BEST PRACTICES 2011

# UCSC Science & Engineering Library Lighting Upgrade

**The in-house project team at UC Santa Cruz used datalogging tools and lighting simulation software to identify and test cost-effective energy saving strategies which yielded savings of 52 percent. The retrofit reduced lighting fixture counts and illumination levels, while also enhancing visual comfort for library users.**

**Award Category**
Lighting Design/Retrofit

**Green Features**
Comprehensive lighting audit using datalogging tools

Modeling retrofit options using Visual software

Delamping fixtures and reducing fixture counts

Replacement of magnetically ballasted recessed fixtures with T5 fluorescents

Installation of LED fixtures in computer lab

Repair of failed relays

Wireless control network with occupancy and daylight sensors

**Size**
78,000 ft$^2$

**Annual Energy and Cost Savings**
431 MWh

$49,600

**Cost**
$235,000 (Including $108,000 incentive)

**Completion Date**
December 2010

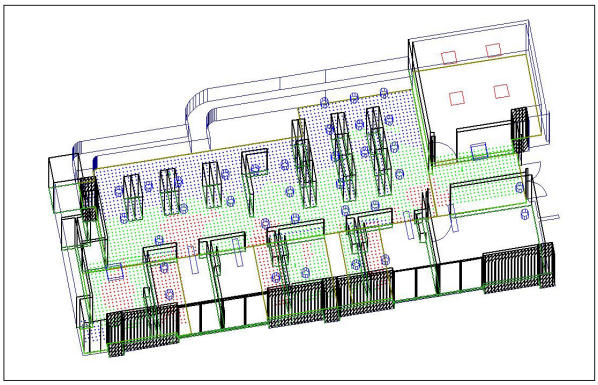
The Science and Engineering Library at UC Santa Cruz is a three-story, 78,000 ft$^2$ facility constructed in 1990. An extensive lighting retrofit completed in spring of 2011 reduced lighting power density from 1.4 W/ft$^2$ to a miserly 0.7 W/ft$^2$. The project was unique in that it was executed primarily by campus staff, who leveraged resources available from the partnering utility.

One key to the project's success was the rigorous lighting audit conducted prior to planning and implementation. The audit included a physical inventory, a review of construction documents, interviews with facility and maintenance staff, and measurements of light levels, occupancy and lighting power.

## Lighting measurement tools from PG&E's tool lending library were used to conduct a detailed lighting energy audit.

The physical review allowed the team to identify a number of simple energy-saving opportunities. Using hand-held light meters, the project team discovered that light levels were excessive, and in some areas as high as 50-100 footcandles. The review also revealed that twenty-five percent of the lighting panel relays had failed in the on position, and remained on continuously. As the switches were far from some of the lights being controlled, it was not apparent to library staff that some lights were not turning off. Replacing the failed relays resulted in an annual energy savings of 120 MWh. Andy Shatney, the UCSC energy analyst who led the audit, notes that inspecting the installed fixtures was critical, and that it also revealed that many recessed "can" fixtures that had been installed with two inefficient magnetic ballasts per fixture.

As part of the audit the project team also installed numerous dataloggers throughout the space to measure lighting usage and to estimate possible savings. The devices used, "IT-200" loggers from Wattstopper, measure both light levels and occupancy, and then calculate the potential savings that can be achieved by installing occupancy sensors. The team also coupled power loggers with current transducers — installed by a campus electrician in lighting panels — to measure lighting power loads. All the monitoring devices used in the audit were provided by PG&E's tool lending library, which is housed in the Pacific Energy Center in San Francisco. Staff from the Energy Center assisted the team with training and retrofit recommendations, allowing the campus to avoid the cost of a lighting consultant.



*Lighting simulation using Visual software. Image: UCSC.*

The results of the datalogging exercise showed the percentage of time that lights were on during both occupied and unoccupied periods, and provided additional metrics such as the number of on/off cycles. Combined with the power lighting measurements, this data allowed the team to determine the library's total annual electrical lighting consumption.

After completing the audit, the team compiled an extensive list of retrofit measures, which included delamping of overlit areas and redesigning spaces to use fewer and more efficient light fixtures. To evaluate these design options, the team used the lighting simulation software

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### Project Team

Campus: Work Management Group, UCSC Physical Plant

Controls Contractor: Cyclops Electrical Systems

Utility Partner: PG&E

### More Information

http://www.cahigheredusustainability.org/program/documents/BPTues11TestoniShatneyCHESC2011.pdf

http://news.ucsc.edu/2011/08/green-science-library-retrofit-honored.html

http://www.pge.com/pec/tll/

Visual available from Acuity Brands. This software allows users to create 3-D representations of a space, including furniture, and to test the impacts of various luminaire types and layouts. Measurements taken after the retrofit confirmed that the lighting simulations were highly accurate.

Of the various conservation measures, delamping was one of the most straightforward. Two-lamp fixtures with stacked T8 lamps (one above another) were modified by removing the top lamp. Many three-lamp fixtures were delamped by removing the center lamp, however in areas where the library staff did not want lights off during library hours, the relays were modified so that only the center lamps are on when areas are unoccupied, and the two flanking lamps are on during occupied times. Prior to full implementation of these measures, demonstration areas were set up for approval by library staff.

*Wireless daylight sensors have been installed on light fixtures in perimeter zones. Image: UCSC.*

Lighting in several areas was "depopulated" to reduce the number of light fixtures, and upgraded with more efficient fixtures. In reading areas magnetically ballasted 66-watt can lights were replaced with 39-watt T5 volumetric 2x2 fixtures, and the quantity was reduced from 265 to 111. At the circulation desk an additional 49 can lights were replaced with 32 26-watt 1x1 recessed volumetric fixtures. These measures alone are expected to save 100 MWh annually. In the computer lab, the team installed 2x2 LED fixtures, which allowed the fixture quantity to be reduced by over 50 percent. Shatney says that the team installed LEDs only in the computer lab for demonstration purposes, as the cost for wider use was prohibitive. The LED fixtures have a clean appearance and have been well received by library users.

## Wireless controls provided a flexible and cost-effective means to implement daylight harvesting and occupancy control.

The audit showed that occupancy and daylight sensors would provide significant savings, however the existing system posed many challenges to their use. For example, many book stacks run perpendicular to the direction along which the lights are wired. The team came up with a creative control solution of using wireless, self-powered sensors and relays from Leviton. The team designed the new control system with hundreds of occupancy sensors located at key points of entry to spaces, and also daylight sensors, and wireless wall switches. Combined these control measures have led to annual savings of 50 MWh.

## LESSONS LEARNED

Andy Shatney explains that since he had studied at UCSC he had a strong understanding of many campus facilities. Such insight allowed him to communicate effectively with campus stakeholders, in ways that consultants might not be able to. He also notes that there had been challenges with occupancy sensors turning off lights when spaces were occupied; however by installing more wireless repeaters this problem has been improved upon. With the successful outcome of this project, campus library staff implemented similar lighting strategies in another $100 million library retrofit and addition.

*Best Practices* case studies are coordinated by the Green Building Research Center, at the University of California, Berkeley.

The Best Practices Competition showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. Funding for *Best Practices* is provided by the UC/CSU/IOU Energy Efficiency Partnership.