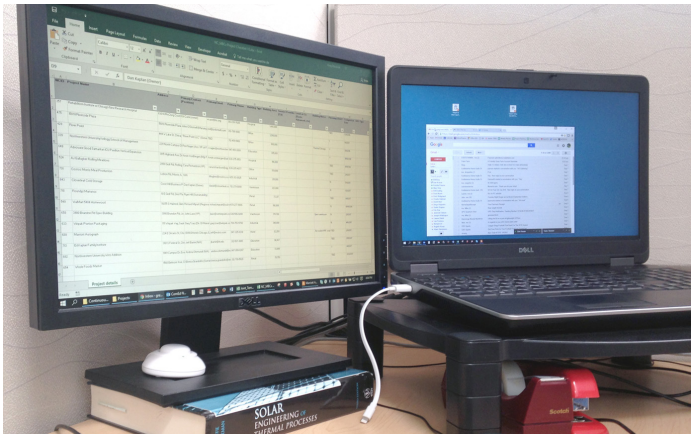
Power down, power off

BEGINNING TO CAPTURE THE UNTAPPED ENERGY SAVINGS IN OFFICE PLUG LOADS

In the quest to reduce energy use in offices, plug loads are becoming impossible to ignore. In Midwest office spaces, plug loads account for approximately 28% of the energy used. However, as we install ever more efficient lighting in these spaces, replace HVAC equipment and commission and tune controls the fraction of energy use from plug loads increases—in many high performance buildings it is closer to 40–50% (about 15 kBtu/ft²/yr) of the energy used.

There are a number of basic solutions we can begin to employ to solve this challenge. We recently conducted research on plug loads such as computers, copiers and kitchen equipment in the state of Minnesota. We tested plug load reduction strategies and identified the potential to save over 100 million kWh annually in that state alone.



Effective strategies

Implementation of effective plug load energy reduction strategies must take into account the many ways plugged in devices are used, as well as the variety of people using them. During our study, we tested four energy reduction strategies in office workstations: computer power management (CPM), advanced power strip (APS) controlled by an occupancy sensor, APS controlled by the occupant (foot pedal) and an education/behavior campaign paired with the APSs. We also tested timers on common area equipment.

Computer power management

Energy use at workstations is driven primarily by the computer which can account for as much as 66% of workstation energy use from desktop computers and 30% from laptops. CPM automatically puts computers and monitors in low power mode after a period of inactivity and can achieve significant energy savings. However, this strategy can be difficult to implement because it must be integrated with IT department protocols, it interacts with other software, and it can make remote access to computers difficult. Due to these concerns, most of the offices we observed had not widely implemented CPM. Fortunately, we identified solutions to the above concerns.

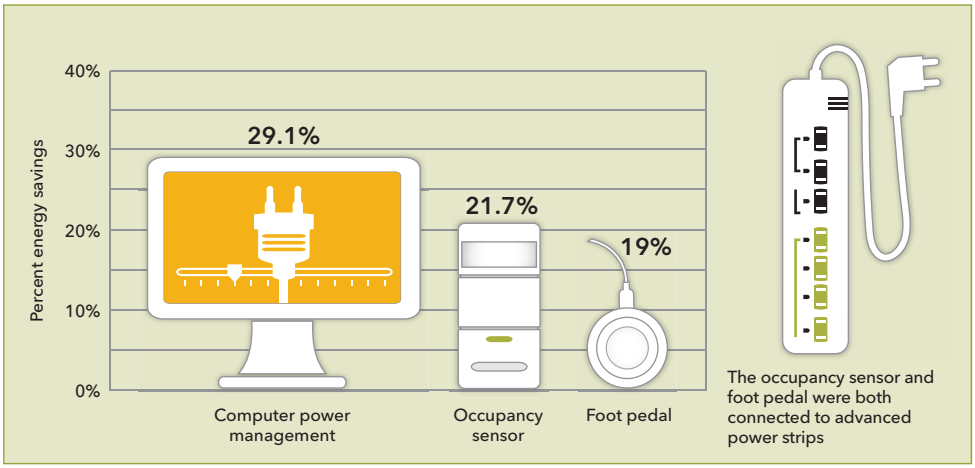


Figure 1: Proven savings from reduction strategies.

Saving 29% of plug load energy with CPM

Effective CPM balances energy savings and productivity. Powering down saves energy. However, if it happens too frequently it reduces productivity and frustrates users. As a starting point, we suggest adjusting computer settings according to ENERGY STAR recommendations. Employees at 80% of the CPM installation sites we studied indicated that ENERGY STAR settings were about right for them.

IT professional's CPM concerns, even in offices with intense computer use demands, were able to be addressed during our study. In some cases, it required motivation from management within the office, close coordination with IT professionals and some testing of the strategy prior to deployment. In the end, implementation of ENERGY STAR recommended settings yielded an average

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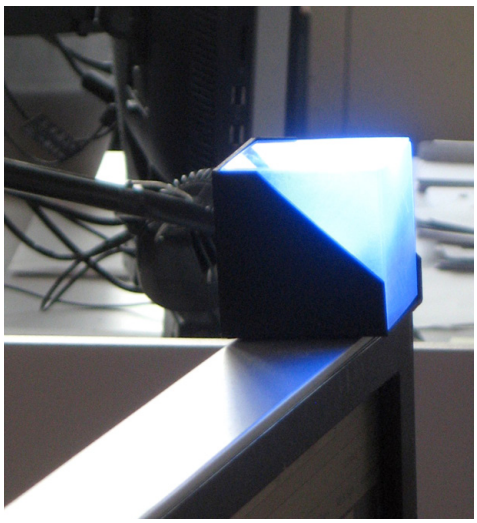

of 29% energy savings in workstation energy use.

Advanced power strip

APSs save energy from peripheral loads such as task lights and monitors that are left on when not in use. We found that a lot of people are leaving such equipment on: night and weekend "unoccupied" workstation power at most of the sites we monitored was at least a quarter of the active daytime use (and up to 45% in one site).

Advanced power strips cut peripheral consumption

We tested two control strategies using APSs: occupancy sensors and a foot pedal switch. The occupancy sensors were set to turn off the controlled outlets after 10 minutes of inactivity. The foot pedal switch could be used to manually turn off the controlled outlets, but was also equipped with a timer to turn everything off at the end of a workday (for those less engaged with the manual control). These APS devices saved between 5–28% of the workstation energy use in our tests. Both APS control strategies were well received by participants and given high ratings for ease of use and effectiveness. Participants expressed a slight preference for the foot pedal switch over the occupancy sensor because it gave them more control over when to shut things down.

The average energy impact of the APS and CPM strategies is shown in *Figure 1*.

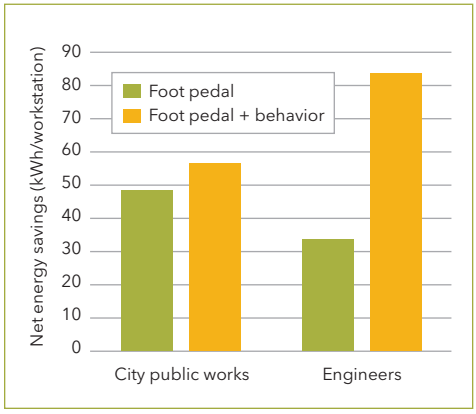

Figure 2: Energy impact of behavior campaigns.

Behavior campaign

Technology is only one part of a holistic plug load energy reduction strategy—people are the other part. More specifically, technology coupled with education and behavior modification can unlock additional energy savings. We found this approach substantially increased energy savings compared to the technology solution alone.

Behavior goes well with technology

We tested an education/behavior campaign built around the APS with foot pedal control technology. The campaign had three components: education, feedback and rewards. Posters and emails were used to give office occupants information on how to reduce their plug load energy use. An LED light placed on the desktop let people know if their power strip was on and provided a reminder to turn off the strip as they left their workstation. Finally, small rewards such as chocolates and coffee gift cards were given to people who demonstrated energy saving behavior (by turning off their power strip when leaving their workstation for lunch or meetings). As *Figure 2 shows*, the impact of these added elements was significant.

	ENERGY SAVINGS		IDLE POWER
	kWh	%	W
Projectors	0	0	0
Televisions	43	42%	12
Desktop printers	47	27%	16
Medium-sized MFDs	51	17%	19
Water coolers	104	21%	––
Coffeemakers	110	18%	30

Table 1. Savings from common area timers.

Common area strategies

There is significant energy to be saved through common area equipment, outside of workstations. Two effective approaches are time-based control and equipment removal. Removing equipment will of course prevent it from using energy—from 550 kWh for coffeemakers to 170 kWh for printers. We refer to the NREL RSF case study as an ideal example. This office demonstrated that one breakroom only is needed for every 60 employees and only one multifunction device is needed for every 60 employees. For common area equipment that is installed (i.e. energy intensive equipment such as coffeemakers,

water coolers and printers) a simple timer can be applied or the circuit scheduled to cut all power during the nights and on weekends. Demonstrated energy savings for this time-based control are shown in *Table 1*.

Other research results

Our tests also yielded a few other interesting results:

- We focused most heavily on workstation energy use and found that typical workstations had five devices plugged in and annually use an average of 330 kWh each. This translates to 4.1 kBtu/ft²/year for workstations alone.
- The energy savings realized from switching from desktops to laptops is being partially offset by the addition of monitors and increased monitor size at each workstation.
- Both the IT department and the sustainability champion at a firm are instrumental in successful plug load control. Having the champion gain management support and then jointly talking to IT is one recipe for success.
- A large number of peripheral devices at workstations is not necessarily an indication of where significant energy savings can be achieved. We found that better indicators include the presence of desktop computer(s), multiple monitors or laser printers. Our research suggests most offices should consider the addition of APS at every workstation.

Are these strategies cost effective?

All of the strategies we tested do come with costs. We estimate the costs to range from $17 per workstation for CPM to $55 per workstation for APSs. In a new office, where new power strips will be purchased anyway, the incremental cost drops to $35 per workstation. These strategies appear to be well worth the expense. Life cycle cost analysis yields a break-even cost of $75 for APSs—any power strip that costs less is cost effective. This corresponds to a payback of just under six years with typical incentives. The break-even cost for CPM, which saves more energy, is $143. This corresponds to a payback of just 1.6 years. It appears that both CPM and APS could be deployed widely. ■

SERVER ENERGY

Plug loads in workstations and common areas are significant, but there is another significant component of plug loads behind closed doors—in the server room. Energy and IT professionals should be equally concerned with those loads. We were able to obtain energy use for servers in three of the eight offices we monitored. We found it was on the same order of magnitude as the workstation energy use. A separate research project in Minnesota is currently addressing the server portion of plug loads; look for results of that study in Spring 2017.

For more information

Contact Scott Hackel at shackel@seventhwave.org

Full report of our research: https://www.seventhwave.org/commercial-plug-load-study

Computer power management guidance: ENERGY STAR Low Carbon IT Campaign energystar.gov/products/low_carbon_it_campaign/put_your_computers_sleep

Advanced power strip guidance: Better Buildings Alliance

betterbuildingssolutioncenter.energy.gov/myth-busting-market-barriers-advanced-power-strips

Designing offices for lower plug loads: NREL Research Support Facility Study nrel.gov/docs/fy11osti/49002.pdf

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