Attacking Plug Loads: A Campaign to Deploy Automated Plug Strip Controllers

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ABSTRACT

Plug loads are among the fastest growing energy consumers in commercial buildings. Reducing plug loads can present a challenge in the design and operation of commercial buildings because they are spread throughout the building and typically not controlled. However, it is a challenge that can be addressed with planning and new technology.

A recent National Renewable Energy Laboratory (NREL) technology demonstration has shown that deploying advanced power strips (APSs) in office buildings can result in plug load energy savings of up to 28% and whole-building energy savings of up to 8%. In some cases, the payback for APSs is less than one year. Additional evidence supporting this energy savings claim was substantiated by multiple studies and technology demonstrations. Despite incentives and the available information showing that APSs offer cost-effective plug load energy savings, this technology has not been widely adopted.

The U.S. Department of Energy, through its Better Buildings Alliances is preparing to launch an Advanced Power Strip Campaign to:

- Increase awareness about the energy-saving capabilities of APS technology in office buildings and
- Provide a central hub for the marketplace to access information, resources, research and incentives to deploy APS technology.

This paper shows the need for a campaign, discuss how it can help save energy, and provide information on how participation can yield substantial energy savings.

Introduction

Percentage-wise, plug loads are among the fastest growing energy consumers in commercial buildings. Commercial plug and process loads (PPLs)—such as computers, printers, fax machines, beverage dispensers, and ATMs—account for nearly 4 quads of primary energy per year, or about 20% of commercial building energy use. Office equipment alone consumes approximately 7% of all commercial electric energy (DOE 2012). Office equipment and plug loads draw power and emit heat that often contributes to higher cooling loads. Reducing the electricity consumed by office equipment, as well as all PPLs, has the potential to significantly reduce the utility bills of businesses and institutions across the nation.

In recent years, energy codes have significantly reduced the amount of energy used for HVAC and lighting in commercial buildings. Most of these codes impact the design phase of buildings, equipment selection, and product selection. In many cases, plug loads are beyond the scope of design teams and thus not addressed. As a result, PPLs are becoming a bigger piece of the energy pie. For example, in the National Renewable Energy Laboratory's (NREL) Research Support Facility (RSF)—which is a large scale net-zero energy building (NZEB)—the lighting

and HVAC systems are so efficient that PPLs make up more than 50% of total energy consumption (Lobato et al. 2011). The next frontier in energy efficiency is reducing plug loads.

This paper focuses on plug loads that are connected to 110-V circuits where a plug strip can be installed between the devices and the wall receptacle. According to the Building Technologies Office Prioritization Tool, controllable power outlets may save 830 TBtu of primary energy in 2030 (Farese et al. 2012). However, a challenge to effectively controlling plug loads is that they are diverse (there are many types of 110-V-powered devices) and diffuse (these loads are typically spread throughout buildings).

What is an APS?

APSs (also referred to as *smart power strips*) save energy by shutting off power to the outlets. They have a similar physical appearance to ordinary power strips (including those that are used as surge protectors or surge suppressors). APSs achieve energy savings by turning off equipment when it is not needed—especially in offices during unoccupied hours. Even for equipment that has a "sleep" mode, APS units can disconnect the power and prevent vampire loads.

The big opportunity for reducing plug loads is to ensure that they are off when buildings are not occupied. Two-thirds of a year consists of nights, weekends, and holidays. Even during working hours, people are often out of their offices because they attend meetings, take vacations, and go out to lunch. U.S. General Services Administration (GSA) conducted a study that shows that occupants are only at their workstations approximately 30% of the day (GSA 2006). When occupants are away from their workstations their plug loads should be off (with only a few exceptions). A secondary savings impact is in reduction of air-conditioning loads as the energy going into plug loads is converted to heat that must be removed by the air-conditioning system. As APSs gain market penetration, they will change the overall plug load profile, which may allow for downsizing of HVAC systems. If this occurs, it will further increase building efficiency and decrease construction costs. This was experienced in the NREL RSF, where a 50% reduction in plug loads allowed for a reduction in HVAC sizing (Lobato et al. 2011). Table 1 highlights the benefits and considerations of installing APSs in commercial buildings.

Types of APSs

Four main types of APSs available on the market are detailed in Table 2. Different APS features are best suited for specific types of applications.

Energy Saving Results from APSs

The greatest opportunity to reduce PPLs is during unoccupied times: nights, weekends, and holidays (which typically account for two thirds of the hours in a year). Another significant savings opportunity occurs during working hours when people are not in their offices. .

A recent NREL technology demonstration has shown that deploying APSs in office buildings can result in PPL energy savings of up to 28% and whole-building energy savings of up to 8% (Sheppy et al. 2014). In regions of the country with higher electricity prices, the payback for this technology is less than one year (Sheppy et al. 2014). In addition, energy savings have been substantiated by the GSA Green Proving Ground, NYSERDA, and the DoD (GSA 2013, NYSERDA 2011, Buczynski 2012).

Table 1. Benefits and considerations of installing APSs in commercial buildings

Benefits	• Built-in, automatic energy-saving functionality • Low procurement cost makes this technology a prime candidate when budgets are tight or when funds from other efficiency projects are available • Can be deployed individually and not necessarily for the entire building, allowing flexibility in capital cost expenditures • Added value in that some units also have a built-in surge protection with a coverage policy for equipment damages caused by electrical surges • Low or no-maintenance required • In many cases, transparent to the user • High rate of acceptance by users (Sheppy et al. 2014) • Simple installation requiring minimal training in most cases • Utility rebates/incentives are offered by many utilities
Considerations	• In certain applications, management must approve the use of APSs with certain plug loads prior to installation • Training may be required for some APS models to ensure proper operation and maximize energy savings • The appropriate APS must be selected for the given configuration of plug-in electronics and building space type to maximize the energy savings.

Installation and Setup of APSs

An example of the setup for an APS is shown below. This image is specific to an office workstation, but APSs can also be used for retail task lighting and plug loads, kitchen appliances, and print rooms—there are many uses for APS in commercial buildings.

Table 2. Four main types of APSs

	Features	Possible Drawbacks	What To Look For	Typical Application
Timer	Power strip automatically turns off outlets based on preset schedule	You have to set up the timer and stick to your schedule for maximum energy savings	Digital or dial timer	On loads, such as vending machines that only need to be powered on during business hours
Activity Monitor	Power strip looks for signs of activity in the room, and turns off outlets if none is detected	Motion sensors don't always work perfectly	Motion sensor or an infrared "eye" that detects remote control use around a TV	In spaces where loads only need to be used when people are present (such as a gym)
Remote Switch	Power strip can be turned off by the user via a remote switch	To save any energy, operator must remember to turn off the power strip each time	A tethered switch or a remote switch	Where it is desirable to control loads from a remote location (such as a group of sales displays at a store)
Master Controlled	When a primary device (such as a computer or TV) is turned off by the user, the power strip automatically turns off the controlled outlets where the peripheral devices (such as the printer or game console) are plugged in	It can be tricky to select which device should be used as your "master" device	Where it is desirable to control loads from a remote location (such as a group of sales displays at a store)	In spaces, such as a cubicle, where peripheral electronics (e.g. monitors and task lights) only need to be powered when a "master" device (e.g., a laptop computer) is powered
Masterless	When all of the controlled devices are turned off, this type of power strip turns off power to those outlets completely, eliminating all of the vampire loads	Turning off one device with a high load could turn off the entire power strip	No "master" outlet. Description may include "automatic switching" or "power detection"	In spaces, such as a classroom, where groups of electronics are typically powered on and utilized at the same time.

Adapted from NREL 2013.

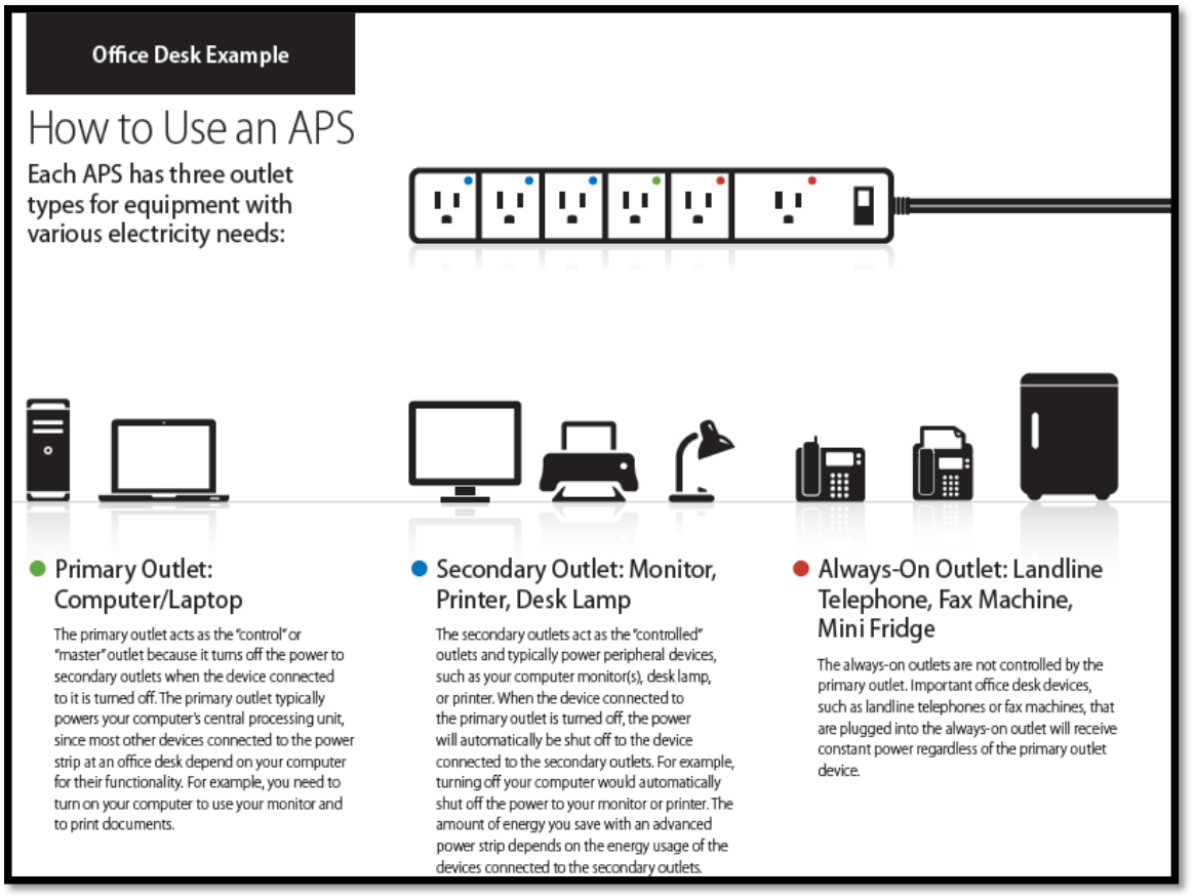

Figure 1. Master-controlled advanced power strip setup for an office desk (Credit: Joelynn Schroeder/NREL).

APS Manufacturers, Retailers, and Pricing

APS devices are widely available from a variety of retailers, including hardware, electronic, big box retail, and online merchants. An example list of APS manufacturers is shown in Table 3, with the product types and approximate price range.

APSs are widely available from a variety of retailers, including hardware, electronic, big box retail, and online merchants. Table 4 lists some of the retailers where APSs can be purchased.

Prices for APSs typically range from $15 to $50; most are approximately $30. The number of switchable outlets varies from 1 to 10. Other variations in the pricing are tied to features such as algorithm sophistication and add-on motion sensors. Compared to the price of a standard surge suppressor of $10-$50, the price premium for an APS is minimal.

Table 3. APS manufacturers

Selected Manufacturers	Products	Approximate Price Range
APC	Several master-control and timer models	$20
Belkin	Several master-control and timer models, some with remote control	$25-$45
BITs	Master-control models with 7-10 outlets	$25-$40
TrickleStarr	Master-control models with 6-12 outlets	$25-$50
TrippLite	Master-control models with 8-12 outlets	$30-$50
Coleman Cable, Inc.	Master-control models with 6-10 outlets	$25-$40
EcoStrip	One master-control model with 6 outlets	$25
Ethereal	Load-sensing model with an information LED display and 8 outlets	$130
iGoGreen	Master-control model with 4 outlets and a load-sensing 8-outlet model with USB interface	$25, $50
Monster Power	Master-control models with 6-8 outlets	$40-$60
NuGiant	Master-control models with 6-8 outlets	$20-$40
Rocketfish	Master-control models with 7-12 outlets	$20-$30
Watt Stopper (Legrand)	Load-sensing model with an occupancy sensor and 8 outlets	$70-$85

Source: Information gathered from a web search on May 10, 2013 (Sheppy et al. 2014).

Table 4. APS retailers

	Top 10 Mass-Market Retailers (2012)		Top 10 Consumer Electronics Retailers (2011)	
	Store	Carries APS?	Store	Carries APS?
1	Wal-Mart	Yes	Dell	Yes
2	Kroger	No	Hewlett Packard	No
3	Target	No	Best Buy	Yes
4	Walgreens	No	Walmart	Yes
5	Costco	No	Apple	No
6	The Home Depot	Yes	Amazon.com	Yes
7	CVS Caremark	No	CDW Corporation	Yes
8	Lowe's	Yes	Staples	Yes
9	Best Buy	Yes	GameStop	No
10	Safeway	No	Target	No

Sources: A web search on May 10, 2013 (Sheppy et al. 2014).

The Campaign Concept: Moving to Market Penetration

APSs have good commercial availability, including established distribution channels, and are low cost and easy to install, not requiring any special expertise. Actual implementations of the technology show good energy savings and a low payback period, making them a good investment. They are challenged in that plug loads are often not considered an energy efficiency

strategy in commercial buildings and are not in the deployment pathway typical of building level energy efficiency strategies. Most energy efficiency strategies are either designed into a building by the architects and engineers, or the actual device is purchased as an energy-efficient item (such as specifying ENERGY STAR® Products).

Underutilized technologies are those that have a proven energy and cost performance, but have not had good market penetration. DOE has promoted underutilized technologies via a campaign strategy for the past two years. Two campaigns are currently in process. The Lighting Energy Efficiency in Parking Campaign focuses on improving the efficiency of parking lots and parking garages by deploying high-efficiency lighting (www.leepcampaign.org). Likewise, the Advanced Rooftop Unit Campaign seeks to improve the efficiency of rooftop air-conditioning units with either replacement or by upgrading controls and hardware in existing units (www.advancedrtu.org). Both campaigns have successfully gained market interest. These campaigns are run under the auspices of the Better Buildings Alliance, an activity of the DOE Building Technologies Office. DOE has identified the need for a new campaign to promote APSs. This campaign would target commercial building owners in the commercial real estate, healthcare, higher education, and retail sectors.

The APS Campaign will be structured similarly to the other DOE campaigns, but focused on building owners, tenants, and facility managers. The key will be to engage the appropriate decision-makers who can specify, procure, and install the APSs. The campaign is in the planning stages and is expected to launch in late 2014. Like the other campaigns, this one has a focused vision of improving the market uptake of controlling outlets in buildings.

A key part of the timing of a campaign is to align with other market and government forces to make a strong push for deploying the technologies. The following table presents the steps to a successful campaign and provides specific information about the APS Campaign:

Step		Details		APS Campaign
1.	Plan the campaign	a.	Perform an exhaustive literature search to identify available resources and case studies	This search yielded a variety of resources from the national labs, as well as from outside organizations such as utilities, vendors, and other supporting entities. Some resources are APS-specific research studies. Others are fact sheets and informational documents focused on building types such as offices and retail.
		b.	Develop a website as a hub to disseminate resources	The Campaign website will be developed as a hub to disseminate resources. As a placeholder, the Commercial Buildings Resource Database (https://buildingdata.energy.gov/cbrd/search/resources/?f[0]=im_field_collections%3A781) has a collection called “Plug and Process Loads: Energy-Saving Resources” that has some early information. Many utilities and state efficiency programs recognize the energy saving opportunity of APS and offer residential and commercial rebates for the purchase of select models.

Step		Details		APS Campaign
2.	Set measurable goals	a.	Define the urgency for the change or to support a cause	
		b.	Develop a short, simple, clear message that permeates all the literature and outreach activities	
		c.	Back the message with effective metrics that show progress toward the goals	- Develop and publish a technical specification for APS that will maximize energy savings and user acceptance - Within 2 years, secure at least 25 commercial partners and deploy at least 50,000 APSs in partners' buildings
3.	Identify barriers to success, such as:	a.	Businesses and institutions are unwilling to pay a price premium	Businesses and institutions are unwilling to pay a price difference between a standard power strip and an APS
		b.	Business and institutions are unwilling to invest the necessary time	Business and institutions are unwilling to invest the necessary time to install APSs correctly
		c.	Businesses and institutions are unaware of the campaign or find the website unmotivating	Businesses and institutions are unaware of the APS campaign or find the website unmotivating
		d.	Businesses and institutions don't know which products to purchase	Businesses and institutions don't know which products to purchase to maximize energy savings in their buildings
4.	Identify and work with large-scale adopters to identify organizers who can help formulate the plan	a.	Collaborate with market stakeholders	NREL will collaborate with key market stakeholders to overcome barriers that could limit the campaign's success. NREL will create a webpage for the campaign and develop and APS specification that will include outlining market needs for various end users and aligning specifications to them.
5.	Finalize technical specifications		Work with code officials, manufacturers, vendors, and other stakeholders to determine the right technology threshold	In 2014, the Campaign worked with code officials, manufacturers, vendors, and other APS stakeholders in a working group to determine the right technology threshold for the Campaign technical specifications. The BBA Plug and Process Load team, with commercial members from across the country, provided constructive comments and feedback throughout the process.

Step		Details		APS Campaign
			for the technical specifications.	The BBA technical team tried to make the technical specs as fair and inclusive as possible for manufacturers and vendors to comply; endorsements of any kind were avoided. As a starting point, GSA's tech spec as well as NEEP's tech spec for APSs were used.
6.	Identify ways to participate in the campaign	a.	There will be three ways to participate in the Campaign: • Organizing partner • Supporter • Participant	
7.	Identify participants' roles	a.	Evaluate opportunities in their buildings	
		b.	Commit to an implementation strategy	
		c.	Install the measure	
		d.	Share information with the campaign about the measures installed and the energy savings	
8.	Identify supporters	a.	Utilities	
		b.	Manufacturers	
		c.	Other organizations that don't own buildings but support market transformation	
9.	Identify the supporters' roles	a.	Promote local, regional or national recruitment of participants	
		b.	Provide resources or services to participants to help them overcome financial and technical resources (this may include distributing DOE-provided resources)	
		c.	Promote the campaign through equipment distribution networks, client interactions, websites, and other	

Step		Details		APS Campaign
			media venues	
10.	Identify organizing partners	a.	GSA: General Services Administration ACEEE: American Council for an Energy-Efficient Economy NEEP: Northeast Energy Efficiency Partnerships DOE: Better Buildings Alliance Plug and Process Loads Technical Team	
11.	Identify organizing partners' roles	a.	Provide input and decision-making on design and implementation	Organizing partners will: • Evaluate opportunities for APSs in their building or portfolio (which may involve using campaign tools) • Commit to an APS implementation strategy based on the technical specification • Install APSs • Share information with the Campaign on (1) the number of APSs installed and (2) the measured energy savings (optional).
		b.	Recruit participants and supporters	
		c.	Provide outreach, marketing, and promotion of campaign resources	
		d.	Help track campaign impacts	
		e.	Include campaign logo on their websites and provide links to the campaign website	
		f.	Host webinars and educational opportunities	
12.	Develop technical resources and marketing materials			

Step		Details		APS Campaign
13.	Provide technical support			
14.	Provide rewards and recognition			
15.	Close out			

Plan Execution and Tracking of Campaign Progress

The Campaign will officially launch in late 2014. When the Campaign launches, the website will go live. Website will include the ability to sign-up as a partner or supporter. The success of this campaign will be measured by (1) the number of APSs installed in buildings, (2) the number of participants that sign up (and the relative size of their building portfolios), and (3) qualitative – the level of awareness that is raised in the areas of APSs and plug load controls.

Conclusions

APSs have a proven track record of reducing plug loads in commercial buildings. The APS campaign will build off the successes of past technology demonstrations and connect key decision makers with the resources they need to achieve savings in their own buildings with a desirable return on investment. After the Campaign concludes, the Campaign website will transition into a repository of APS information, resources and tools.

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