Introduction

This fact sheet introduces two emerging technologies that could streamline plug load management (PLM) for increased energy savings for building owners. Plug loads are responsible for 47% of the energy consumed in commercial buildings[1], yet their distributed and ever-changing nature makes them challenging to manage. PLM systems exist today that use smart plugs to meter and control devices at the outlet level, but their uptake has been relatively slow in part because of the significant labor required for installation and maintenance.

Two emerging technology areas may address these challenges and provide additional energy efficiency and nonenergy benefits:

Learning behavior algorithms (LBA) learn occupant behavior and adjust plug load controls accordingly, allowing for the automatic creation of optimized control schedules.

Automatic and dynamic load detection (ADLD) allows a PLM system to identify devices as they are plugged in to a building and keeps the system up to date as devices are moved throughout a building.

This fact sheet summarizes the findings from a 2020 conference paper.[2]

What is the current state of LBA & ADLD technologies in PLM systems?

▶ **Learning Behavior Algorithms**

Behavior-based machine learning algorithms have been applied to HVAC and lighting end uses more frequently than plug loads. Still, some companies are actively investigating LBA for plug load applications. There are at least 5 companies developing or offering products with behavior-based machine learning technologies.

▶ **Automatic and Dynamic Load Detection**

At the time of this writing, there is no well-vetted technology through which a building management system can automatically identify the type and location of a device plugged in to an outlet. There are several ADLD-related patents and completed research projects supporting the R&D of this technology. Three of the 7 companies interviewed for this paper have explored ADLD plug load applications. Depending on market demand, this technology is expected to become available to consumers within 3-5 years.

Conclusions

As PLM evolves, expect to see the integration of LBA and ADLD into product offerings, with LBA arriving to market earlier. Both will allow for streamlined plug load control, saving building owners time and money in their pursuit of energy savings.

KEY TAKEAWAYS

▶ LBA reduce human impact in a PLM system and can predict anomalies, flagging possible issues in device performance and health. Additionally, LBA could encourage integration of plug load data with data from other sources. Researchers are working to expand the technology beyond simple cases and single building types, and to provide a low-cost product to meet market demand. There are at least 5 companies developing or already offering products with LBA technologies.

▶ ADLD offers a plug-and-play system and easy installation that saves time. Researchers are working to reduce development costs and fully automate the technology. ADLD is expected to become available to consumers within 3-5 years.

▶ Some areas of R&D for both technologies are scaling for large commercial building applications, achieving economies of scale, and addressing data privacy and cybersecurity.

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[1] EIA (U.S. Energy Information Administration). 2020. Annual Energy Outlook 2020. https://www.eia.gov/ outlooks/aeo/.

[2] K. Trenbath, et. al (2020). Emerging Technologies for Improved Plug Load Management Systems: Learning Behavior Algorithms and Automatic and Dynamic Load Detection. *ACEEE Summer Study Energy Effic. Build*., 409.