Spectrally Enhanced Lighting: U.S. Forest Service 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%.

The Western Regional Headquarters is a 119,000-square-foot office building in Vallejo, California, where the Forest Service coordinates activities between national forests, monitors activities in the forests, provides planning guidance, and allocates budgets.

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 U.S. Forest Service reduced lighting energy consumption at its Western Regional Headquarters nearly 20 percent by retrofitting its office building in California with SEL. The project paid for itself in less than four years and occupants were pleased with the results.

The U.S. Forest Service, Mare Island, Western Regional Headquarters building is a 119,000-square-foot, four-story office building in Vallejo, California. From that office, the Forest Service manages 18 national forests and a national grassland. A DOE Economics Validation Study gave the Forest Service the opportunity to gather in-depth data while retrofitting the headquarters in 2006.

The Upgrade

The Western Regional Headquarters had a pre-retrofit lighting system that consisted primarily of 2x4-foot, three-lamp fixtures fitted with T8 lamps that had a 730 lamp color. Approximately 2,800 overhead lamps with electronic instant start ballasts were replaced in the headquarters, which houses 20 enclosed offices, 122 cubicles, and several conference rooms. All of the work was completed outside of business hours, with no disruption of office activity or productivity.

The lamps in all the fixtures were replaced with new General Electric F32T8/XL/SPX50/HLEC lamps and the ballasts were replaced with electronic programmed start ballasts. Light-level measurements taken in a sample of workstations following the retrofit indicated that horizontal photopic light levels decreased by 31 percent and horizontal scotopic light levels did not change.

Occupants were surveyed before and after the retrofit and there was no significant change in their satisfaction with the lighting. Furthermore, use of task lighting did not change following the retrofit.

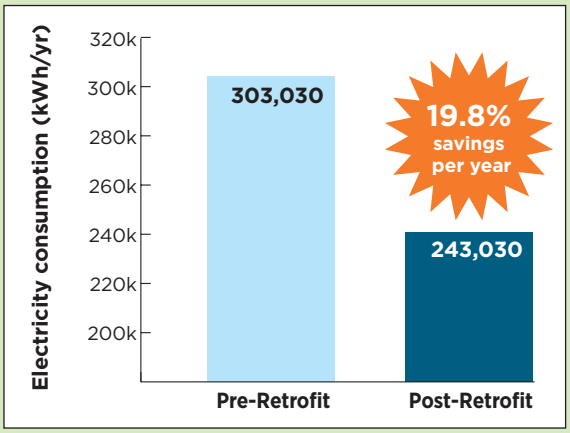
Conclusions

SEL technology reduced lighting energy consumption in the U.S. Forest Service's Western Regional Headquarters by 19.8 percent and decreased annual lighting costs by more than $15,500, meaning the retrofit paid for itself in 3.6 years. The retrofit did not disrupt business or productivity and occupants were satisfied with the results.

Specifications (for the majority of the fixtures)

	Pre-Retrofit	Post-Retrofit
Lamp	F32T8/SP30/ECO	F32T8/XL/SPX50/ HLEC
Nominal lamp wattage	32	32
Temperature (Kelvin)	3000	5000
CRI	75	85
Lamp color	730	850
Rated photoptic lumens (P)	2800	3000
Ballast factor (BF)	0.88	0.60
Lumen output (PxBF)	2464	1800
S/P ratio	1.30	2.00
Visually effective lumens (PxBF) x (S/P).78	3024	3091
Measured connected load	87.2 per fixture	70 per fixture

Note: Ballast factor reflects dimmed lighting.



Total installed cost	$56,049
Annual savings from retrofit	**$15,557**
Payback (years)	3.6
Rate of return	28%

LIGHTING TERMS

For the most part, the U.S. Forest Service selected T8 fluorescent lamps with a temperature of 5000K and CRI in the 80s—also known as 850 lamps—for the retrofit of its Western Regional Headquarters.

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