Field Validation of Lighting Retrofit with HVAC Integration and Plug Load Controls at CentraCare in Becker, Minnesota

Background

CentraCare is a non-profit health care system in Central Minnesota that operates outpatient clinics, pharmacies, senior care facilities, and hospitals. CentraCare has a long history of energy and sustainability efforts and actively explores new energy-efficient building technologies. The Becker, MN, site was acquired and renovated by CentraCare before the field evaluation started.

Project Summary

The project provided a packaged solution for a retrofit of the lighting, including site survey, design, system selection, and financial assistance with materials and labor.

The existing lighting was comprised of recessed fluorescent luminaires with some vacancy sensors in patient rooms. Due to privacy concerns at this medical outpatient building, there are limited windows into the building and most of the spaces along the perimeter with windows are doctors' offices. The lighting was replaced with LED lighting with networked luminaire level lighting controls. Each luminaire contained both an occupancy and daylight sensor. Sensors communicate wirelessly with each other to create a flexible, granular mesh sensing network throughout the building, which can be used for individual receptacle control, HVAC zone control, and lighting control.

The building had undergone an expansion before CentraCare acquired it. As a result, multiple mechanical systems served the building. Both systems (single zone RTU and VVT RTUs) have constant supply fans with on/off heating and cooling. Normal mechanical sequence of operation changes (e.g., supply air static pressure reset, or supply air temperature reset) are not an option with these systems, but the addition of a new lighting control network made it possible.

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:** 12800 Rolling Ridge Rd, Becker, MN 55308
- **Building Size:** 12,400 ft^2
- **Building Sector Type:** Medical outpatient building (offices, doctor offices, nurse station, physical therapy)
- **HVAC Unit Type:** Different systems served different parts of the building. One zone roof-top unit (RTU); RTUs with variable volume and temperature control (VVT)
- **Building Automation System (BAS) Type:** Johnson Controls METASYS system, with controls technicians at the university making the improvements
- **Occupancy Description:** 50 occupants, operating 8 a.m.–5 p.m., Monday–Friday
- **Utility Incentives:** $9,500
- **Project Completion Year:** 2021

The building's controls contractor implemented new HVAC sequences using occupancy data from the lighting network.

In addition to the new lighting fixtures and controls, CentraCare also installed wirelessly controlled receptacles. As a medical outpatient facility, controlled receptacles had to be selectively deployed as not all devices could be turned on/off frequently. Some devices (e.g., medical scanning) needed to remain in low operating state.

Project Cost			
	Material (/ft²)	Labor (/ft²)	Payback (years)
Lighting	$3.01	$1.99	29.2
Lighting w/ Incentives	$1.22	$0.80	11.8
Plug Load	$0.09	$0.03	24.3
HVAC	—	$0.64	N/A
Subtotal	$3.10	$2.93	—
Subtotal w/ Incentives	$1.21	$1.47	—
Total	$6.03		32.7
Total w/ Incentives	$2.68		15.7

Energy Saving Control Strategies

- LED with networked lighting controls (task tuned, occupancy sensors, and some daylight sensors)
- Plug load controls in a few offices, nurse station, physical therapy room, patient check-in area, and medical imaging space
- Plug load controls on common area equipment like printers, chargers, monitors, some physical therapy equipment
- Thermostat setback based on occupancy
- Variable air volume box shut off based on occupancy
- Supply air temperature reset
- Demand control ventilation

Project Cost Considerations

- The project used networked lighting controls, which requires a certain amount of equipment independent of space size. The 25,000 ft² is a minimum threshold where networked lighting controls typically become more cost effective, meaning that cost per square foot may be higher for small buildings, such as CentraCare's 12,40-ft² outpatient building.
- Lack of successful HVAC integration resulted in additional costs that were not recovered by the energy savings.
- Although the plug loads have a long payback period, they contribute only a small amount to the overall project cost.

Lessons Learned

Integrating controls across systems is relatively new, and the CentraCare project resulted in several lessons learned:

- **Ensure the building system is a good candidate for controls integration.** Certain building and mechanical system designs, such as the constant volume systems (e.g., single zone, variable volume, and temperature rooftop units) diminish the energy savings potential of controls integration, especially when combined with predictable building occupancy. All zones had to be fully unoccupied before setbacks occurred, which only happened when the building was closed. Scheduling would yield the same amount of savings.
- **Allow several weeks of data collection to verify lighting controls are properly integrated with the HVAC system.** Verification of integration requires a few weeks of operational data (i.e., trend data) to be analyzed.
- **Lighting controls provided limited energy savings.** Most of the energy savings from lighting upgrades was achieved by converting to LED. The baseline lighting was turned off when spaces were empty. Given that the lighting in the building was already efficient after the conversion, the additional savings from the occupancy sensors was minimal.
- **Significant energy savings can be achieved from automatic receptacle controls (ARCs).** Plug loads that automatically turn off when the space was unoccupied resulted in 46 percent energy savings.
- **Identify high power loads to connect to automatic receptacle controls.** Although the total savings was 46 percent, the average savings per receptacle was only 52 kWh. This results in $5 per receptacle saved because of the low actual energy saved. When possible, pair high power plug-in loads that can be controlled with ARCs.

Potential Energy Savings		
Lighting Savings	1.65 kWh/ft^2	57%
Plug Load Savings	Average 52 kWh/ receptacle/yr	46%
HVAC Savings	N/A	—
Total Cost Savings	$0.18/ft^2	

- **Existing wiring scenarios can accidentally control non automatic receptacle controls.** All of the receptacles in the room shared a common neutral wire. When the ARC turned off, it turned off other non-controlled receptacles. This was addressed by correcting the wiring to the non-controlled receptacles downstream from the controlled one.
- **Properly label automatic receptacle controls.** A guidance sheet indicated the controlled portion was on the top. However, when installed in some of the rooms, they were placed in the bottom position. This led building occupants to believe they were using the controlled receptacles, when in fact they weren't.

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