General Services Administration
Public Buildings Service

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WIRELESS ADVANCED LIGHTING CONTROLS

Wireless Implementation Increases Opportunity for Savings from Advanced Lighting Controls

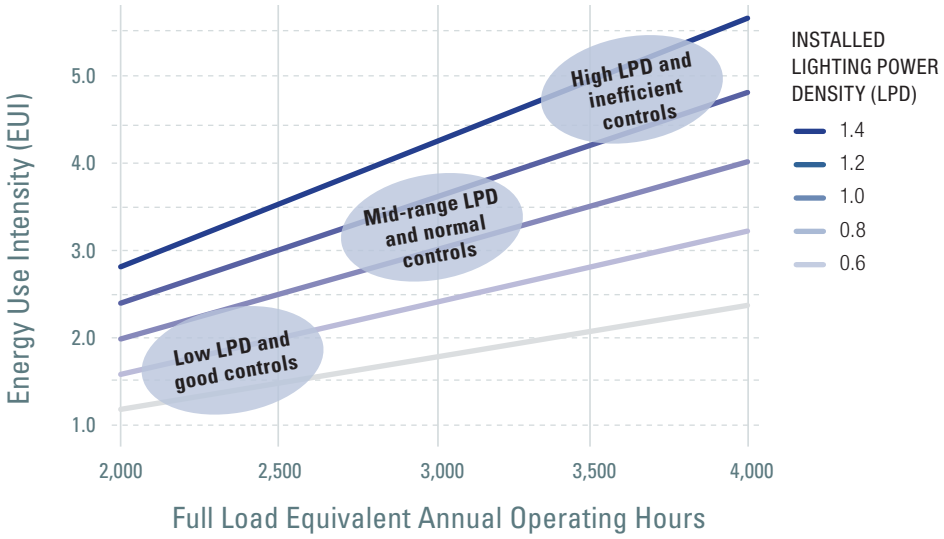
At 26%, lighting accounts for the largest percentage of electricity use in U.S. office buildings.[1] Advanced lighting control (ALC) strategies have demonstrated the ability to curb that use by more than 30%, by providing light only when and where it is needed.[2] But the cost and complexity of installing and commissioning advanced lighting controls, which are traditionally hardwired in place, have limited the presence of ALC to less than 2% of all U.S. commercial properties.[3] Wireless networking, which is relatively new to advanced lighting controls, enables ALC functionality without the expense of installing dedicated control wiring. GSA's GPG program commissioned Lawrence Berkeley National Laboratory (LBNL) to assess wireless ALC at two federal sites in northern California: the John E. Moss Federal Building in Sacramento and the Appraisers Building in San Francisco. Results showed 54% normalized energy savings for GSA when fluorescent lamps with dimmable ballasts were retrofitted with wireless ALC, and 78% when the wireless ALC retrofit was coupled with LED fixtures. Wireless ALC integrated with LED fixtures is recommended for new construction and renovations, with simple payback between 3 and 6 years. It should also be considered for retrofits in facilities with minimal existing controls, high lighting energy usage, and high electricity costs.

The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

INTRODUCTION

Estimating Building Lighting Energy Use Intensity (EUI)

A thorough understanding of existing installed Lighting Power Density (LPD) and annual Energy Use Intensity (EUI) is key to gauging potential energy savings from advanced controls.



"Wireless controls have helped us match lighting with what occupants actually need in their workspace."

— Opelia Opelinia
Building Manager, Appraisers Building
San Francisco
Pacific Rim Region
U.S. General Services Administration

What Is This Technology?

WIRELESS ALC NETWORKING OFFERS VERSATILITY AND STABILITY

Advanced lighting controls match lighting conditions to occupant needs with occupancy sensing, dimming, institutional tuning, and daylight harvesting. Wireless ALC uses radio frequency communications to relay commands, thereby eliminating long runs of dedicated control wiring and minimizing costly work above the ceiling. The assessed wireless ALC system operates as a mesh network, combining versatility with stability. Devices can repeat control messages and route communication via multiple paths, providing signal redundancy and improved communication range. The technology assessed is open source and provides two-way communication between a dashboard controller and enabled devices to allow real-time system monitoring and fixture status, as well as extended capabilities such as plug load control.

TECHNOLOGY SPECIFICATIONS
Wireless ALC Assessed

FEATURES
Open Standards ZigBee Mesh Network
Building Automation System Integration
Web-Based Interface
Controls Beyond Lighting

What We Did

THOROUGH VETTING WITH BOTH DIMMABLE FLUORESCENT AND LED

Preceding measurement and verification (M&V) at the Moss Federal Building, existing fluorescent fixtures were upgraded with new lamps and dimmable ballasts. At Appraisers, fluorescent fixtures were replaced with LEDs and dimmable drivers. To control the fixtures, each dimmable fluorescent ballast or LED driver was connected to a wireless fixture adapter. Fixtures were then programmed into groups, or "zones," so that multiple fixtures operated in the same way. To enable daylight harvesting, a photosensor was installed in zones located along building perimeters, and at least one occupancy sensor was installed in each control group. Site characterization visits, energy monitoring activities, photometric characterizations, and occupant satisfaction surveys were conducted during the pre- and post-retrofit study periods. Wireless controls performance was measured and verified at LBNL.

FINDINGS

NORMALIZED ENERGY SAVINGS FOR GSA OF 54% At Appraisers, with a baseline EUI of 2.3 kWh/ft^2, wireless advanced lighting controls saved 39% lighting energy over an automated scheduling baseline, with estimated 22% savings from occupancy sensors, 10% from institutional tuning, and 7% from daylight harvesting. Using the GSA average EUI of 3.25 kWh/ft^2, total savings jump to 54%, or 78% when wattage reductions from an LED retrofit are included.

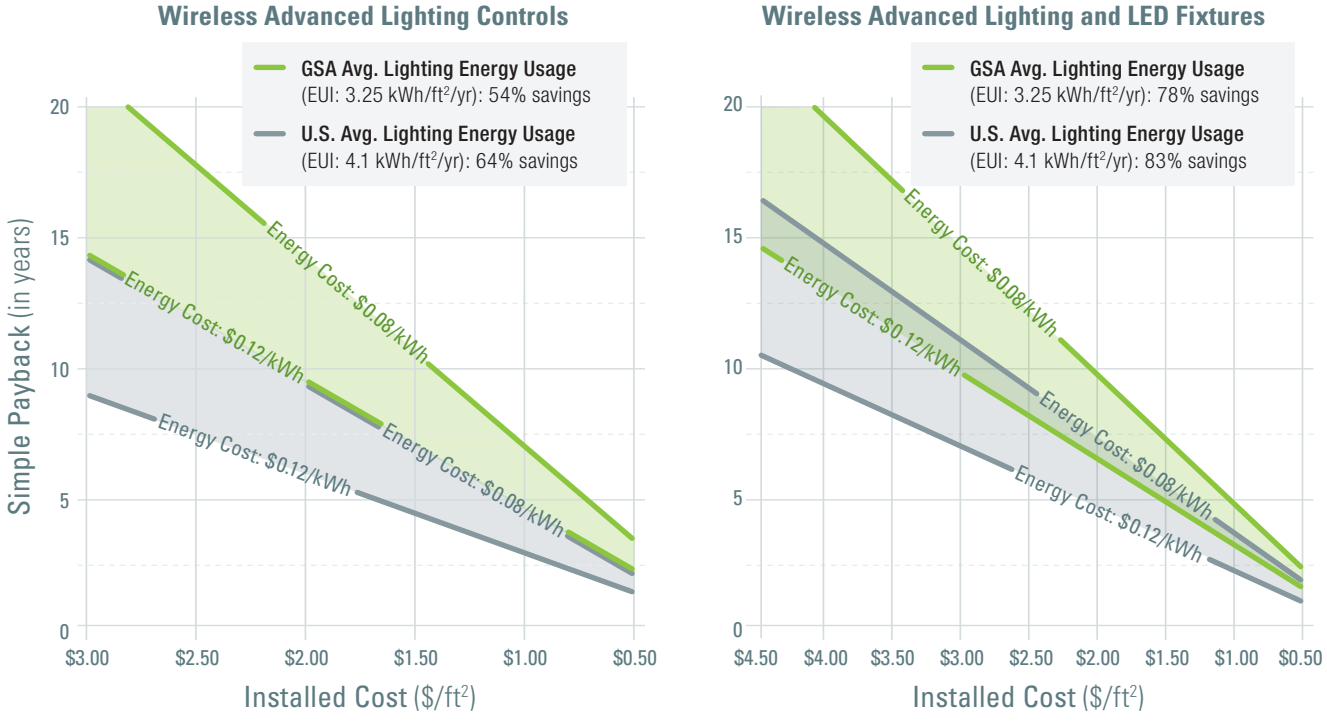
INCREASED FLEXIBILITY IN LIGHT LEVELS The addition of advanced wireless controls allowed building management greater flexibility in varying light levels according to user preferences.

INCREMENTAL PAYBACK BETWEEN THREE AND SIX YEARS For locations with GSA's average energy use intensity (EUI) of 3.25 kWh/ft^2, installed costs for retrofitting with wireless advanced lighting controls and LED must be $3.00/ft^2 at an electricity rate of $0.12/kWh for a 10-year payback. The incremental cost of adding wireless ALC is approximately $1/ft^2, with paybacks between three and six years. Payback for LED does not include operational savings from reduced maintenance with longer-life lamps. NOTE: Controls manufacturers have begun partnering with fixture manufacturers to embed controls directly into the fixtures, thereby reducing installation costs. This report is based on an earlier approach where sensors and communication components were installed by electricians in the field.

RECOMMENDED FOR NEW CONSTRUCTION AND RENOVATIONS Wireless advanced lighting controls integrated with LED fixtures are recommended for all new construction and renovations. It should also be considered for retrofits, targeting facilities with minimal lighting controls, lighting energy use greater than the GSA average EUI of 3.25 kWh/ft^2/yr, and local utility rates greater than the national average of $.10 kWh.*

Payback for Advanced Lighting Controls

Savings are heavily dependent on baseline conditions



CONCLUSIONS

These Findings are based on the report, "Wireless Advanced Lighting Controls Retrofit Demonstration," which is available from the GPG program website, www.gsa.gov/gpg

For more information, contact GSA's GPG program gpg@gsa.gov

What We Concluded

SAVINGS DEPENDENT ON BASELINE CONDITIONS

Wireless networking enables ALC functionality without the expense of dedicated control wiring. It facilitates adding and/or retrofitting devices in the lighting network and reconfiguring systems as workspace occupancy and use change. Some implementations of wireless ALC can be extended beyond lighting, leveraging the wireless network to create an information pathway for the control of other devices and building systems. Energy savings for ALC are significant but heavily dependent on baseline conditions. In facilities with minimal existing controls, high lighting energy usage, and high electricity costs, wireless ALC can be cost-effective and should be considered. Wireless ALC integrated with LED fixtures is recommended for new construction and renovations.

Barriers to Adoption

- Lack of knowledge about baseline lighting systems and operating profiles in existing buildings.
- Low awareness of lighting as a strategy to achieve significant reductions in electricity consumption.
- High labor costs due to unfamiliarity with the technology.
- Undervalued non-energy benefits of improved lighting controls (such as operational efficiencies, occupant satisfaction and productivity improvements) and the absence of an objective assessment methodology.

Facilitators to Adoption

- More stringent code requirements around efficient lighting and controls (e.g., P-100, ASHRAE 90.1, California Title 24).
- Integration of advanced lighting controls directly into fixtures to drive down installation costs.

Reference to any specific commercial product, process or service does not constitute or imply its endorsement, recommendation or favoring by the United States Government or any agency thereof.

Footnotes

[1]Navigant Consulting Inc., 2012a. 2010 U.S. Lighting Market Characterization. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf. (Accessed 10 October 2012.)

[2]Rubinstein, F. M., 2012. Advanced Lighting Controls and Services: A Snapshot of Where We Are. s.l., Prepared for Advanced Energy 2012 Conference.

[3]Williams, A. et al., 2011. A meta-analysis of energy savings from lighting controls in commercial buildings, Berkeley: s.n.

*Subject to evaluation and approval by GSA-IT and Security.

Technology for test-bed measurement and verification provided by Daintree.