy.
  - Example: Laptops increase productivity by offering a more flexible computing solution.
Step 3: Business Case Example

**Avoided Cost of Renewables (ACR):**
- Equates the cost of PPL efficiency measures to avoided renewable costs.
- Gives all parties a financial incentive to investigate PPLs.

**ACR for the RSF:**
- Used to justify demand-side efficiency measures.
- In the RSF, every continuous 1 Watt load requires 6.6 Watts of PV (rated peak power) to offset the annual energy use. Every 1 Watt reduction in load resulted in $33 reduction in PV costs.

**The total PV cost avoided by PPL reductions exceeded $4 million.**
Step 4: Identify Occupants’ True Needs

True need:
Equipment or procedure **required** to achieve a given business goal or an assigned task.

Understand:
What do occupants produce as part of their jobs and what tools do they require?

Every occupant, including those working in sensitive operations, must be accounted for.

Nonessential equipment:
A business case must be made for continued use.
Step 5: Meet Needs Efficiently

Search energy-efficient equipment databases.

**Nonrated equipment:**
- Investigate the most efficient model.
- Turn off when not in use (if possible).

Pay attention to parasitic loads.

Credit: Chad Lobato/NREL
Step 6: Turn It All Off: Office

Opportunities in offices:

- Nights, weekends, and holidays account for 66% of the year.
  - A typical office building is unoccupied during this time.
- During a typical work day, building occupants are at their desks less than 30% of the time.
  - Workstations are vacant and should be powered down during more than 70% of business hours.
- Workstations should only be powered 7% of the year!

References:

Credit: Chad Lobato/NREL
Step 6: Turn It All Off: Retail

Opportunities in retail:
- Turn cash registers off during unoccupied hours.
- Turn cash registers off or put in standby when they are not being used during business hours.

Cash Register Load – "Always-On"

Wasted energy during nonbusiness hours

Credit: Michael Sheppy/NREL
Step 6: How To Turn It All Off

Step 6: Plug Load Control Devices
Step 6: Plug Load Control Device Cost Justification

Based on an example office equipment schedule, selected payback, utility rate, and device cost, any load greater than 100 W is cost effective to control.

Cost justification charts for other payback periods are available here:
Selecting a Control Strategy for Miscellaneous Electrical Loads

Credit: Chad Lobato/NREL
Step 7: Institutionalize PPL Measures

Day-to-day energy efficiency: Depends on the decisions of occupants, facility managers, and owners.

Identify decision makers who can:
• Institutionalize PPL measures through procurement decisions and policy programs.
• Promote buy-in.
• Identify unbreakable and unchangeable policies.
Step 8: Address Unique PPLs

**EXAMPLE:** Contractors and food service areas. Building owner should *contractually require* or *provide* the most efficient equipment available.

**Case-by-case evaluation:**
- Energy-efficient equipment may not be available and may be restricted from being turned off (e.g. ATM).
- Manufacturers may be able to recommend alternatives.
Step 9: Promote Occupant Awareness: Office

- Encourage and allow occupants to “do good.”
- PPL strategies should counteract “bad users.”
- Emphasize the importance of turning off personal electronics when leaving a workspace.
Promoting occupant awareness in retail buildings is just as important as in office buildings.

<table>
<thead>
<tr>
<th>Employee awareness:</th>
<th>Customer awareness:</th>
</tr>
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<tbody>
<tr>
<td>• Use training to gain buy-in from management and employees.</td>
<td>Use signage to:</td>
</tr>
<tr>
<td>• Use stickers, placards, and emails that remind employees to “do good.”</td>
<td>• Explain energy efficiency measures.</td>
</tr>
<tr>
<td></td>
<td>• Inform customers that they are supporting environmentally-friendly practices by shopping at your store.</td>
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Example of signage in a big box retail outlet
Step 10: Address PPLs (Design Team)

- Question standard specifications, operations, and design standards.
- Maximize space efficiency.
- Integrate PPL control strategies into the building’s electrical system:
  - Switches
  - Vacancy sensors
  - Timed disconnects for outlets
  - Controlling outlets through the building management system

Other loads:
- Elevators
- Transformers
- Process cooling systems
- Data centers
Each how-to brochure provides simple recommendations for reducing plug loads.

- **Office brochure provides recommendations for common equipment found in various office space types.**

- **Retail brochure provides recommendations for common equipment types found throughout a retail building.**
A simple worksheet is provided in each brochure that allows plug loads to be inventoried and potential savings to be calculated for a given building.

Download the plug load savings calculators here:

- **Office:**

- **Retail:**
References


Any Questions?

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