Field Validation of Lighting Retrofit with HVAC Integration and Plug Load Controls at the Minnesota Department of Transportation (MnDOT)

Background

The Minnesota Department of Transportation (MnDOT) maintains the state roads and highways in the Twin Cities Metro area from the Cedar Truck Station. Before the retrofit project, the building used outdated fluorescent lighting that over lit the building.

Project Summary

The variable needs of the facility required that it operate 24 hours a day to handle unpredictable activities such as snow plowing and deployment of temporary barriers for parades or other road-related pedestrian events.

MnDOT retrofitted approximately 11,300 ft^2 of the Cedar Truck Station with a luminaire-level lighting controls (LLLC) system. The occupancy sensors in the LLLC signaled the receptacle to turn off and communicated with the building automation system (BAS) to adjust the mechanical systems, such as temperature and fans, when the space is unoccupied. The goal was to drive deeper energy savings by deploying a system that could take advantage of the highly variable occupancy in the building. The LLLC featured dimming control, photosensing, and occupancy sensing capabilities for each individual fixture.

Energy Saving Control Strategies

- Light emitting diodes (LED) with networked lighting controls (task tuned, occupancy sensors, and some daylight sensors)
- Plug load controls in office spaces
- Plug load controls on common area equipment like printers and chargers
- Plug load controls near the fitness center exercise equipment
- Thermostat setback based on occupancy

The project was funded by U.S. Department of Energy (DOE) via the Scaling Up the Next Generation of Building Efficiency Packages Funding Opportunity Announcement (FOA), which "supports high-impact real building demonstrations led by strategically structured teams who will identify and verify the cost and energy performance of multisystem energy efficiency packages." The goal of the field validation was to test the performance of plug load integration and identify potential challenges and future opportunities. Members of this project team members include Slipstream (formerly Seventhwave); Cree Lighting; Legrand/ Wattstopper; Xcel Energy; and Pacific Northwest National Laboratory (PNNL).

PROJECT QUICK FACTS

- **Location:** 1900 East 66th Street Richfield, MN 55423
- **Building Size:** 74,776 ft^2
- **Retrofit Areas:** 11,300 ft^2
- **Building Sector Type:** One-story administrative office and maintenance facility (conference room, office areas with enclosed and open offices, lunchroom, hallway, locker rooms, storage areas, and warehouse area)
- **Heating, Ventilation, and Air Conditioning (HVAC) Unit Type:** One single-duct, variable air volume (VAV) air handling unit (AHU) serving 10 zones controlled by series fan-powered VAV terminal units with hot water reheat coils. The fan powered VAV boxes have fan speed control regulators.
- **BAS System Type:** Distech Controls Inc. (Tridium Niagara framework)
- **Occupancy Description:** 30 occupants, operating 24/7
- **Utility Incentives:** $11,224
- **Project Completion Year:** 2019

- VAV box shut off based on occupancy
- AHU supply air temperature reset
- Hot water supply temperature reset

Project Cost Considerations

- The initial purchase cost of networked lighting controls requires a certain amount of equipment regardless of the size of the space. Therefore, the cost per square foot for this project was high because only 11,300 ft^2 was retrofitted with controls.
- Individually, the lighting controls and receptacle controls would have struggled for cost effectiveness. However, when included with the HVAC integration, the HVAC savings helped make all three systems cost effective..

Lessons Learned

- **Establish methods to determine if integration failed/stopped.** The lighting systems do not notify when connection with the HVAC system is interrupted therefore, it is recommended to create a feedback mechanism that notifies when the integration has stopped or is interrupted.
- **Plan the lighting and HVAC zones in advance.** Mapping control points between lighting and HVAC involves coordination between multiple parties: electricians, lighting controls person, mechanical contractors, and building staff

Project Cost

	Material (/ft^2)	Labor (/ft^2)	Payback (years)
Lighting	$2.93	$4.07	40.0
Lighting w/ Incentives	$1.48	$2.07	20.3
Plug Load	$0.08	$0.03	14.8
HVAC	—	$0.38	< 1 years
Subtotal	$3.01	$4.48	—
Subtotal w/ Incentives	$1.56	$2.48	—
Total	$7.49		4.9
Total w/ Incentives	$4.04		2.7

- **Buildings with variable (and unpredictable) occupancy are ideal for occupant-driven controls.** Buildings that must stay open but may have unoccupied spaces sporadically can save significant money and energy by using occupant-based controls.
- **Determine if plug load devices have warm-up time before connecting to automatic receptacle controls (ARC).** Post ARC installation, two of the ARCs were removed because the devices connected to the ARC could not turn on quickly once being powered off. The devices connected to the ARC include a vending machine and a video-conferencing equipment. Both pieces of equipment had a warm-up period upon power being turned off at the receptacle. As a result, the staff were unhappy with warm-up periods of both pieces of equipment. MnDOT removed the ARC to address the staff concerns.

- **Educate the building occupants about advanced or novel features.** Occupants are more likely to adopt and use receptacle controls if they have been trained properly on their purpose and operation.
- **Train building owner's staff during commissioning.** Once commissioning is completed by the vendor, it is beneficial to assign a local staff who can take ownership of the controls who can adjust settings as appropriate.

Potential Energy Savings		
Lighting Savings	1.7 kWh/ft^2	77%
Plug Load Savings	0.1 kWh/ft^2	72%
HVAC Savings	12.6 kWh/ft^2 0.02 therms/ft^2	62%
Total Cost Savings	$1.59/ft^2	

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