

DLC Advanced Lighting Technology Demonstration: Enlighted

This demonstration is one in a series of advanced lighting demonstration projects being completed through a joint initiative between the DesignLights[®] Consortium (DLC) and the U.S. Department of Energy. Additional partners for this site included Wendel Energy, Enlighted, United Illuminating, Energize Connecticut, Beacon Electric, and Yale University.

Demonstration Site

The demonstration site at 221 Whitney Avenue in New Haven, Connecticut is a 75,000 ft², 6-story administration building. This demonstration involved floors 5 and 6 with approximately 25,000 ft² of office space for the Yale Human Resources department. The space was originally lighted with fluorescent T8 technology. Controls included on/off wall switches and occupancy sensors in perimeter private offices and meeting rooms and only 7 am to 7 pm timeclock control in open cubicle office areas.

Demonstration Technology

The Enlighted Advanced Lighting Control System provides a distributed architecture with a SMART sensor at each fixture. The programming resides locally at the fixture and adjusts (by dimming) the lighting level for each fixture according to that sensor's unique perception from its position in its environment. The sensor is powered by the fixture and collects occupancy and daylight data that combines with schedule and set point data to determine the optimal light level for that fixture. This network of sensors performs fine-grained control of light levels based on measured data through the Enlighted Gateway and Enlighted Energy Manager (EEM). The Enlighted Gateway aggregates wireless communications between the network of Enlighted SMART Sensors and the EEM appliance. The Enlighted system is designed to be easy to install, configure, commission, and service.

Project Savings

Pacific Northwest National Laboratory managed the measurement and verification component of the demonstration and the Cadmus Company completed field energy measurements of the lighting system before and after the upgrade to capture the energy savings of the new LED system. The results show that initial replacement of older fluorescent fixtures with LEDs saved 43% of the estimated annual lighting energy use.

Energy savings increased by an additional 27% with combined task tuning, occupancy sensing, and daylight controls. Savings could have been even higher if occupancy sensors had not already been in place in private office and meeting rooms. Also, some fixtures were initially left on after hours (later corrected) which further reduced the measured savings. Task tuning was used to reduce initial high light levels to more closely match typical office light levels.

Total annual energy savings is estimated to be 34,600 kWh, which is a 70% savings compared to baseline energy use at this site. This equates to an energy cost reduction of approximately \$5,190 annually and the total project cost was \$116,600. Project payback is calculated to be 13 years after applying a \$49,000 incentive provided through United Illuminating from EnergizeCT initiative funds. Part of the relatively high payback for this project is likely due to the limited potential for occupancy sensor savings at the site.

Installation and Operation

The Human Resources department at Yale operates on an 8 am to 5 pm weekday schedule. The new advanced Enlighted control system manages the lighting in the space automatically with daylight harvesting and granular occupancy-based dimming.

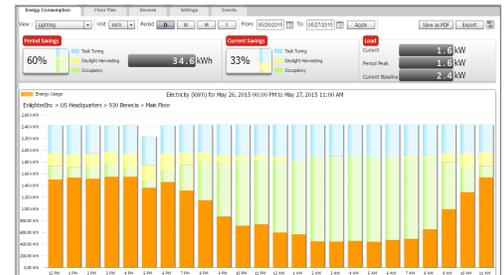
YALE UNIVERSITY, NEW HAVEN, CT



Photo courtesy of Yale University.

Enlighted Energy Manager Advanced Lighting Control System

Photo courtesy of Enlighted



Advanced lighting control systems can incorporate a variety of options. The Enlighted system offers the following:

- Occupancy Sensing
- Daylight Harvesting
- High-End Trim/Task-Tuning
- Scheduling On/Off Functionality

Philips EvoKit LED + Enlighted IoT

Photos courtesy of Philips and Enlighted



Occupant Lighting Satisfaction

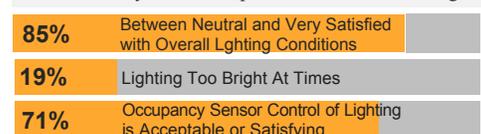
BEFORE THE LED RETROFIT*

A staff survey of 21 occupants found the following:



AFTER THE LED RETROFIT*

A staff survey of 18 occupants found the following:



* Before and after the retrofit 2 occupants noted that they thought the lighting was too dim.

PROJECT ENERGY SAVINGS

Total Lighting System Savings*

New LED Fixtures Only

New LED Fixtures
with Controls

43%

70%

Lighting Control Savings**

Occupancy Sensor
Shutoff***

Daylight
Harvesting

High-End Trim /
Task Tuning

-2%

7%

43%

*The 43% energy savings resulted from installing more efficient LED fixtures. The additional 27% resulted from task tuning the new lighting down to preferred operational light levels plus occupancy sensor and daylighting savings.

**Data shows, at this site, the advanced controls alone would reduce the energy use of the new LED fixtures by 48% (43% + 7% - 2%). This includes significant task tuning with some daylight harvesting.

***This site already had functioning occupancy sensor controls in private offices and conference rooms prior to the retrofit. Building operators also noticed that several fixtures were found to be continuously operating after the retrofit which further reduces the measured savings shown here.

NOTE: Applications with different installed equipment, layouts, and occupant needs could see higher or lower savings.

Application Determines Savings

In most areas, the technology change from fluorescent to LED fixtures provided a significant portion of the savings. Control savings that included task tuning significantly increased the savings. Note that this site initially had hardwired occupancy sensors and therefore there was no significant additional savings from the new sensors installed as part of the advanced control system.

Note: These results represent potential savings for one building type with representative space types and activities. It is important when choosing a lighting system and controls to determine the best fit for a given mix of space types and activities.

Facility Acceptance

The lighting contractor found the process of installing the LED retrofit kits to be straightforward and generally similar in time and effort to installing standard fluorescent fixtures. Instructions were easy to read and understand. One installer indicated he would be able to install the system without any instructions. Another installer commented that the retrofit kits had minor fit issues due to having more components to install. The same installer commented that maintenance and troubleshooting may be harder due to additional parts.

The system took about 26 days to install on both floors working around occupant activity schedules. System commissioning was performed manually and found to be relatively simple. Commissioning was implemented within about one day throughout the two office floors.

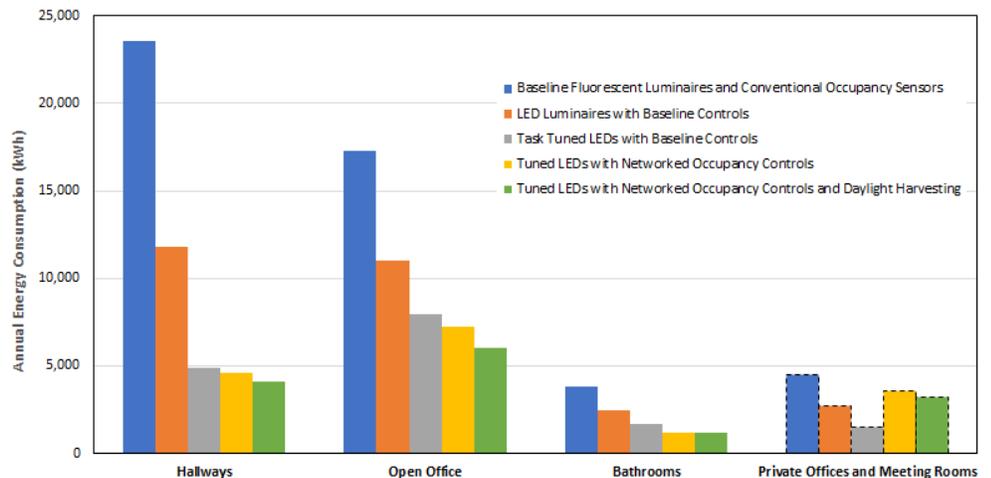
Lighting System Performance

Lighting measurements were taken in selected areas on the 6th floor that were typical of the types of spaces in the test area but not necessarily all light levels across the test areas. This included a major conference room and open office areas. Measurements show that the retrofit effectively corrected light levels with slight increase in open office and reduction in conference room to meet a mid-40s level that is often typical of office environments.

Location	Before* (fc)	After* (fc)	% Change
Open Office	32	44	38
Meeting Room	62	45	-27

* The measurements shown are for conference room table level and open office desk level. The initial raw measurements were taken at floor level in open office and at both floor and table level for conference room. The office desk level measurements shown were developed using the ratio of floor vs table values taken in the conference room.

Annual Extrapolated Energy Consumption by Space Type



Note that the "Private Office and Meeting Rooms" group shows a lack of energy savings with the new LED and control system. This was found to be the result of 1) occupancy sensors already existing for these spaces before the retrofit and 2) several fixtures found to be continuously operating after the retrofit and captured in the metered.

This technology demonstration is supported through a partnership of multiple organizations including:



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