DR11SCE1.05.01: Demand Response Tests of Lighting in a Class A Office Corridor

DR LIGHTING TESTS IN A CLASS A OFFICE CORRIDOR

Demand reduction is needed when there is a stress to the electric grid. This stress occurs when demand for electricity nears the capacity of the available power generation, an event that is typically most prevalent during hot summer afternoons. SCE is investigating the potential for Demand Response (DR) technologies on several projects to reduce the peak electric system load. This project focuses on demand response potential of lighting in offices. According to the California Commercial Energy Use Survey (CEUS), offices are the single largest draw of commercial energy use in California. In the SCE service territory, offices represent 18% of commercial square footage (385,110,000 sf), and have an interior lighting connected load of 1.16 Watts per square feet (W/sf).

This study evaluates the Demand Response (DR) capability of Advanced Lighting Control System (ALCS) developed by Lutron Electronics. This ALCS was installed on the 10th floor of the Landmark Square office building in Long Beach, CA. This study examined the energy savings potential in corridors and stairwell where the lighting was controlled by occupancy sensors. The primary goals of this project are to:

1. Determine whether the advanced lighting controls system allows for reliable control of corridor lighting loads from SCE or business management as part of a DR program,
2. Examine demand reductions that can be achieved with a well-designed lighting system, and
3. Provide measured and technical data in support of the Smart Corridor and Stairwell concept.

The project site consists of the 10th floor corridor in the Landmark Square building. The corridor area represents 970 square feet (sf) of a multi-tenant high-rise office building.

INTRODUCTION

What Is This Technology?

ADVANCE LIGHTING CONTROL SYSTEM

The technology being tested in this study is an advance lighting control system (ALCS) which allows for DR response in an office corridor. The system includes Lutron H-Series, 2-lamp, T5 ballasts. The Lutron ballasts provide full dimming from 1% to 100% using Lutron's digital protocol. This allows the user to fully personalize high and low levels in the space, achieving maximum savings while maintaining visual comfort.

Occupancy sensors provide bi-level control of the lighting fixtures between high and low mode. The bi-level control solution is based on occupancy to reduce demand on a regular basis. The ballasts use wired communication while the occupancy sensors use wireless communication to interact with the control system. The system optimizes both the reliability of wired ballasts and the convenience of wireless sensors while maintaining a low installation cost. In addition, it allows users to place sensors in the optimum location, regardless of wiring capability. The Lutron Wireless Control System uses Energi Savr Node, QS Sensor Module, and wireless occupancy sensors.

The ALCS is capable of DR and can respond to a DR or real-time pricing signal. The lighting that is capable of DR can be dimmed to any level that is agreed upon by the owner and SCE.

What We Did?

TECHNOLOGY AND TESTING

The ALCS was installed in the corridor of the 10th floor of the Landmark Square building in Long Beach, CA. The project area consists of an "L" shaped corridor and a freight elevator lobby directly connected to the corridor. The corridor is 850 sf, and the freight elevator lobby is 120 sf for a total of 970 sf.

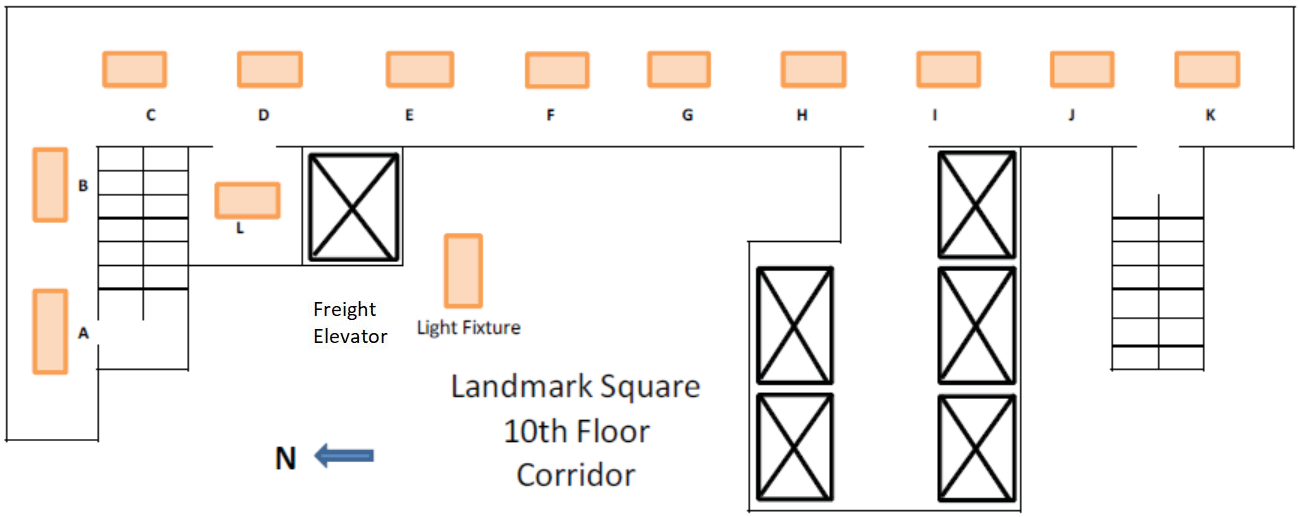
Data loggers were installed in each individual light fixture to collect electric load profile data during DR testing, and to measure demand reductions attributable to the ALCS.

The system provides the following functions and strategies:

- Commissioning reduced the ballast dimming settings to 65% of the lighting's rated electrical input, without an adverse impact on lighting levels. This new commissioned level is also designated as the baseline for the DR testing.

- DR was measured for 12 lighting fixtures. A signal from SCE or building management can reduce the power setting of the fixtures by 10%, 15%, 20%, 25%, and 30% below the commissioned level. Each setting lasted for one hour, after which it returned to the baseline DR level of 0%.

Figure 1: Tenth Floor Corridor Lighting Layout



DEMAND RESPONSE TEST DAYS DR testing was successfully conducted on the same business hours over three separate days in October of 2011: Tuesday, October 18; Wednesday, October 19; and Friday, October 21. During the test periods, recording intervals were 1-minute intervals. Analysis of the data included five DR tests on three different days, one test for each of the power reduction settings. Data loggers also recorded a non-test day, October 20, a comparison to demand during the three test days.

DEMAND RESPONSE REDUCTION The average reductions from this study were as follows: 1.4 Watts/fixture (W/fix) at 10% DR level; 2.7 W/fix at 15% DR level; 4.3 W/fix at 20% DR level; 4.8 W/fix at 25% DR level; and 7.4 W/fix at 30% DR level. The maximum DR reduction of 7.4 W/fixture represents an approximately 17% reduction of average wattage. In an alternative analysis, the impact of dimming from the occupancy sensors was ignored. This resulted in a maximum DR reduction of 8.9 Watts per fixture (0.11 W/sf) or 17% of the commissioned wattage from the fixtures at the 30% DR level setting.

GROUPING FIXTURES INTO ZONES The controls were originally designed to group fixtures into zones. It is noted that during the DR testing period all fixtures were grouped as one zone. Therefore, if someone were to activate an occupancy sensor, all the lighting fixtures would change to high light output mode. Although this strategy improves the average DR reduction, it reduces the energy savings capability of the system.

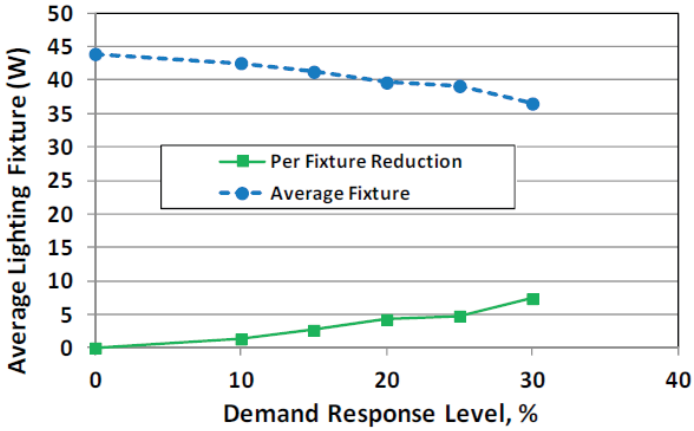


Figure 2: Demand Response Reduction

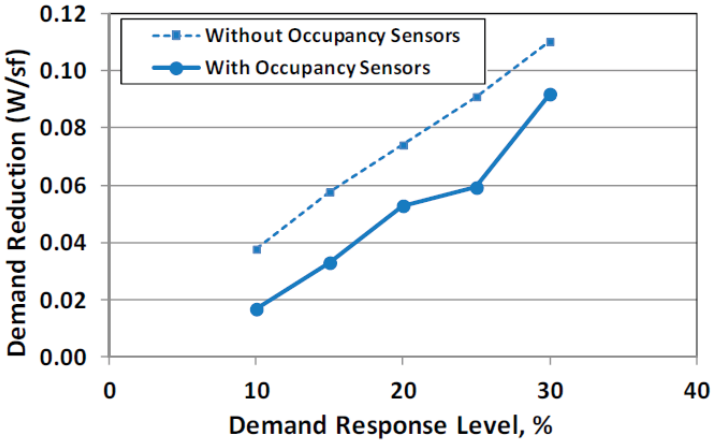


Figure 3: Effect of Occupancy Sensors

CONCLUSIONS

What We Concluded?

ALCS A VIABLE OPTION

The main objectives of the project were to determine the following:

1. *Examine the advanced lighting controls system that allows for reliable control of corridor lighting loads from business management as part of a Demand Response Program*: DR testing for the ALCS confirmed that business management as part of a DR Program could reliably manage lighting loads.

2. *Examine demand reductions that can be achieved with a well-designed, smart lighting control system:* There was a reduction in overhead corridor lighting load demand after the installation of ALCS and new lighting fixtures, including occupancy sensors. The DR reduction for lighting averaged 7.4 W/fixture, or 0.092 W/sf at the 30% DR level. The percentage reduction is approximately 17%.

The results of this pilot and other DR projects show evidence of demand reduction. The highly controlled lighting solutions demonstrated in the pilot qualify for SCE's incentive program. In addition, the broader Smart Corridor concept that addresses demand feedback to occupants and overall building demand would experience further demand reduction under these methods.

These Findings are based on the report "Demand Response Tests of Lighting in a Class A Office Corridor," which is available from the ETCC program website, https://www.etcc-ca.com/reports.

Recommendations

This pilot study was successful in demonstrating that the ALCS is a viable demand response option. However, there are still further steps to take.

FURTHER STUDIES

Further study of highly controlled lighting solutions may further clarify the results, which include the following:

- Evaluation of DR strategies and their interaction with other controls such as occupancy sensors.
- Measurement of power usage throughout the course of the year to better understand seasonal variations in various locations.
- Measurement of hourly profiles to study demand reduction impact potential for various time windows that are most likely to have a call for DR.

ADDITIONAL RECOMMENDED STEPS

Additional recommended steps may support and expand upon the results of this pilot:

- This pilot only explored incremental DR settings up to 30%. Future studies that examine greater power reductions (for example, incremental DR settings up to 50%) could further the understanding of the power saving potential of this ALCS.
- Further study of the market impact of mass implementation of this ALCS would improve our understanding of factors related to easing the stress to the electric grid.