



Decision Guides for Plug and Process Load Controls

DECEMBER 2015

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Introduction

Plug and process loads (PPLs) consume about one-third of the primary energy in U.S. commercial buildings. PPLs cover a wide variety of electronic, computer, refrigeration, and cooking devices, including essential equipment for information processing, medical treatment, and food service businesses. Within each category, contain several 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 because the number and energy intensity of plug-in devices continue to increase. This is due to the wide range of U.S. commercial building types, uses, sizes, and vintages, PPL energy consumption can range from 10% in warehouses to nearly 60% in food sales.

The decision guides found in this resource were created to help building owners find the right control strategy for PPLs in their buildings. The guides are developed for different building types and outline the costs, potential savings, complexities, and user friendliness of various control strategies and their applications to each building type. The guides also aim to help building owners determine whether a control is appropriate for particular project applications such as staged retrofit projects, whole-building retrofits, new construction projects, and projects that involve tenants and landlords. Lastly, the guides provide links to additional resources that can further help building owners assess and reduce the energy use that is associated with PPLs, find rebates for PPL control measures, and procure the right control types for their building equipment.

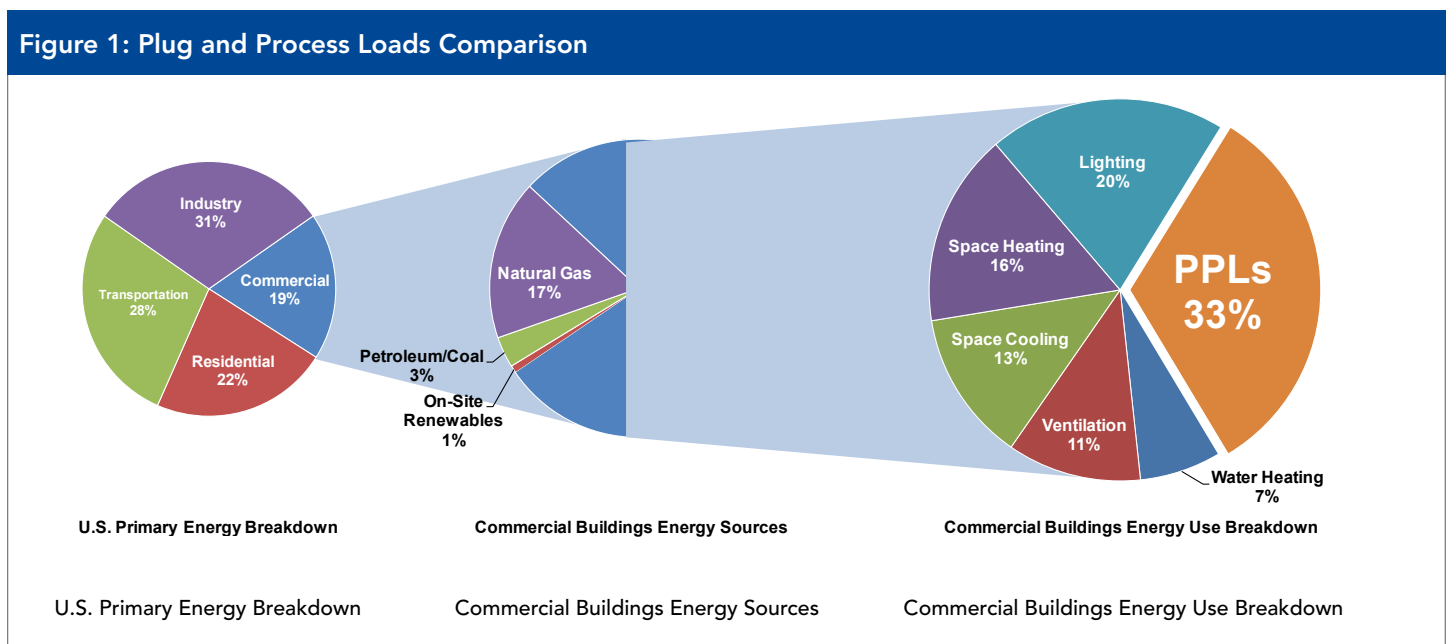


Figure 1. PPLs account for 33% of the total energy consumed by commercial buildings. Graph by Chad Lobato, NREL; Data source: DOE (2010).

Strategy Descriptions and Considerations

PPL control strategies are listed in the [decision guides](#) for each building type, as well as considerations for application and links to additional resources.

Turn It Off! Campaign

The Turn it Off! campaign promotes occupant awareness to turn equipment off when not in use. The campaign can include training, informational letters and internal newsletters, emails, signage, videos, periodic reminders and updates, and incentive programs ([NREL 2013](#)). Check out resources on Assessing and Reducing PPLs in [Office and Retail](#) buildings and a [Flip the Switch](#) campaign for ideas.

Advanced Power Strips

Advanced power strips (APSs) are similar to conventional power strips that are often used to plug multiple electronic devices into a wall outlet; however, APSs have built-in technology to reduce PPL runtimes and save energy when the devices are not in use. The [APS Technical Specification](#) offers guidance on the APS procurement process and selecting effective APS models for commercial buildings.. The Better Building Alliance has also developed a one-page [how-to guide](#) on properly installing an APS in an office setting, and includes a [list of utility incentives](#) for APSs.

Upgrade Equipment with Low-Energy or ENERGY STAR®-Certified Equipment

ENERGY STAR® is a U.S. Environmental Protection Agency voluntary program that has helped businesses and individuals save money through superior energy efficiency over the past two decades. As of December 2013, families and businesses realized savings of more than \$295 billion on utility bills and prevented more than 2.1 billion metric tons of greenhouse gas emissions. Significant energy savings can be achieved by replacing old, inefficient equipment with low-energy or [ENERGY STAR®-certified equipment](#).

Use Built-In Low Power States for Equipment

Built-in automatic low-power state functionality, such as standby and sleep modes, often effectively saves energy. Idle time can be monitored by these internal processes, which cause the device to power down to a low-power state when it has been idle for a given period of time. Automatic low-power states provide limited control, but when configured correctly are often the most accessible, inexpensive, and effective energy-saving strategy. The prime example of this type of control is a computer that enters a ["sleep" mode](#). One challenge with low-power state control is ensuring that the information services departments enable the appropriate settings and use newly available updating techniques (such as wake-on local area network) to enable low-power states and effective business operations ([NREL 2014](#)).

Design Strategies for Consolidating Plug and Process Loads

New construction and major retrofit projects offer design teams new PPL reduction opportunities. A designated ["plug load champion"](#) should work with the design team to question standard specifications, operations, and design standards that limit energy-saving opportunities. The design team plays a key role in maximizing space efficiency, which increases the ratio of occupants per building area to a piece of equipment, and can reduce PPL energy use drastically. Space efficiency can be achieved by consolidating break rooms, common print areas, and cafeterias. Equipment in these specific areas is used more efficiently when they are consolidated rather than distributed, and thus lowering PPLs.

Integrating Plug and Process Load Controls with Other Building Systems

PPL control strategies can be integrated into a building's electrical system to control outlets at workstations and in common areas. This strategy can be as simple as installing switches, vacancy sensors, or timed disconnects for outlets, or as sophisticated as controlling outlets through the building management system ([NREL 2013](#)). These integrated control strategies would typically apply to new construction, whole-building retrofits, and staged retrofit projects.

Additional Submetering and Control Options

For new construction and extensive retrofits, PPLs should be aggregated onto dedicated electrical panels. With dedicated PPL panels, the circuits can be integrated into a building control system to turn off PPLs during nonbusiness hours. These panels also allow for easy energy submetering, which can be used to develop a building PPL energy-use display system that can provide feedback to the occupants ([NREL 2013](#)).








How to Use the Decision Guides

A decision guide has been compiled for each building type, outlining general assumptions on cost, potential savings, implementation complexity, user acceptance of change, and project application for seven different plug load control strategies. Each guide has been developed to be visual and user friendly, with links to useful resources for each strategy and building type. More information about the guides is provided in this section.















The guides were developed to highlight the PPL control strategies described in the Strategy Descriptions and Considerations section. The building types were selected to align with the CBECS building categories, as well as Department of Energy's Better Buildings Solution Center building types. The columns show high-level estimates based on industry practice for total cost, potential savings, implementation complexity, and user acceptance of change, and are intended to be used as a starting point in making decisions on PPL controls for each building type. The project types that are applicable to each PPL control strategy are indicated with a check mark.

Each decision guide has additional considerations for APSs, ENERGY STAR®, design strategies, and submetering control options as indicated by asterisks. The legend for these considerations is shown below.

Legend

*	Ensure that you select the appropriate APS control strategy for your building type and application. More information on APS control strategies can be found in the APS Technical Specification .
**	Energy efficient upgrades can be low-cost if equipment is at the end of its useful life and needs replacement. Higher costs are associated with an overhaul of all building equipment.
***	Design strategies can be as easy as designating a location for a central printer, or it can require an overhaul of space planning to consolidate unnecessary PPLs throughout a building to optimize energy efficiency.
****	Actual savings do not come from submetering directly, but through the management of systems as a result of decisions based on data analysis.
✓	Solutions are applicable to identified project type.
✓+	Solutions may be available with the landlord's buy-in.
\$ - \$\$\$	Low (\$) to high (\$\$\$) costs are associated with purchasing and installing this strategy.
 - 	Low (👉) to high (👈) energy cost savings are associated with this strategy.
○	There is minimal-to-no complexity associated with implementing this strategy in a building.
	Some complexity is associated with implementing this strategy, but simple resource guides or contractors are available to help.
	Implementing this strategy can be complex. Refer to resources listed in this guide and your local contractor in charge of building controls for more information on how to integrate the strategy into your building systems.
	This strategy is either very easy to use, or requires little-to-no interaction by building occupants. Users of this plug load control strategy should be quick to accept the strategy and associated behavioral changes.
	This strategy should be easy to use but may require a small level of interaction or behavior change by building occupants.
	This strategy requires an educational component to address behavioral change that will affect a successful implementation of the strategy in a building. Building occupants may be slower to accept the behavioral change associated with this strategy.

Decision Guide

Education Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	✓
Advanced Power Strips (APSs)*	\$		○			✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○			✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$		○			✓	✓	✓	✓
Integrate PPL Controls with Other Building Systems	\$\$\$		○				✓	✓	
Additional Submetering and Control Options****	\$\$		○			✓	✓	✓	
Click here to view the legend									

Available resources for PPL control strategies.















Education Building-Specific PPL Resources

[Advanced Energy Design Guide for K-12 School Buildings: Achieving 30% Energy Savings](#)

[Advanced Energy Design Guide for K-12 Schools: Achieving 50% Energy Savings](#)

[Advanced Energy Retrofit Guide for K-12 Schools](#)

Decision Guide

Food Sales, Retail, and Services Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	✓
Advanced Power Strips (APSs)*	\$		○		✓	✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○			✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$					✓	✓	✓	✓
Integrate PPL Controls with Other Building Systems	\$\$\$						✓	✓	
Additional Submetering and Control Options****	\$\$					✓	✓	✓	✓+
Click here to view the legend									

Available resources for PPL control strategies.

Food Sales, Retail, and Services Building-Specific PPL Resources

[Assessing and Reducing Plug and Process Loads in Retail Buildings](#)

[Target Pilots Energy Efficiency Measures for Broad Rollout in Existing Colorado Store](#)

[Advanced Energy Design Guide for Small Retail Buildings: Achieving 30% Energy Savings](#)

[Advanced Energy Design Guide for Medium to Big Box Retail Buildings: Achieving 50% Energy Savings](#)

[Advanced Energy Retrofit Guide for Retail Buildings](#)

[Campus Cafeteria Serves As Sustainable Model for Energy-Efficient Food Service](#)

[Thinking Like a Whole Building: A Whole Foods Market New Construction Case Study](#)















































[Thinking Like a Whole Building: Whole Foods Market New Construction Project Summary](#)

[Advanced Energy Design Guide for Grocery Stores: Achieving 50% Energy Savings](#)

[Advanced Energy Retrofit Guide for Grocery Stores](#)

Learn more at betterbuildingsolutioncenter.energy.gov

Decision Guide

Healthcare Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$								
Advanced Power Strips (APSs)*	\$								
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$								
Use Built-In Low Power States	\$								
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$\$								
Integrate PPL Controls with Other Building Systems	\$\$\$								
Additional Submetering and Control Options****	\$\$\$								
Click here to view the legend									

Available resources for PPL control strategies.

Healthcare Building-Specific PPL Resources

Healthcare Energy End-Use Monitoring















Quantifying hospital cord connected plug loads in inpatient areas

Advanced Energy Design Guide for Small hospitals and Healthcare Facilities: Achieving 30% Energy Savings

Advanced Energy Design Guide for Large Hospitals: Achieving 50% Energy Savings

Advanced Energy Retrofit Guide for Healthcare Facilities

Decision Guide

Hospitality Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	N/A
Advanced Power Strips (APSs)*	\$		○		✓	✓	✓	✓	N/A
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○			✓	✓	✓	N/A
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	N/A
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$		○			✓	✓	✓	N/A
Integrate PPL Controls with Other Building Systems	\$\$\$		○				✓	✓	N/A
Additional Submetering and Control Options****	\$\$		○			✓	✓	✓	N/A
Click here to view the legend									

Available resources for PPL control strategies.

Hospitality Building-Specific PPL Resources

Advanced Energy Design Guide for Highway Lodging: Achieving 30% Energy Savings

Decision Guide














Office Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	✓
Advanced Power Strips (APSS)*	\$		○		✓	✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○		✓	✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$		○			✓	✓	✓	
Integrate PPL Controls with Other Building Systems	\$\$\$		○				✓	✓	
Additional Submetering and Control Options****	\$\$		○			✓	✓	✓	✓+
Click here to view the legend									

Available resources for PPL control strategies.

Office Building-Specific PPL Resources

Assessing and Reducing Plug and Process Loads in Office Buildings
Advanced Energy Design Guide for Small to Medium Office Buildings: Achieving 50% Energy Savings
Advanced Energy Design Guide for Small Office Buildings: Achieving 30% Energy Savings
Advanced Energy Retrofit Guide for Office Buildings

Decision Guide

Public Assembly and Religious Worship Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	✓
Advanced Power Strips (APSs)*	\$		○		✓	✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○		✓	✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$					✓	✓	✓	
Integrate PPL Controls with Other Building Systems	\$\$\$						✓	✓	
Additional Submetering and Control Options****	\$\$						✓	✓	✓ ⁺
Click here to view the legend									

Available resources for PPL control strategies.

Public Assembly and Religious Worship Building-Specific PPL Resources
















Green Church Association

Green Faith

ENERGY STAR Action Workbook for Congregations

ENERGY STAR Action Workbook for Congregations Appendices

Decision Guide

Public Order and Safety Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓	✓	✓	✓	✓
Advanced Power Strips (APSs)*	\$		○		✓	✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○		✓	✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$					✓	✓	✓	
Integrate PPL Controls with Other Building Systems	\$\$\$						✓	✓	
Additional Submetering and Control Options****	\$\$						✓	✓	✓+
Click here to view the legend									

Available resources for PPL control strategies.

Decision Guide

Warehouse and Storage Solutions	Strategy Considerations				Project Types				
	Total Cost	Potential Savings	Implementation Complexity	User Acceptance of Change	Do it Now	Staged Retrofit	Whole-Building Retrofit	New Construction	Landlord Tenant Solutions
Turn it Off Campaigns	\$		○		✓				
Advanced Power Strips (APSs)*	\$		○		✓	✓	✓	✓	✓
Upgrade Equipment with Low-Energy or ENERGY STAR Certified Equipment**	\$\$		○		✓	✓	✓	✓	✓
Use Built-In Low Power States	\$		○		✓	✓	✓	✓	✓
Design Strategies for Consolidating Plug and Process Loads (PPLs)***	\$\$							✓	
Integrate PPL Controls with Other Building Systems	\$\$\$						✓	✓	
Additional Submetering and Control Options****	\$\$						✓	✓	✓+
Click here to view the legend									

Available resources for PPL control strategies.

Warehouse and Storage Building-Specific PPL Resources

[Prologis Rolls Out Its Warehouse Energy Retrofits](#)

[Advanced Energy Design Guide for Small Warehouses and Self-Storage Buildings: Achieving 30% Energy Savings](#)

Building Type Descriptions

Each building type referenced in the guides has been categorized using the U.S. Energy Information Administration's [Commercial Buildings Energy Consumption Survey \(CBECS\) definitions](#) and maps to DOE's [Better Buildings Solution Center](#) building types. Building types are described in this section.

Education	Classroom buildings on college or university campuses that are used for academic and technical classroom instruction. This building category includes elementary, middle school, and high school; college and university; preschool and daycare; adult education; career and vocational training, and religious education. Buildings on education campuses for which the main use is not instruction are categorized based on their use. For example, administration buildings are part of "Office," dormitories are "Lodging," and libraries are "Public Assembly."
Food Sales, Retail, and Services	Buildings that are used for retail or wholesale food sales. Buildings that are used for the sale and display of goods other than food. Buildings in which some type of service is provided other than food service or retail sales of goods. This building type category includes grocery stores and food markets; gas stations with convenience stores; convenience stores; retail stores; beer, wine, and liquor stores; rental centers; dealerships and showrooms for vehicles and boats; studios and galleries; vehicle service and vehicle repair shops; vehicle storage, maintenance, and repair shops; dry cleaners and laundromats; post offices and postal centers; car washes; gas stations; photo processing shops; beauty parlors and barber shops; tanning salons, copy centers and printing shops; and kennels.
Healthcare	Buildings that are used as diagnostic and treatment facilities for inpatient and outpatient care. Medical offices are included here if they use any type of diagnostic medical equipment. (If they do not, they are categorized as office buildings.) This building type category includes hospitals, inpatient rehabilitation facilities; medical offices, clinics, and other outpatient rehabilitation facilities; and veterinary hospitals.
Hospitality	Buildings that are used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings. This building type category includes hotels, dormitories, retirement homes, nursing homes and assisted living facilities, shelters, and children's homes.
Office	Buildings that are used for general office space, professional offices, and administrative offices. Medical offices are included here if they do not use any type of diagnostic medical equipment. (If they do, they are categorized as outpatient healthcare buildings.) This building type category includes government offices; mixed-use offices; banks and other financial institutions; medical offices (see previous statement); sales offices; contractor's office for construction, plumbing, heating, ventilating, and air conditioning, etc.; nonprofit and social services; city halls and city centers, religious offices; and call centers.
Public Assembly and Religious Worship	Buildings in which people gather for social or recreational activities, whether in private or nonprivate meeting halls. This category could include social and meeting halls (e.g., community centers, lodges, meeting halls, convention centers, and senior centers); recreation centers (e.g., gymnasiums, health clubs, bowling alleys, ice rinks, field houses, and indoor racquet sports facilities); entertainment and culture (e.g., museums, theaters, cinemas, sports arenas, casinos, and nightclubs); and buildings in which people gather for religious activities (e.g., chapels, churches, mosques, synagogues, and temples).
Public Order and Safety	Buildings that are used for the preservation of law and order and public safety, including police stations, fire stations, jails, reformatories and penitentiaries, courthouses, and probation offices.
Warehouse and Storage	Buildings that are used to store goods, manufactured products, merchandise, raw materials, and personal belongings (such as self-storage). Examples of these buildings include refrigerated and nonrefrigerated warehouses and distribution and shipping centers.

Project Type Descriptions

Project types are described in this section to establish a consistent definition of the level of renovation or construction being completed in a building.

Do It Now	Do It Now recommendations are low or no-cost actions that yield energy savings and are easy to implement in a building regardless of building type, ownership, or age of building.
Staged Retrofit	Also defined by the AERGs , staged retrofits are implemented in several steps over a longer period of time than whole-building retrofits. This approach allows retrofits to be aligned more closely with the facility's capital improvement plans; it reduces the incremental cost of the upgrades because equipment is replaced near the end of its useful life. An integrated design approach is recommended even for staged retrofits, but properly leveraging system interactions when time passes between stages can be more challenging. All retrofits need to be planned early in the process, even though they are implemented over time. This will help mitigate inefficiencies if new contracts must be developed and different personnel are involved later. Some potential energy savings are delayed in a staged retrofit, but the economics can be more sensible than for a whole-building retrofit, in which equipment may be replaced with significant useful life remaining.
Whole-Building Retrofit	As defined by the Advanced Energy Retrofit Guides (AERGs) , whole-building retrofit projects use an integrated design approach to develop a package of energy-efficiency measures (EEMs) that can be implemented as a single project over a short time. Often this approach leverages a major remodeling effort or a similar opportunity to address many systems at once. Whole-building retrofits may offer greater savings than individual EEMs, because the packages are optimized and all system interactions are considered. System interactions and equipment downsizing are important components of this approach, and broader ranges of equipment replacements and envelope upgrades are often possible. Higher average savings are likely when an integrated whole-building approach is used.
New Construction	The Advanced Energy Design Guides define new construction as site preparation for, and construction of, an entirely new structure and/or significant extensions to existing structures (whether the site was previously occupied). In many situations, the best EEM packages for new construction will be similar to those for whole-building retrofits.
Tenant/Landlord	A tenant is an organization that occupies land or property that is rented from a property owner (landlord). The projects that are undertaken by a property owner who is occupying a building (owner/occupier) versus those that are undertaken by a property owner who leases the property to tenants (tenant/landlord) may have different drivers, end goals, and control options. Solutions can be implemented that align the financial and energy incentives of building owners and tenants so they can work together to save money, conserve resources, and ensure the buildings are operated efficiently. More information about these solutions can be found in the Green Lease Library .

Available Resources

Turn it Off Campaigns		
Creating an awareness campaign	GUIDE	carbontrust.com/media/13089/ctg056_creating_an_awareness_campaign.pdf
Assessing and Reducing PPL in Office Buildings	GUIDE	nrel.gov/docs/fy13osti/54175.pdf
Creating an Energy Awareness Campaign: A Handbook for Federal Energy Managers	GUIDE	energy.gov/eere/femp/downloads/creating-energy-awareness-campaign-handbook-federal-energy-managers
Green Lease Library	WEBSITE	greenleaselibrary.com/
Shorenstein Flip the Switch/I Will if You Will Campaign	CASE STUDY	greenshorenstein.info/main.cfm?sid=ftswitch&pid=iwiwill
GSA Sustainable Facilities Tool - Plug Loads	TOOL	sftool.gov/learn/about/426/plug-loads

Advanced Power Strips		
GSA Advanced Power Strips for Plug Load Control	FACT SHEET	gsa.gov/portal/content/164611
Technical Specification for Advanced Power Strips	SPEC	www4.eere.energy.gov/alliance/sites/default/files/uploaded-files/Advanced_Technical_Power_Strips_FINAL%20040915_508.pdf
How To Use Advanced Power Strips in an Office Setting	GUIDE	nrel.gov/docs/gen/fy15/63800.pdf
List of Utility Incentives for Purchasing Advanced Power Strips	LIST	www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads/utility-incentives
NEEP Advanced Power Strips Test Protocol	TEST PROTOCOL	neep.org/sites/default/files/resources/Report_APSTestingProtocolFINAL.pdf
Saving Energy Through Advanced Power Strips	GRAPHIC	nrel.gov/docs/fy14osti/60461.pdf
GSA Sustainable Facilities Tool - Plug Loads	TOOL	sftool.gov/learn/about/426/plug-loads
Leveraging the APS Specification for Commercial Buildings	WEBINAR	www4.eere.energy.gov/alliance/events/past-webinars/#070815
Reducing Office Plug Loads	REPORT	nrel.gov/docs/fy13osti/57730.pdf
GSA Plug Load Savings Through APS	CASE STUDY	gsa.gov/graphics/pbs/PlugLoadControl_508c.pdf
GSA SFTool	TOOL	sftool.gov/learn/about/426/plug-loads
Getting to Know Advanced Power Strips	FAQ	neep.org/sites/default/files/resources/APSCCommonMisconceptionsFinal.pdf

Upgrade Equipment with Low-Energy or energy star		
List of ENERGY STAR certified products	LIST/REFERENCE	energystar.gov/products/certified-products
Energy and Cost Savings Calculators for Energy-Efficient Products	CALCULATOR	energy.gov/eere/femp/energy-and-cost-savings-calculators-energy-efficient-products

Use Built-In Low Power States		
Power Manage Computers: Put Your Computer to Sleep	WEBSITE	energystar.gov/index.cfm?c=power_mgt.pr_power_mgt_low_carbon_join
Assessing and Reducing Plug and Process Loads in Office Buildings	GUIDE	nrel.gov/docs/fy13osti/54175.pdf
Assessing and Reducing Plug and Process Loads in Retail Buildings	GUIDE	nrel.gov/docs/fy13osti/54174.pdf
GSA SFTool	TOOL	sftool.gov/learn/about/426/plug-loads

Available Resources, continued > next page

Available Resources

Design Strategies for consolidating PPLs

Assessing and Reducing Plug and Process Loads in Office Buildings	GUIDE	nrel.gov/docs/fy13osti/54175.pdf
Assessing and Reducing Plug and Process Loads in Retail Buildings	GUIDE	nrel.gov/docs/fy13osti/54174.pdf
Reducing Plug and Process Loads for a Large Scale, Low Energy Office Building: NREL's Research Support Facility	REPORT	nrel.gov/docs/fy11osti/49002.pdf
GSA SFTool	TOOL	sftool.gov/learn/about/426/plug-loads

Integrate PPL Controls with other Building Systems

Lessons Learned and the Future of Plug Load Controls	PRESENTATION	betterbuildingssolutioncenter.energy.gov/sites/default/files/Wednesday%20-%20Lessons%20Learned%20and%20the%20Future%20of%20Plug%20Load%20Controls.pdf
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Additional Submetering & Control Options

What Type of Submetering is Right For Me?	FACT SHEET	gsa.gov/portal/mediald/156787/fileName/Energy_Submeter_Comparison_Knetwork_2012_11_26(508)
Advanced Electric Metering in Federal Facilities	TRAINING	www4.eere.energy.gov/femp/training/training/advanced-electric-metering-federal-facilities

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DC: U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. <http://buildingsdatabook.eren.doe.gov/>.

NREL. (2013). Assessing and Reducing Plug and process Loads in Office Buildings. Golden, CO: National Renewable Energy Laboratory. <https://www.nrel.gov/docs/fy13osti/54175.pdf>.

NREL. (2014). Reducing Office Plug Loads through Simple and Inexpensive Advanced Power Strips. Golden, CO: National Renewable Energy Laboratory. <https://www.nrel.gov/docs/fy13osti/57730.pdf>.

