Spectrally Enhanced Lighting: San Jose State University Case Study

Spectrally enhanced lighting (SEL) is a lighting design technique that saves energy by changing the color of light to be closer to daylight. Buildings that are retrofitted with SEL can reduce their energy costs by 25–50%.

San Jose State University's Dr. Martin Luther King, Jr. Library (King Library) had lighting troubles since it opened in 2003 as the largest all-new library west of the Mississippi River. A new technology called spectrally enhanced lighting was easily retrofitted into the library, improving brightness and visual acuity while significantly reducing electricity and maintenance costs.

DOE research studies show that by simply shifting the color in fluorescent lamps from the warmer yellow end of the color spectrum to the cooler blue end of the spectrum, we can see things more clearly and spaces appear brighter. Therefore, when we change the color of light to be more like daylight, lighting levels can be reduced to save energy while still achieving the same visual acuity. In T8s with electronically ballasted fluorescent lighting systems, this translates to a 20 percent energy savings, and in T12s with magnetically ballasted systems, SEL can achieve a 50 percent savings.

The $177.5 million King Library, designed by Gunnar Birkerts in 1999, is SJSU's flagship building and also the main library for the city of San Jose.

Unfortunately, the original lighting in the library was inefficient, glaring, and dim. Incompatible lamps and ballasts, coupled with poor network conditions on the building's lighting control system and multiple override switches, resulted in an installation burn time of 8,000 hours on lamps rated at 20,000 hours. The university's Facilities Development and Operations team designed the lighting retrofit with SEL fixtures, and it was reviewed by outside architect Carrier Johnson. Installation began at the end of 2009.

The Upgrade

For its extensive library lighting upgrade, SJSU ultimately settled on three types of fixtures:

- T5HO (high output) lamps coupled with program start ballasts fitted with occupancy sensors
- Basket troffers arranged as 2x4's with T8 linear fluorescent lamps and 2x2's with biax lamps
- Parabolic troffers arranged as 2x4's and 2x2's both with T8 linear fluorescent lamps.

A feast for the mind, as well as the eyes, the 475,000-square-foot King Library boasts a collection of roughly 1.9 million items, as well as delightful public art installations on all eight floors.

Results

Pre-Retrofit

Post-Retrofit

All of the luminaires are 850 lamps.

The library has many different areas—ranging from the book stacks and reading areas to offices and common areas—and each has unique lighting needs. SEL was used creatively to accommodate these needs. For example, in the book stacks, SEL was installed on sensors that would trigger when someone walked into the stacks. The daylight-mimicking color worked well in the stacks, without interfering with the warmer, yellow color in the nearby reading areas.

Retrofitting its lighting system was a more cost-effective option for SJSU than replacing with new fixtures because the retrofits could be installed by a lighting maintenance worker, while a new fixture would have to be installed by an inside wireman. Also, retrofitting minimizes waste, since fixture components that are reusable are retained.

Conclusions

SJSU recouped the cost of its $1.36 million SEL retrofit in less than two-and-a-half years and reduced lighting energy consumption by a remarkable 72 percent. In addition to the energy savings, significant maintenance savings were accomplished because there is less lamp burnout and the ballasts are now located in a more easily serviceable location.

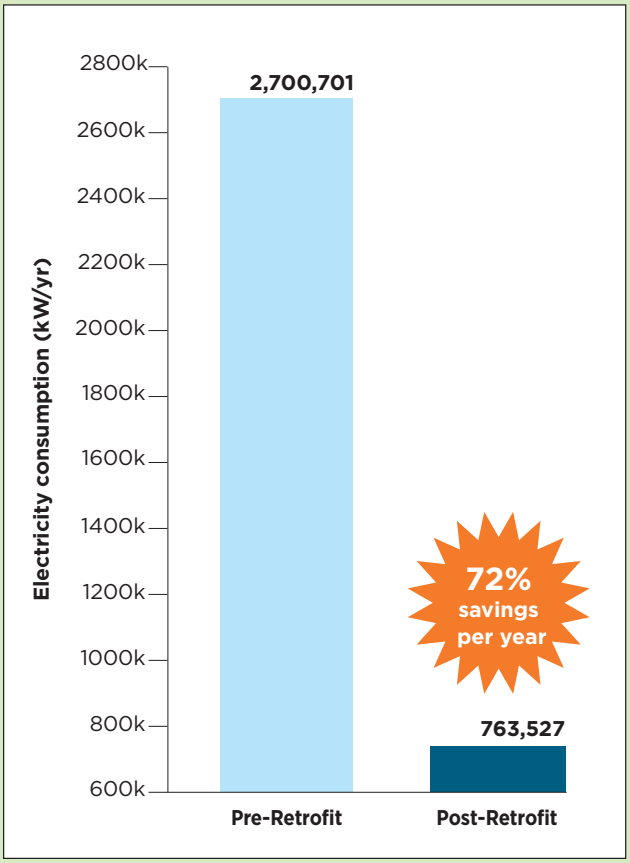
The library staff has been pleased with the results. Initially skeptical of the safety, color, and visual acuity of the proposed lighting, unofficial staff feedback is that most employees and visitors don't even notice a difference. When the change is brought to their attention, building occupants take pride in the fact that the retrofits save energy and reduce the campus' carbon footprint.

Specifications

	Pre-Retrofit	Post-Retrofit
Nominal lamp wattage (per fixture)	Ranged from 47 to 89	Ranged from 27 to 47
Temperature (Kelvin)	3000	5000
CRI	85	85
Lamp color	830	850

Total installed cost	$1,360,793
Annual savings from retrofit	**$430,148**
Payback* (years)	2.28
Rate of return	32%

**Includes one-time incentive of $378,195*



LIGHTING TERMS

SJSU selected T8 and T5HO fluorescent lamps with a temperature of 5000K and CRI in the 80s—also known as 850 lamps—for its retrofits.

Correlated color temperature (CCT)—A measure of the color appearance of a white light source. It is measured on the Kelvin absolute temperature scale and commonly ranges from 2700K (warm white) to 8000K (sky white).

Color rendering index (CRI)—A measure of how a light source renders the colors of objects. CRI is given as a number from 0 to 100, with 80 being the minimum CRI recommended for interior lighting.

Electronic ballast and ballast factor (BF)—To improve energy efficiency, SEL technology usually includes Premium electronic ballasts designed to work with the new T8 or T5HO fluorescent lamps. Ballast factor (BF) is the factor applied to the rated lumens of the lamps and is a function of the lamp/ballast combination employed. When dimming ballasts are used, the dimmed BF should be used in all calculations.

T8—A type of fluorescent lamp. The "T" means it is tubular in shape and the "8" means the diameter is eight-eighths of an inch, or 1 inch. A T12 lamp is twelve-eighths of an inch, or 1.5 inches thick. T8 lamps have a better CRI and are more efficient than T12 lamps.

850—A number that combines the CCT and CRI into one number. The "8" in 850 references a CRI in the 80s and the "50" refers to a CCT of 5000K. A 730 lamp would have a CRI in the 70s and a CCT of 3000K.

For More Information

For more information about spectrally enhanced lighting, or to download complete technical reports about its feasibility and economics, visit www.eere.energy.gov/buildings/spectrally_enhanced.html.

EERE Information Center

1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov/informationcenter

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

November 2010