Integrated Controls for Plug Loads and Lighting Systems

CASE STUDY: Minnesota DOT Cedar Avenue Truck Station

About the Participant

The Minnesota Department of Transportation (MnDOT) has more than 1,075 buildings with 137 truck station campuses across the state. MnDOT's Cedar Avenue truck station, located in Richfield, Minnesota, provides critical roadway snow removal support within the Minneapolis metro area. It includes administrative offices, a training room, and a large breakroom, along with truck maintenance and service facilities.

The focus of this case study is to highlight the strategies used at Cedar Avenue truck station for integrating plug load and lighting systems. An integrated controls pilot project with retrofit installation was conducted from October 2019 to April 2020 and has been recognized by the Integrated Lighting Campaign in the following categories:

- Integrated Controls for Plug Loads & Lighting Systems
- Integrated Controls for HVAC & Lighting Systems

The lighting-plug load integration project was co-funded by MnDOT, the U.S. Department of Energy, and Xcel Energy.

Project Motivation

The project included the retrofitting and integrating the solid-state networked lighting control with plug load, and HVAC (heating, ventilation, and air conditioning) system operation. Existing lighting fixtures in the office space were near the end of their life. The facilities team looked at this retrofit and integration effort as an energy savings project. This facility was a suitable candidate to achieve energy savings by implementing occupancy-based control and lighting integration because of its continuous operation and highly variable occupancy pattern.

Plug Load + Lighting System Integration

Each of the new luminaires has an occupancy sensor, light level sensor, and wireless communication capabilities. The occupancy sensors in the virtually created lighting zones manage the lighting system operation. The plug load control module operates controlled outlets based on the wireless signal from the occupancy sensors. All faceplates of the controlled outlets have a button for manual override by the user. The signal flow is unidirectional—from the lighting occupancy sensor to the plug load controller. The plug load control module cannot operate the lighting fixtures.

Cedar Avenue truck station
Photo from Mark Moehlenbrock, MnDOT

Participant Quick Facts

- Building Details
  - Location: Richfield, MN
  - Office area: 11,300 sq.ft.
  - Total building size: 74,776 sq.ft.
  - Office usage: 24/7 operational facility with highly variable occupancy pattern
- Controlled Plug Load Details
  - Dual controlled outlets: 4
  - Half controlled outlets: 5
  - Transmitters: 4
  - Cubicle controls: 2
- Loads Connected to Controlled Outlets
  - Computer monitors
  - Desk fans
  - Miscellaneous office equipment

About Automatic Receptacle Controls (ARCs)

- ARCs turn off power to receptacle plugs using occupancy sensors, control schedules, or timers
- Available in single or duplex outlet control configurations
- Plug load controllers can communicate to the outlets through wires or wirelessly
- Also known as controlled receptacles or controlled outlets

Office space in the Cedar Avenue facility
Photo by Mark Moehlenbrock, MnDOT

Project Outcomes

Monitors, desk fans, television sets, and office equipment are connected to controlled outlets. The plug load integration setup was optimized based on the pilot test run and user feedback, which included changes to devices connected to controlled outlets and optimizing virtual occupancy zones.

- **Annual energy saved with retrofitted luminaires: 19,036 kWh**
- **Total controlled outlets: 13**
- **Annual plug load energy saved in controlled outlets: 774 kWh**
- **Plug load material cost: $1,654**
- **Plug load labor cost: $556**

The energy savings were measured during the COVID-19 pandemic with lower occupancy, and the savings could change once the office returns to the typical occupancy level. Integration with HVAC systems realized additional energy savings due to temperature setbacks in the unoccupied areas.

Lessons Learned and Best Practices

Establish a champion to lead the plug load integration project, from planning and implementation through maintenance. The champion is the main point of contact for all stakeholders, including decision makers and occupants.

- **Controlled Plug Load and Zone Selection**
  Ensure that devices plugged into controlled outlets are good candidates for controls. High-energy consuming loads should be identified and controlled for maximum savings potential. Devices with a long startup time (like vending machines) should be plugged into an uncontrolled outlet. Select occupancy zones so that they cover all users of the controllable loads (like TV and audio-visual equipment) in conference rooms and common areas.

- **User Engagement**
  Provide a level of occupant education that matches the needs of the occupant. At the Cedar Avenue truck station, controllable outlet user guides were provided to building occupants during construction. Engage with occupants regularly to keep them updated on the best devices to plug into controlled outlets. Other locations, such as those with more occupant turnover, may need signage or regular communication about the technology.

- **Installation and Commissioning**
  Engage the information technology department at the beginning and keep them informed throughout the project. Make sure the electricians are educated on the installation scope and commissioning process.

Project Partners

Slipstream was the project lead and collaborated with the building owner representatives. Cree Lighting provided the lighting system integration and commissioning. Wireless ARCs for plug loads were provided by Legrand/Wattstopper. Energy monitoring and data analysis was provided by Pacific Northwest National Laboratory.

About the Integrated Lighting Campaign

The Integrated Lighting Campaign (ILC) is a program designed to help facility owners and managers take advantage of savings opportunities and benefits of advanced lighting controls and of integrating lighting systems with other building or business systems in their facilities. The ILC serves as a resource for relevant research regarding new advanced lighting controls and integrated lighting systems and provides a platform to recognize exemplary projects shared by ILC participants and supporters.