

GPG-024 | AUGUST 2015

# LED FIXTURES WITH INTEGRATED CONTROLS



## Integrated Controls Maximize LED Savings and Simplify Installation

Light-emitting diode (LED) technology for commercial lighting applications is evolving rapidly, and market penetration is keeping pace: installations of recessed LED fixtures, commonly called troffers, have increased by a factor of eleven in only two years.<sup>1</sup> With expanded market share, LED fixture costs are decreasing, and in many applications the added expense of LED technology is offset by energy and maintenance savings. Advanced lighting control systems (ALCs), which switch, dim, and brighten lights dynamically in response to occupancy and daylight, can maximize the operational efficiency of LEDs. Until now, however, the cost and complexity of installing such systems has often been prohibitive. LED fixtures with integrated controls address this problem by building onboard daylight and occupancy sensors directly into fixtures. GSA's Green Proving Ground (GPG) program commissioned Lawrence Berkeley National Laboratory (LBNL) to evaluate new plug-and-play fixtures installed at the Ralph H. Metcalfe Federal Building in Chicago and the Peachtree Summit Federal Building in Atlanta. The fixtures maintained lighting quality, simplified control system setup, and achieved lighting energy savings of 69%, over the GSA average. LED fixtures with integrated ALCs should be considered for all facilities, especially those with minimal lighting controls or with fluorescent troffers nearing the end of their useful life.

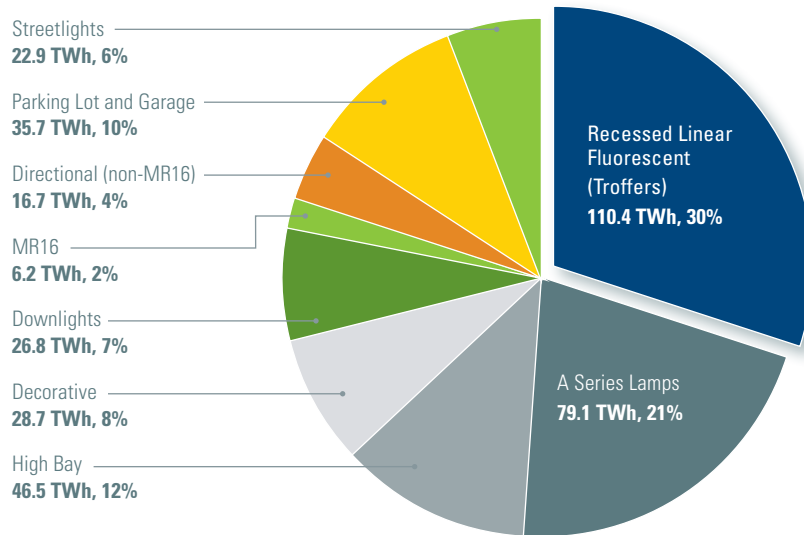
# INTRODUCTION

## Estimated Annual U.S. Savings with 100% LED Penetration: 373 TWh<sup>1</sup>

One TWh is equivalent to the average annual energy usage of approximately 92,000 U.S. households. 373 TWh is the amount of energy used by 34 million households.

*“The system was so easy to set up that it literally took us less than an hour to commission all 300 fixtures—and we didn’t need an engineer or program specialist to do it.”*

— Joshua N. Westhouse  
Building Manager  
Ralph M. Metcalfe Federal Building  
Chicago, Illinois  
Great Lakes Region  
U.S. General Services Administration



## What Is This Technology?

### PLUG-AND-PLAY FIXTURES WITH ONBOARD SENSORS AND INTEGRATED CONTROLS

LED fixtures with integrated advanced lighting controls dynamically determine light levels using onboard occupancy and daylight sensors. This implementation connects directly to wiring used by legacy recessed fluorescent fixtures, which minimizes installation costs. Commissioning is also much easier with this technology. Earlier implementations of ALC required complicated programming to predetermine lighting zones and connect strategically placed remote sensors to lighting fixtures. With LED fixtures integrated with ALC, individual fixtures are easily programmed and assigned to zones using handheld remote controls. Once the zones are set up, the fixtures in each zone communicate with one another wirelessly. Fixtures operate both as members of the group and independently. For instance, all fixtures in a zone turn on to a minimum background level if any area within the zone is occupied, but only the fixtures that sense occupancy brighten to full output. For additional savings, the maximum light level for each zone can be independently tuned to low, medium, or high, depending on occupant needs. Light levels change gradually to minimize distraction.

## What We Did

### ASSESSED LIGHTING IN TWO OPEN-OFFICE RETROFITS

GSA replaced fluorescent lighting with integrated ALC LED fixtures in two federal buildings with large open-office spaces: 19,750 ft<sup>2</sup> at Metcalfe in Chicago and 12,900 ft<sup>2</sup> at Summit in Atlanta. At both sites, lights were tuned to the medium setting. LBNL researchers measured energy savings and cost-effectiveness. To assess the new system’s performance, they took photometric measurements in addition to conducting interviews and surveys with occupants and lighting system installers.

## TECHNOLOGY SPECIFICATIONS

LED Fixtures Integrated with ALC

### FEATURES

- Stand-Alone Wireless Mesh Network
- Integrated Daylight Harvesting & Occupancy Sensing
- Zones Include Up To 50 Fixtures
- No BAS Integration

# FINDINGS



**ENERGY SAVINGS UP TO 75%** LED fixtures with integrated ALC provided lighting energy usage intensity (EUI) savings of 69%, compared to the GSA average of 3.25 kWh/ft<sup>2</sup>/yr, and 75%, compared to the national average of 4.1 kWh/ft<sup>2</sup>/yr. Measured against the fluorescent baseline, wattage reduction from the LED technology was responsible for 41% of the savings. Advanced lighting controls further reduced energy by 28% (GSA average) and 34% (national average).



**IMPROVED LIGHT QUALITY** Surveys showed significant increases in satisfaction with the lighting environment after the retrofits, with building occupants reporting pleasant brightness and well-lit surfaces.



**REDUCED COMPLEXITY AND CONTROL COSTS** Compared to LEDs with separate control systems, LEDs with integrated ALCs required minimal setup. After the manufacturer programmed a few sample zones, building staff and contractors were able to program the rest. Also, the controls themselves were less expensive when integrated into fixtures —\$0.47/ft<sup>2</sup> for integrated ALC as compared to \$1/ft<sup>2</sup> for stand-alone ALC.<sup>2</sup>

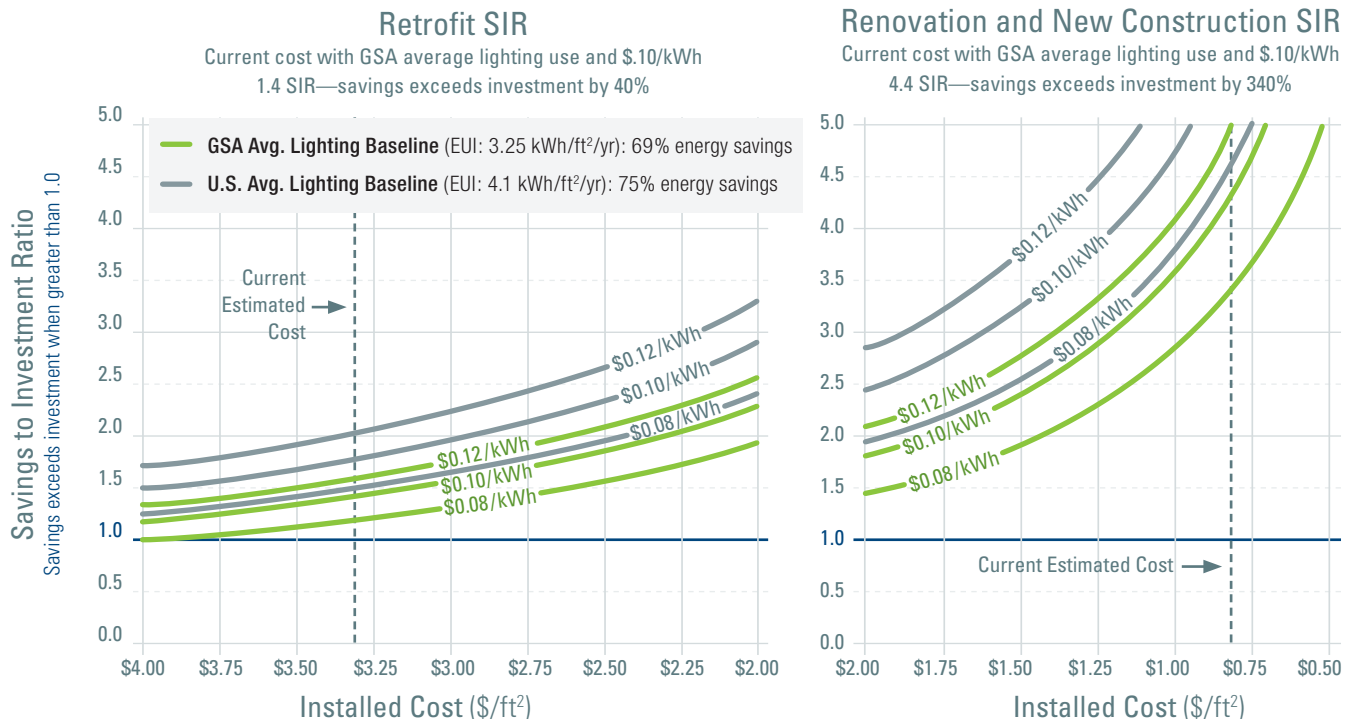


**INCREMENTAL PAYBACK BETWEEN THREE AND FOUR YEARS** Payback for facilities with a GSA average usage and utility rate is 3 to 4 years for renovations and 10 to 14 years for retrofits. Discounted life-cycle cost analysis that considers avoided costs as well as savings creates a more accurate picture of LED cost-effectiveness. Longer life LED lamps significantly reduce maintenance costs, increasing total system savings by about 25%. For GSA retrofits, the average Savings to Investment Ratio (SIR) is 1.4 (savings exceeds investment by 40%), assuming the national average utility rate of \$.10/kWh and the current estimated cost of \$3.29/ft<sup>2</sup>. For renovations and new construction, the SIR is 4.4.



**RECOMMENDED FOR RENOVATIONS AND NEW CONSTRUCTION\*** Consider retrofitting LED integrated with ALC in buildings without existing lighting controls. Prioritize facilities with lighting energy use that exceeds 3.25 kWh/ft<sup>2</sup>/yr (GSA average) and utility rates that exceed \$.10/kWh (national average).

## Positive Return on Investment for Both Retrofits and Renovations



# CONCLUSIONS

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These Findings are based on the report, "Retrofit Demonstration of LED Fixtures with Integrated Sensors and Controls," which is available from the GPG program website, [www.gsa.gov/gpg](http://www.gsa.gov/gpg)

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## What We Concluded

### A COST-EFFECTIVE PATH TO DEEP ENERGY SAVINGS AND CODE COMPLIANCE

Advanced lighting controls are essential to capturing the full energy and cost savings potential of LED technology. In Chicago and Atlanta, integrating ALC directly into fixtures dramatically increased ease of installation while reducing both the complexity of commissioning and the cost of the controls themselves. Combining significant energy and maintenance savings, LED with integrated ALCs were also found to be generally cost-effective. At the current estimated cost of \$3.29/ft<sup>2</sup>, the average GSA retrofit yields a 1.4 SIR (40% return on investment); for new construction, the SIR increases to 4.4. High occupant satisfaction and increasingly stringent building energy codes that require ALCs (e.g., ASHRAE 90.1, California's Title 24) also support the broad deployment of this plug-and-play technology. LED fixtures with integrated ALC should be considered for all GSA facilities, with priority given to those with minimal lighting controls, lighting energy use that exceeds 3.25 kWh/ft<sup>2</sup>/yr (GSA average), and utility rates that exceed the national average of \$.10/kWh. They are recommended for new construction and for facilities where fluorescent troffers are nearing the end of their useful life.

### VAST MARKET POTENTIAL

Despite rapid growth, LEDs still make up less than 1% of the U.S. installed commercial light fixture base. Recessed linear fluorescent fixtures are the most prevalent light source in U.S. commercial buildings, accounting for more than 50% of the installed base.<sup>3</sup> With 26% of building energy spent on interior lighting in the U.S., replacing linear fluorescents with LED technology could save up to 110 TWh annually, enough to power 10 million homes.<sup>1</sup> Pacific Northwest National Laboratory estimates that 153 million square feet of GSA owned space is lit by fluorescent troffers. Replacing 50% of this installed base will reduce average energy intensity in transformed spaces by more than 2.25 kWh/ft<sup>2</sup>/yr, saving GSA more than \$17 million dollars a year in energy costs and reducing GHG by more than 118,000 metric tons.

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*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

<sup>1</sup>Navigant Consulting Inc. April 2013 (Revised May 2013). *Adoption of Light-Emitting Diodes in Common Lighting Applications*. Prepared for Solid-State Lighting Program, Building Technologies Program of the Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy. [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led-adoption-report\\_2013.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led-adoption-report_2013.pdf)

<sup>2</sup>Wireless Advanced Lighting Controls Retrofit Demonstration. Francis Rubinstein (LBNL), April 2015, p.79

<sup>3</sup>Miller, NJ, MP Royer and ME Poplawski, of Pacific Northwest National Laboratory (PNNL). March 2013 (Revised June 2013). CALIPER Exploratory Study: Recessed Troffer Lighting. Prepared for Solid-State Lighting Program, U.S. Department of Energy, by Pacific Northwest National Laboratory (PNNL). [http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper\\_recessed-troffer\\_2013.pdf](http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/caliper_recessed-troffer_2013.pdf)

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