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Best Practices for Plug Load Management Using a Building Energy Management System

As commercial buildings become more energy efficient through efficiency gains in end uses such as lighting and heating, ventilating, and air conditioning (HVAC), the portion of plug load energy use will continue to grow. Plug loads—the energy loads resulting from plug-in devices—can be challenging to reduce as they are numerous, diverse, and heavily influenced by occupant behavior.

However, these challenges can be overcome when plug load controls (PLCs) are integrated with the building energy management system (BEMS). When PLCs are integrated with the BEMS, they are easier to manage because the plug load data and controls can be accessed from the same location as HVAC and lighting, consolidating and streamlining the effort to control these building end uses.

The University of California San Diego (UCSD) successfully integrated PLCs with their BEMS, which resulted in 66% energy savings over one week across 25 plug loads (Chia et al. 2023). The types of plug loads they controlled include TVs, printers, coffee makers, and computers, to name a few. UCSD documented each step of this effort, highlighting best practices along the way, in their 10-page brief, "Best Practices for Plug Load Management Using a Building Energy Management System" (also referred to as the "brief" in this document). The brief includes 8 detailed steps to guide a building owner/operator on how to successfully integrate PLCs with their BEMS.

This fact sheet provides highlights and key takeaways from UCSD's brief. The reader is encouraged to read UCSD's full brief if they wish to move forward with implementing PLC integration with their BEMS.

Steps To Integrate PLC With BEMS

Table 1. Summary of UCSD's 8 Steps To Integrate Plug Load Controls With a Building Energy Management System

Step	Summary	Outcome
Step 1: Familiarize Yourself With Your Whole Building's Electricity Use	• It is important to understand your facility's electricity use as a whole before you identify PLC opportunities. • Look for usage patterns and categorize them as baseload, active load (non-working day), active load (working day), and peak demand (see Figure 1). For detailed definitions refer to the brief.	Understanding of your building's baseload, active loads, and peak demand.
Step 2: Survey Plug Loads in Your Facility	• Go room by room and photograph all plug loads plugged into wall outlets. • Document plug load information for each device such as: voltage, plug load type, make, model, description of use and requirements (e.g., device must be ON during business hours), owner (i.e., Who is responsible for device? Who are primary users?), location, notes (e.g., observations such as which devices are left in standby mode when not in use).	Documentation of plug load inventory in your building.

Step	Summary	Outcome
Step 3: Decide Which Plug Loads To Control	• Organize plug loads by type (e.g., printer, TV). • Target appliances that are pulling at least 5–10 watts when they are not in use (see Figure 2). • Build a business case for implementing PLC by using the equation provided in the brief that will estimate the savings for each plug load on your list. • Engage stakeholders to understand their plug load usage patterns, establish usage schedules that can be used to inform PLC, and address and note installation concerns. • Based on findings from steps above, update your prioritized list of plug loads to target for control.	Prioritized list of plug loads to target for control, with a supporting business case.
Step 4: Select and Procure PLC Hardware	• Consider key characteristics for PLC hardware selection such as BEMS integration, wireless connectivity, override button, and scheduling.	PLC hardware with appropriate capabilities has been selected and procured.
Step 5: Setup and Install PLCs	• Connect PLCs to the network and integrate them into the BEMS. • Install and label PLCs for easy identification (i.e., PLC name, location, plug load appliance type, use).	PLC has been set up and integrated with your building's BEMs, and baseline data have been collected.
Step 6: Train and Conduct Ongoing Engagement With Occupants	• Understand the importance of training occupants on PLC use and benefits. • Implement strategies for ongoing engagement and communication with building occupants.	Occupants understand why PLCs are being used, types of controls to expect, how to manually override controls, and who to contact for troubleshooting.
Step 7: Implement Plug Load Controls	• Implement control strategies based on occupancy and usage patterns. • Understand levels of control (Level 1 to Level 4) and their implications.	PLCs have been applied. PLCs have been classified into different levels based on occupant risk tolerance and plug load type.
Step 8: Conduct Ongoing Maintenance and Operation	• Monitor and verify PLC performance. • Report energy savings and maintain engagement with occupants.	Progress reports are being generated, alerts have been created to flag PLC connection or status issues, and occupants are regularly engaged.

Summary

Many plug loads consume energy unnecessarily when left on or in standby mode, making them a prime target for energy reduction, yet they remain challenging to control. However, by following the steps above—prioritizing the most suitable plug loads to control, effectively procuring hardware, integrating with the BEMS, engaging occupants, and performing ongoing maintenance—UCSD achieved 66% energy savings over 1 week across 25 plug loads (Chia et al. 2023). They found that PLC integration with the BEMS not only provides energy savings but also enhances operational efficiency by having a single interface for the operator, and delivers additional non-energy benefits such as reduced staff time turning appliances on and off each day.

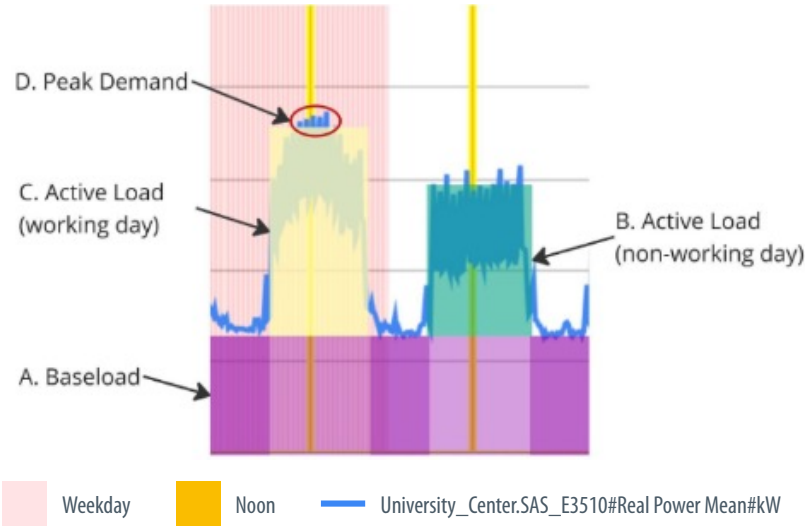

Figure 1. Power measurements from a UCSD office building with labels for different building electricity use patterns. *Data from UCSD (2024)*

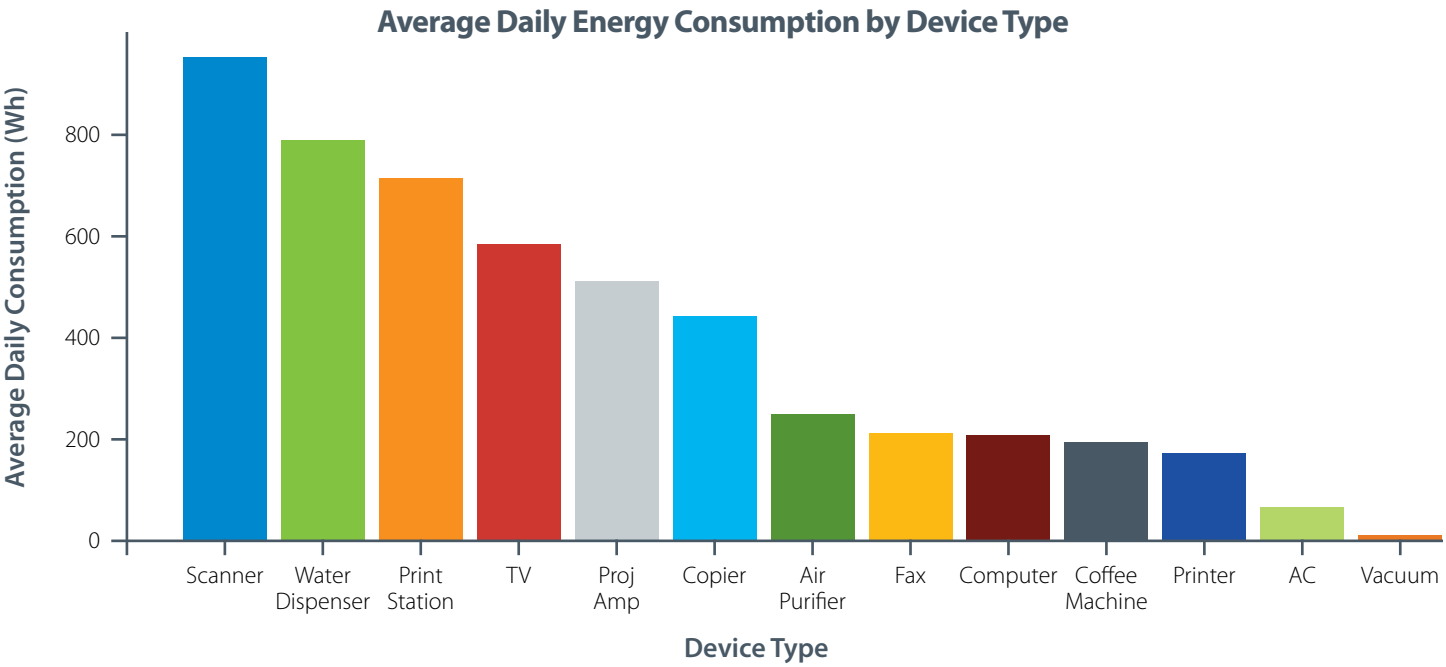

Figure 2. Energy consumption of common plug loads at UCSD. *Data from UCSD (2024)*

Conclusion

Integrating PLC with BEMS simplifies plug load management, allowing for streamlined operations. Regular monitoring and maintenance of PLCs, combined with ongoing occupant engagement through training, education, and progress reporting on energy savings, can result in substantial energy reductions. For those interested in integrating PLC with BEMS, the full document, "Best Practices for Plug Load Management Using a Building Energy Management System," offers detailed steps and examples.

Additional resources on plug load management include the Assessing and Reducing Plug and Process Loads in Office Buildings guide (NREL 2020) and Smart Outlets: Wireless Meter and Control Systems for Plug and Process Loads guide (NREL 2021), both found on the Better Buildings Plug and Process Loads website.

Contact

For further inquiries or additional resources, please contact kwchia@ucsd.edu or PPL@nrel.gov.

References

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