DR9.09: Demand Response Tests at a Typical Office Space in a Federal Building

This report evaluates the lighting Demand Response (DR) technology installed at the Federal Building in Los Angeles, CA. The DR study is managed by Southern California Edison's (SCE) Design and Engineering Group and is part of the Office of the Future (OTF) initiative.

The primary goals of this project are the following:

- Determine whether the advanced lighting controls system, (ALCS) allows for reliable control of facility lighting loads from SCE, or business management as part of a DR Program,
- Examine demand reductions that are achievable with a well-designed lighting system, and
- Provide measured and technical data in support of the OTF initiative.

The project site consists of one-half of the 12th floor of the Los Angeles Federal Building. The site has 8,000 square feet (sf) in area space occupied by a division of the Federal Bureau of Investigation (FBI). This building was previously de-lamped and retrofitted with T8 lamps and electronic ballasts, and fitted with a relay-based lighting control system. The east half of the floor was relighted using state-of-the-art technology, while the west half was left in its original condition. The new lighting is capable of demand reduction, tuning, and other energy-savings strategies.

Lighting circuits in the building were monitored to document the demand reduction of the new lighting and control systems. An ALCS was installed and tested in 2011. The system's ability to respond to remotely generated demand response commands was also completed at that time.

DR signals were tested at five different reduction settings; 10%, 15%, 20%, 25%, and 30% for the lighting system. The demand reduction at DR level 30% is .073 W/sf. An average power savings of 17% was achieved for the lighting systems being controlled during the DR test with control level at 30%.

The Role of ALCS and Demand Response

According to the California Commercial Energy Use Survey (CEUS), offices are the single largest commercial energy use in California. Offices represent 21% of the total commercial square footage and 25% of total commercial energy usage 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 W/sf. It follows that the connected interior lighting load in offices is 447 megawatts (MW). If 75% of the lighting was operating and DR could reduce 30% of the operating load, that would result in 100 MW that could be shed.

The ability of owners and utilities to effectively reduce lighting power consumption depends on whether the building has centralized control of the lights with an ALCS.

The ALCS in this study was installed on half of the 12th floor of the Los Angeles Federal Building. It is comprised of a central programming and processing server with a number of distributed control modules throughout the space. It is able to control on/off settings and has the ability to dim the lights.

The system also has the following functions and strategies:

- Server based networked control system.
- Tuning to reduce overall lighting use by 20%.

Commissioning reduced the ballast dimming settings to 80% of the lighting's rated electrical input. This reduced level is the new baseline for the system.

What was done?

SCE initiated DR commands from an offsite office.
The testing procedure included changing the lighting level to five different settings: 10%, 15%, 20%, 25%, and 30% below the baseline level. Each setting lasted for one hour, after which it returned to the baseline DR level of 0%. Table 1 shows the planned schedule of the lighting tests.

Table 1

DR LEVEL, %	CONTROL SYSTEM TIMING
10%	9:30 a.m. – 10:30 a.m.
0%	10:30 a.m. – 11:00 a.m.
15%	11:00 a.m. - 12:00 p.m.
0%	12:00 p.m. - 1:00 p.m.
20%	1:00 p.m. - 2:00 p.m.
0%	2:00 p.m. – 2:30 p.m.
25%	2:30 p.m. - 3:30 p.m.
0%	3:30 p.m. - 4:00 p.m.
30%	4:00 p.m. - 5:00 p.m.

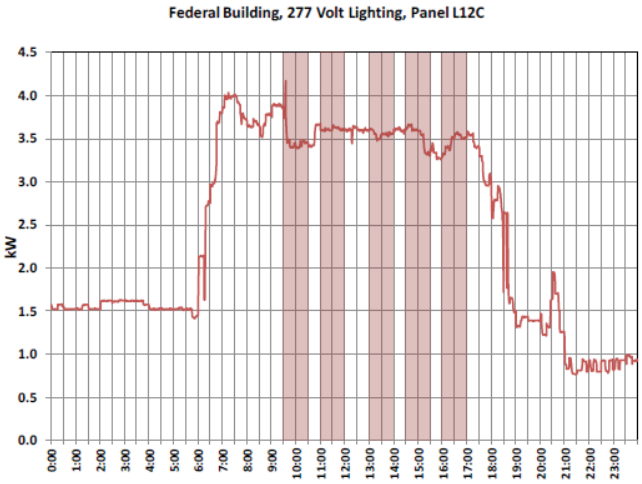

Figure 1 Power Consumption during a Non-Test Day

The test for the DR system was conducted over a three day period in July 2011. Figure 1 illustrates power usage during a non-test day, which is representative of typical power use of the office space without ALCS power level reductions. The shaded vertical portions of the graphs show the periods where power would have been reduced if the tests were implemented. The load fluctuations during the day are from occupancy sensors, daylight dimming, and dimming controls used by occupants.

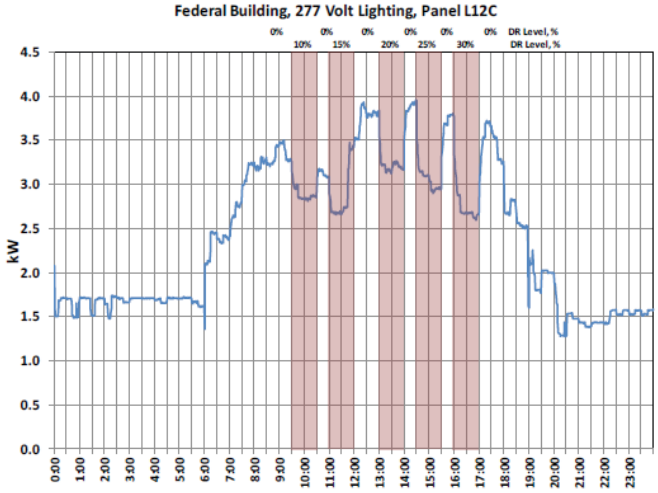

Figure 2 Power Consumption during Test Day

Figure 2 illustrates a DR testing day. The figure shows a drop in demand when power level settings were reduced as per the DR testing schedule. However, the consistency of power reductions with the level settings for the testing day may not be evident due to power fluctuations.

CONCLUSIONS

What We Concluded?

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

• Examine the advanced lighting controls system that allows for reliable control of the facilities lighting loads from business management as part of a DR Program: DR testing for the ALCS confirmed that lighting loads may be reliably managed by business management as part of a DR Program. The demand reduction was not proportionate to the reduction in all setting levels. If a desired reduction is needed, it should be tested to determine actual DR reduction rather than relying on the system setting.

• Examine demand reductions that can be achieved with a well-designed, smart lighting control system: There was a reduction in overhead lighting load demand after the installation of ALCS and new lighting fixtures. The DR reduction for lighting was 0.58 kW, or 0.073 W/sf at the 30% DR level. The percentage reduction is approximately 17% assuming a baseline of 3.4 kW.

This was a case study of the impacts ALCS can have on DR. The results provided may not be effectively extrapolated to other sites or the general population.

Power readings measured throughout the DR test illustrated unstable lighting loads. To remedy this problem, sites with stable base lighting loads should be chosen to establish a more definitive set of readings and results.

Recommendations

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

• Measurement of power usage throughout the course of the year to better understand seasonal variations in various locations.

• Comparisons of existing space lighting quality to advanced lighting design with controls.

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.

• The site may be representative of older office buildings with asbestos requiring expensive hazardous waste removal for conventional recessed lighting fixture replacement. It is suggested that investigation of surface mounted lighting fixtures that could be installed without disturbing the asbestos may alleviate upgrade implementation obstacles.

• 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.

These findings are based on the report "Demand Response Tests of a Typical Office Space in a Federal Building" which is available from the ETCC program website, https://www.etcc-ca.com/reports/dr-tests-typical-office-space-federal-building.