

Getting Plug Loads in Check



**SMART
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A project of NEEC

SUMMARY

Plug loads in commercial buildings consume a significant amount of electricity within commercial buildings—as much as 10-60%, depending on the use type. Forecasts predict these numbers could increase by another 30-35% by 2030.¹ This is due to the proliferation of more energy-intensive equipment and the increased use of task lighting to compensate for lower designed overhead lighting levels. To reduce this energy waste, building owners and operators can implement occupancy-based controls to turn off plug loads when workspaces are vacant. Growing numbers of code entities are starting to require plug load control as a method to reduce this energy waste, including in the City of Seattle and statewide in California.

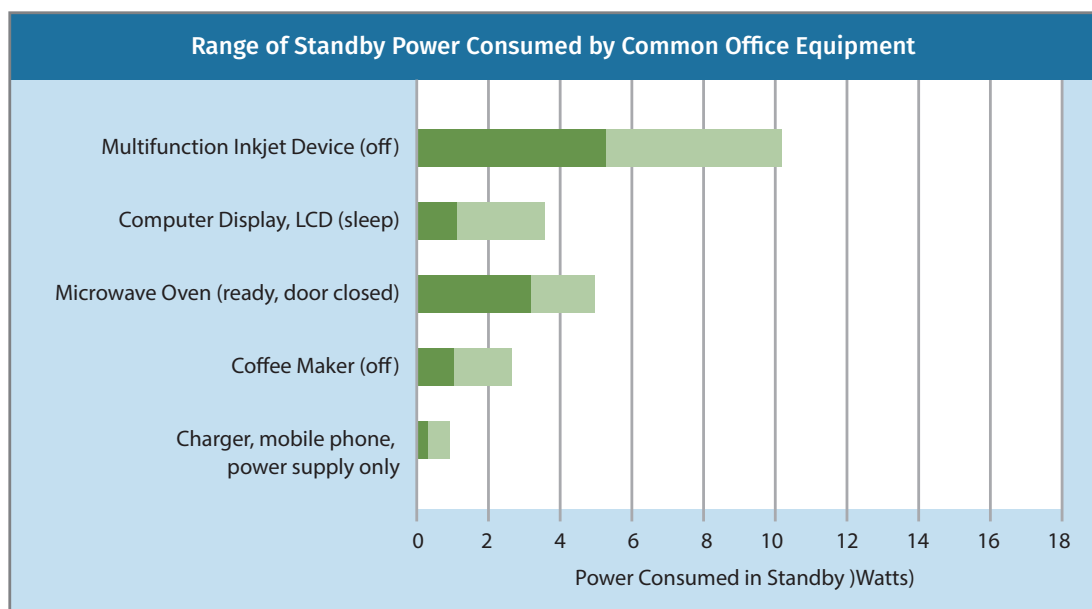
CHALLENGE: PLUG LOADS AN INCREASINGLY IMPORTANT ENERGY FOCUS

Energy efficiency advances in heating, ventilation, and air conditioning (HVAC), building envelope, and lighting systems have greatly reduced the energy footprint of many commercial buildings. Yet as one slice of the energy pie gets trimmed, it means that others become proportionally larger. The percentage of energy used to power computer workstations, office equipment, and kitchen appliances has become a more significant slice of the total energy picture.

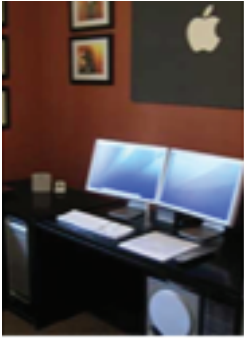
These energy loads are often referred to as “plug loads” and typically account for about 25% of an office building’s electrical consumption. That portion can grow to 50% or more in high-efficiency buildings with optimized HVAC, lighting, windows, and insulation or for building types that feature manufacturing, refrigeration, or the like.²

Compounding the issue, the U.S. Environmental Protection Agency (EPA) estimates that 80% of printers, 70% of copiers, 65% of workstations, and 20-30% of computer monitors and task lights used in offices remain on overnight.³ Much of this equipment draws electrical power even when it is turned off or left in standby mode. These “phantom” loads add up.

The following graph shows the range of power consumed in standby mode for some common equipment, emphasizing the need to check a specific equipment’s draw before attempting a payback calculation for implementing plug load control. Standby load ranges are taken from Lawrence Berkeley National Laboratory.⁴



▶ SNAPSHOT OF THE CHALLENGE



Typical Workstation

- ▶ Dual LCD Monitors: 1.13 W in standby each, 2.26 W total
- ▶ Cell Phone Charger: 0.26 W when not charging anything



Kitchen

- ▶ Coffee Maker: 1.14 W when off
- ▶ Microwave: 3.08 W with door closed



Combination printer/copier/scanner (inkjet)

- ▶ 5.26 W in standby mode

Where Loads Are Controlled

Plug loads can be controlled either inside the wall, as an installed feature, or outside the wall, as a plug strip. Installed solutions are generally much more expensive because they require the electrician to spend additional time during construction running wire from the outlet to a sensor, timer, or building management system and to an additional relay. However, installed solutions are permanent and are required by some building codes that do not allow for outside-the-wall solutions.

Outside-the-wall solutions come in the form of a plug-in strip or module and can be controlled by timers, sensors, the electrical draw on one plug, and/or computer programs. Plug-in strips and modules, ranging from \$20 to \$60 each, vary in expense but are much more affordable than installed outlets.

How Loads are Controlled

Plug load controls can be controlled by:

- ▶ Timers, which can be specific to each user's schedule
- ▶ Occupancy sensors, which are often already installed due to building code requirements
- ▶ "Auto-switching" outlet strips; if the master outlet if it is not drawing power, its corresponding outlets will not draw power
- ▶ A building management system, which can respond to sensors, schedules, loads, users' inputs, and user behavior

Timers

Timers vary in complexity, but are preset based on a user's schedule. For example, a user could set a timer to allow power draw from the controlled outlets only during business hours. Timers work well with equipment that needs a "warming up" period and should not be turned on and off throughout the day, like photocopiers, water coolers, and coffee makers.

Occupancy Sensors

Different occupancy sensors rely on motion, heat, and sound to detect occupants. Occupancy controls are now required by many building codes to control lighting, and these occupancy sensors can be shared with outlets by the lighting control system. Sharing occupancy sensors reduces cost for implementing occupancy controlled outlets. A plug load control tied to motion sensors could be beneficial in a home bathroom or kitchen, where occupants spend a few minutes a day, and could be used

▶ SOLUTION: PLUGLOAD CONTROLS

Plug load controls can eliminate unnecessary loads during non-operational hours by automatically turning off monitors, coffee makers, microwaves, water coolers, printers, copiers, and other equipment. Various plug load control solutions exist and each solution has these two defining features:

- ▶ Where it controls loads
- ▶ How it controls loads

for small equipment like blow dryers, microwaves, or toasters. Occupancy controlled outlets are also useful at workstations to control monitors and task lighting.

Auto-Switching Outlet Strips

An “auto-switching” outlet strip is controlled by a master outlet plugged into a piece of equipment that is used very regularly, like a computer monitor. When the master outlet detects that there is not current being drawn from it, it removes power from its corresponding outlets. Auto-switching outlet strips are inexpensive and easy to use because they require no user programming. They do, however, require occupants to habitually turn the master equipment off, so that the signal is sent to the corresponding equipment.

Building Management Systems

Building management systems (BMSs) are becoming more popular and, like occupancy sensors, can do double duty as outlet controls. A BMS can use sensors, preprogrammed schedules, and real-time occupant feedback to

determine whether different areas in the building need conditioning and lighting, and can use those same sensors, schedules, and feedback to determine which outlets to power.

Snapshot of Solutions

The table below shows these same solutions applied to the same three common outlet scenarios in a commercial office: a dual-monitor workstation, a small kitchen, and a photocopier. Simple payback calculations are based on 270 work days per year, office operating hours from 7am to 6pm, electricity rate of \$0.085/kWh and standby draws are taken from Lawrence Berkeley National Laboratory. Outside-the-wall solution paybacks include equipment cost only; inside-the-wall solution paybacks include equipment cost and an estimated 30 minutes additional installation time per receptacle required by professional electrician, whose rate is assumed to be \$90/hour. Calculations did not include inflation.

Outside-The-Wall Solutions		Inside-The-Wall Solutions	
	Westek TE08WHB Indoor 8-Outlet Weekly Digital Power Strip Timer Price: \$19.97 Payback in Years for: <ul style="list-style-type: none"> Workstation: 8.5 Kitchen: 6.1 Photocopier: 5.1 http://amzn.com/B009KVEENO		Lutron PowerPak RMJ-16R-DV-B, controlling each workstation (retrofit) Price: \$60.00 Payback in Years for: <ul style="list-style-type: none"> Workstation: 25.6 Kitchen: 18.3 Photocopier: 15.3 https://www.platt.com/platt-electric-supply/Wireless-Radio-Frequency-Lighting-Control-System/Lutron/RMJ-16R-DV-B/product.aspx?zpid=879950
	WattStopper IDP-3050 Surge Suppressor with Occupancy Sensor Price: \$87.56 Payback in Years for: <ul style="list-style-type: none"> Workstation: 37.4 Kitchen: 26.8 Photocopier: 22.3 http://amzn.com/B004EZNL58		WattStopper LMPL-101, controlling each workstation (retrofit) Price: \$65.00 Payback in Years for: <ul style="list-style-type: none"> Workstation: 25.6 Kitchen: 18.3 Photocopier: 15.3 https://www.platt.com/platt-electric-supply/Digital-Lighting-Management-DLM-Room-Controllers/Wattstopper/LMPL-101/product.aspx?zpid=149711
	Smart Strip LCG3 Energy Saving surge Protector with Autoswitching Technology Price: \$40.00 Payback in Years for: <ul style="list-style-type: none"> Workstation: 17.1 Kitchen: 12.2 Photocopier: 10.2 http://amzn.com/B0006PUDQK		Dedicated relay panel tied to lighting control occupancy sensor and controlled receptacles (new construction) Price: \$25.00 Payback in Years for: <ul style="list-style-type: none"> Workstation: 10.7 Kitchen: 7.6 Photocopier: 6.4
	ThinkECO's Modlet WiiControlled Outlet 5x Price: \$305.00 in total, \$61.00 per outlet Payback in Years for: <ul style="list-style-type: none"> Workstation: 16.1 Kitchen: 18.7 Photocopier: 15.6 http://shop.thinkecoinc.com/products/5-pack-starter-kit-enterprise-edition		



REMEMBER THE PEOPLE

Plug load controls do require cooperation with occupants. A brief training program or, at minimum, an overview included in a tenant's or owner's manual can explain why the equipment is being implemented, how to use it, and what things to keep in mind. These materials can explain that there will still be some equipment that is operational 24/7, like refrigerators and servers, which are not appropriate for plug load control.

Topics to review with occupants:

- ▶ Location of controls
- ▶ Schedules
- ▶ Any manual overrides and how to restore normal plug load control after a brief override

After training, occupants may still require reminders and help operating the equipment. Making someone specifically responsible for the controls, whether it is a member of the facility staff or an employee with a zest for energy conservation, may be helpful.



CONCLUSION

As buildings become more efficient, plug loads represent a proportionally larger percentage of overall energy use in the building. Plug loads can be controlled during non-operational hours to reduce energy costs, and controls are being required by some energy codes. Loads can be controlled in a number of ways, including via occupancy sensors, timers, and Building Management Systems. These controls vary in cost and are available as outlet strips or installed solutions. As energy costs increase, it will be more beneficial to implement plug load controls and technology will improve in price and capability. In the future, plug load controls will likely remove power from an outlet based on the load profile of the equipment as it goes into standby mode.

¹ U.S. DOE, EERE, <https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads>

² DOE. (2010). 2010 Buildings Energy Data Book. Washington, DC: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. <http://buildingsdata-book.eere.energy.gov>

³ Hordeski, M. (2000). Dictionary of Energy Efficiency Technologies. Liburn, GA: Fairmont Press, Inc., p. 277.

⁴ Lawrence Berkeley National Laboratory (2015). "Standby Power;" <http://standby.lbl.gov/summary-table.html>.

⁵ U.S. Energy Information Administration (2015). "Electric Power Monthly," http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a.

About the Smart Buildings Center

The Smart Buildings Center (SBC) is a project of the Northwest Energy Efficiency Council (NEEC), which is a non-profit industry association of the energy efficiency industry. The SBC supports growth and innovation in the Pacific Northwest's energy efficiency industry, serving as a hub for industry activities and raising the visibility of energy efficiency companies and projects.



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