Spectrally Enhanced Lighting: Washington Navy Yard 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%.

An energy-saving technologies demonstration program gave the Washington Navy Yard in Washington, D.C., the opportunity to test out spectrally enhanced lighting in one of its buildings for potential Navy-wide use. The lighting retrofit reduced electricity consumption in the three-story building by nearly 40 percent, and building occupants were pleased with the results. The Washington Navy Yard is home to the Chief of Naval Operations and is headquarters for the Naval Historical Center.

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 Washington Navy Yard is the oldest shore establishment of the U.S. Navy and currently serves as a ceremonial and administrative center. Over the course of 14 days in 2008, 810 fluorescent light fixtures were retrofitted with SEL technology in Building 166, which houses police and other security personnel. The retrofit was performed by the SEI Group, Inc., a Huntsville, Alabama-based energy technology company.

The Upgrade

The Washington Navy Yard's lighting retrofit was performed in a three-story police and security building with 7.5-foot-high ceilings. It was done as a technical evaluation of SEL by the Naval Facilities Engineering Command. The majority of the 810 existing fixtures were 2x4 fluorescent troffers with T8 lamps that had a CCT of 4100K. The lamps and ballasts were replaced, but the fixtures remained, reducing costs and waste. The new lamps were also T8s, this time with a CCT of 5000K.

When preparing for the retrofit, the SEI Group found that some office spaces were lit as high as 80 to 100 foot-candles. Since the industry standard for office lighting levels is 50 foot-candles, this is the level that the retrofit targeted. In some cases, lower-wattage lamps or fewer lamps were installed in order to reach this standard.

Following the retrofit, the SEI Group surveyed building occupants to determine whether the new lighting was acceptable. The 49 responders rated the new lighting better than the old lighting and agreed that it allowed them to see comfortably.

Conclusions

By retrofitting their police and security building with SEL technology, Washington Navy Yard officials were able to reduce lighting energy consumption in the building by 37.5 percent. "We would like to do some more of these projects in the future," said Paul Kistler, P.E., C.E.M., Navy Facilities Engineering Service Center.

Results

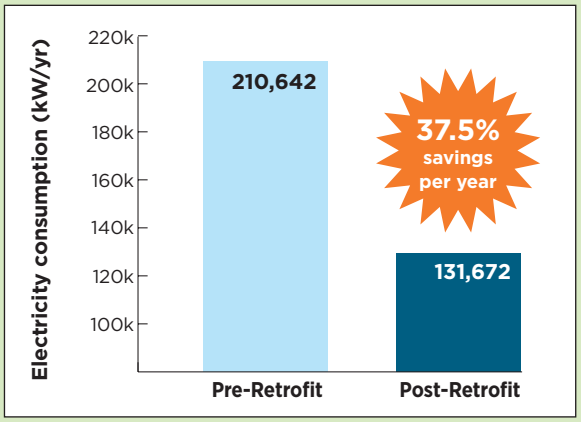
Pre-Retrofit

Post-Retrofit

Specifications (for the majority of fixtures)

	Pre-Retrofit	Post-Retrofit
Lamp	F32T8/TL741	F32T8XLSPX50HLEC
Nominal lamp wattage	32	32
Temperature (Kelvin)	4100	5000
CRI	78	80
Lamp color	741	850
Rated photoptic lumens (P)	2800	3000
Ballast factor (BF)	0.88	0.77
Lumen output (PxBF)	2464	2310
S/P ratio	1.8	2.0
Visually effective lumens (PxBF) x (S/P).78	3897	3967
Measured connected load	81,016 W	50,643 W

Note: Ballast factor reflects dimmed lighting.



Total installed cost	$97,104
Annual savings from retrofit	**$10,266**
Payback (years)	9.5
Rate of return	10.6%

LIGHTING TERMS

For the most part, the Washington Navy Yard selected 5000K, 85 CRI T8 lamps with a temperature of 5000K and CRI of 80—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 741 lamp would have a CRI in the 70s and a CCT of 4100K.

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.

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