**Title**

Case Study: Adaptive Parking Lot Lighting



**Authors**

Arani, Pedram

Johnson, Karl

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# ADAPTIVE PARKING LOT LIGHTING

University of California, San Francisco


Like many structures in San Francisco, the Post Street garage is surrounded by residential buildings. The project team succeeded in adding lighting to the dark top level without disturbing residents of the apartment building next door.

**ENERGY & $CO_2E$ SAVINGS**
88%

**OCCUPANCY RATE**
32%

**15-YEAR (LIFETIME) ENERGY COST SAVINGS**
$ 1065 per fixture, based on UCSF's rate of $0.145/kWh

*In 2012, UC San Francisco launched a pilot demonstration of energy-efficient lighting on the top level of its two-tier parking garage at 2340 Post Street. That level of the parking structure had lacked lighting for some time, but a sharp increase in use prompted some calls expressing safety concerns. More light was clearly needed, but the project team had to be careful not to disturb residents of the apartment building next door.*

Dimmable, full-cutoff LED light fixtures were paired with motion sensors and incorporated into a wireless lighting control system to give the campus a smart, simple way to monitor and manage lighting energy use for the area. The six fixtures now serve as the basis of a network that parking enforcement can access via Web interface to adjust scheduling and tuning.

"It's easy to use," says Patrick A. Dwyer, P.E. and principal electrical engineer of Campus Life Services for UC San Francisco Facilities Services. "It's a great system. I'm hoping to expand it and do other parking facilities." Calls about safety ceased after the lighting installation, and Pat reports "no complaints" from the residents next door. He adds, "I would absolutely recommend the system to other facility managers."

## PROBLEM

Parking lot lighting typically employs high-intensity discharge (HID) light sources such as high-pressure sodium (HPS) and metal halide (MH) lamps. These sources sometimes provide poor lighting quality, and they use substantially more energy than more efficient alternatives.

Installing dimmable LED light sources equipped with lighting controls dramatically improves energy efficiency by reducing lighting power during vacant periods. Incorporating network controls further maximizes system savings. This layer of control also allows facility managers to make dynamic tuning and scheduling adjustments to fit the needs of the facility and nearby residents.

Most area lighting manufacturers offer an integrated occupancy sensor and NEMA twist-lock receptacle as standard options; unfortunately, standard twist-lock receptacles don't have compatible contacts for 0 – 10 V dimming, a necessary feature for adaptive networked lighting.

## SOLUTION

With support from the PIER-State Partnership for Energy Efficient Demonstrations (SPEED) program, and in collaboration with manufacturing partners, the California Lighting Technology Center (CLTC) demonstrated how slight hardware modifications could allow for installation of the Lumewave radio frequency (RF) mesh network control system at UCSF's Post Street garage.

A Lumewave TOP900 control module installed on each light fixture wirelessly connects it with the other light fixtures in the network and with the network gateway. The gateway serves as the central communication point for the Lumewave system, and it provides network access for users to adjust the lighting system.

Specialized occupancy sensors and modified twist-lock receptacles are available OEM to manufacturers interested in partnering with Lumewave. Lighting manufacturers Philips and Cree installed a slightly different occupancy sensor, designed to be powered by the Lumewave TOP900 module, as well as a modified twist-lock receptacle, compatible with the Lumewave controller. The modified twist-lock receptacle allows additional 0 – 10 V leads and low-voltage power to be routed to the dimming power supply and provide power to the occupancy sensor.

Once set up, the system allows for on/off control according to astronomical time switch (or integrated daylight sensor), dimming schedules, and high- and low-mode tuning. The wireless control system also allows administrators to create luminaire groups, event schedules and control profiles, monitor energy use, and receive automatic maintenance alerts pinpointing malfunctions.

## PROJECT TECHNOLOGIES

### LED OUTDOOR AREA FIXTURE

The Edge LED Area Lighting by Cree, available at **cree.com**

PHOTO: CREE

### OUTDOOR MOTION SENSOR

EW-205-LU low-voltage motion sensor by WattStopper (for the Lumewave system), available at **wattstopper.com**

PHOTO: WATTSTOPPER

### NETWORKED CONTROLS

TOP900-TN wireless lighting control module by Lumewave, available at **lumewave.com**

PHOTO: LUMEWAVE

## DEMONSTRATION RESULTS

The SPEED program and CLTC partnered with UCSF Facilities and Transportation to install six area lights on the top deck of the Post Street parking garage owned by UCSF. The project team took special note of the surrounding residential housing when specifying products for the lighting installation. Cree's The Edge LED fixtures with backlight control were chosen to minimize light trespass. When paired with motion sensors and network controls, these parking and area fixtures also allow for curfew dimming with Adaptive functionality.

As the evening progresses and fewer occupants are admitted to the garage, the system setting changes from a high mode of 100 % and low mode of 20 % to a high mode of 70 % when an occupant is detected and off (0 %) during vacant periods. This maximizes the energy efficiency of the system and minimizes light trespass for neighboring residential buildings, without compromising safety or security.

Dimmable LED area lights were selected instead of static high-pressure sodium (HPS) lights. Occupancy sensors enable the LED system to adapt light levels, from low light output to a higher output level, based on whether spaces are vacant or occupied.

The LED fixtures consume approximately 46 watts at 100% power, 32 watts at 70% and 9 watts at 20% of full lighting power. During the eight-week monitoring period, occupancy rates averaged 32%. Based on this information, the top deck of the garage is expected to consume about 390 kWh annually. This is 2922 kWh, or 88 %, less than what a static 100 W HPS system would have consumed, with combined lamp and ballast power consumption at 128 watts.

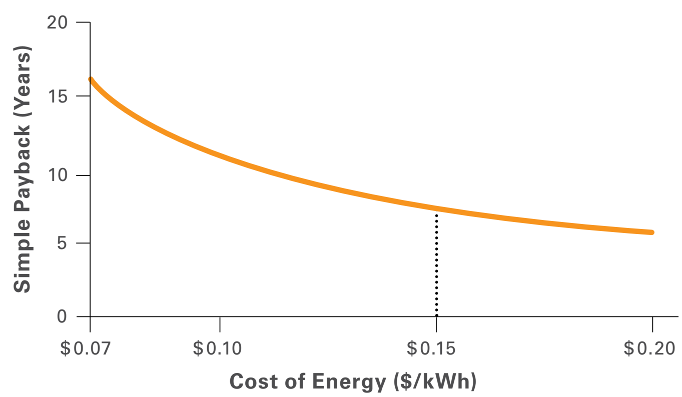
On average, the light fixtures operate for 12 hours each night (4309 hours per year), but because the top deck of the garage gets very little use after dark, the lights on that level are expected to operate at low levels most of this time and should have a very long life.

### TABLE 1: PROJECT ANALYSIS WITH INCENTIVES

| | RETROFIT SCENARIO AT $0.145/KWH | NETWORK CONTROLS AT $0.10/KWH |
|---|---|---|
| **Project Cost per Fixture** | $566 | $566 |
| **Simple Payback** | 8 years | 11.6 years |
| **Payback with Maintenance Savings** | 4.9 years | 6.1 years |
| **ROI** | 0.8 | 0.5 |
| **IRR** | 15 % | 11 % |

Fixture costs and payback periods are calculated based on a retrofit of static HPS fixtures and include Partnership incentives ($0.24/annual kWh saved) and energy savings.

### FIGURE 1: SIMPLE PAYBACK BASED ON ELECTRICITY RATES



## ECONOMIC EVALUATION

The networked control system installed at UCSF was a small pilot demonstration of network controls in parking and area lighting for the UCSF campus. For this reason, it did not produce the energy cost savings that large-scale projects produce. Facilities with limited funding or lower electricity rates may find that installing local controls provides a more affordable solution than network controls.

Utility incentives and funding from the UC/CSU/IOU Energy Efficiency Partnership can also help reduce project costs. The lighting solutions selected by UCSF for this project would be eligible for such incentives, though none were used for this demonstration.

## COLLABORATORS

The California Lighting Technology Center at UC Davis (CLTC) helped coordinate the project, which was made possible through the California Energy Commission and its State Partnership for Energy Efficient Demonstrations (SPEED) program. UCSF and lighting product manufacturers Cree, Lumewave and WattStopper were also collaborative partners on this lighting demonstration.

### TABLE 2: OPERATIONAL COSTS & SAVINGS SUMMARY

Values listed are per-fixture quantities unless otherwise noted.

| Technology Comparison | HPS Fixture without Controls | The Edge LED by Cree with Lumewave Controls | SAVINGS |
|---|---|---|---|
| Fixture Power | 128W (System) | 46W (100%)<br>32W (70%)<br>9W (20%) | |
| Annual Energy Consumption | 552kWh | 65kWh | **487kWh** |
| Annual Energy Cost | $80 | $9 | **$71** |
| Annual Maintenance Cost | $44 | $0 | **$44** |
| Total Annual Cost | $124 | $9 | **$115** |
| Lifetime (15-year) Energy Cost | $1,200 | $135 | **$1,065** |
| Lifetime (15-year) Maintenance Cost | $660 | $0 | **$660** |
| Total 15-Year Operating Cost | $1,860 | $135 | **$1,725** |
| Total 15-Year Cost for All Fixtures | $11,160 | $810 | **$10,350** |

**Number of Fixtures** *6*
**Cost of Labor** *$300 **
**Energy Cost** *$0.145/kWh*
**Occupancy Rate** *32%*
**Pre-retrofit Lifetime** *24,000 hours*
**Post-retrofit Lifetime** *100,000 hours*
**HID Lamp Cost (Maintenance)** *$44*
**Annual Hours of Use** *4,309 hours*
**LED Lifespan** *22 years*

** Includes electrician's fee and rental of bucket truck*

**ABOUT THE STATE PARTNERSHIP FOR ENERGY EFFICIENT DEMONSTRATIONS (SPEED) PROGRAM:** The SPEED program is supported by the California Energy Commission and managed through the California Institute for Energy and Environment (CIEE). SPEED demonstrations are coordinated by the CIEE in partnership with the California Lighting Technology Center and the Western Cooling Efficiency Center, both at the University of California, Davis.

Any questions about lighting technologies, including costs, can be directed to:


**PEDRAM ARANI**
California Lighting Technology Center, UC Davis
pmarani@ucdavis.edu
**cltc.ucdavis.edu**

**KARL JOHNSON**
California Institute for Energy and Environment
karl.johnson@uc-ciee.org
**uc-ciee.org**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