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Focus

## The Leed View: Sustainable Lighting

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In Turner Construction's 2008 Green Building Market Barometer survey of 754 commercial real estate executives, a significant percentage of respondent view green buildings as having lower operating costs and higher building values, rent requirements, occupancy rates and overall return on investment.

According to the U.S. Green Building Council (USGBC), which administers the Leadership in Energy and Environmental Design (LEED) green building rating system, 12 federal agencies and departments, 31 states and 122 cities—including Boston, Chicago, Los Angeles, New York and others—have made commitments to use or encourage LEED in construction of certain public and, in several notable cases, private buildings. Additionally, the stimulus package included billions to convert federal facilities into high-performance green buildings.



Full cutoff light fixtures illuminate the perimeter of a fire station without light trespass.

As a result, green construction is a small bright spot in the overall construction market. McGraw-Hill estimates demand for green construction to be 10–12 percent of the current commercial and institutional building market; it predicts that demand will increase to 20–25 percent (\$96–140 billion) by 2013.

As a primary building system, lighting has a critical role to play in sustainable buildings. At first glance, “sustainable lighting” appears to be a fancy way of saying energy-efficient lighting. However, it encompasses the satisfaction of the lighting system’s design intent for the lowest life-cycle environmental impact. And, it has become associated with quality lighting practices that do not directly save energy but are related to worker or inhabitant satisfaction, such as providing access to daylight and views.



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Due to LEED’s popularity as a green building rating system, it makes sense to better define sustainable lighting within its context. LEED imposes requirements and rewards practices implemented to achieve points toward a certified, silver, gold or platinum rating. Launched in April 2009, LEED 2009 introduces a dramatic revision. It incorporates all of the rating systems addressing commercial buildings into three new systems: Green Building Design & Construction, Green Interior Design & Construction, and Green Building Operations & Maintenance. It creates region-specific credits and reweighs the points to reflect more accurately the impact on the environment and human health.

Lighting relates directly to 23 points in the Green Building Design & Construction rating system, most of them tied to energy savings that compare to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2007. The basic lighting-related elements in Green Building Design & Construction (similar to Green Building Operations and Maintenance, with a few changes) are described here.

**SS Credit 8: Light Pollution Reduction (1 point):** At least 10 percent of all outdoor lighting, even fully shielded lighting, ends up creating light pollution—specifically sky glow and light -trespass—according to the International Dark-Sky Association. The intent of this LEED credit is to improve nighttime visibility by avoiding glare, minimize building and site light trespass onto neighboring property, and reduce skyglow, which increases visibility of the night sky.

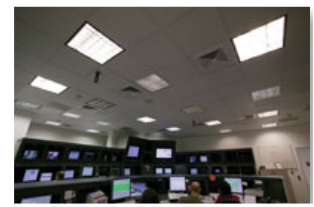
LEED 2009 offers two options to minimize interior lighting’s role in generating light pollution. The first is to automatically reduce the amount of light produced inside the building during nighttime hours, and the second is to automatically close shielding on all fenestration to prevent light from exiting the building.

Regarding outdoor areas, LEED 2009 recognizes a four-zone classification system covering all types of outdoor spaces, from rural areas to high-density commercial districts. Based on the zone, LEED restricts light levels at the site boundary and beyond, while limiting the amount of light that can be emitted in an upward direction from 0 to 10 percent.

The following are tips for outdoor lighting that is sensitive to light pollution:

- Light only those areas that need to be lighted.
- Minimize site lighting where possible.
- Consider modeling the site lighting with computer software.
- Consider full cutoff fixtures, low-reflectance surfaces and low-angle spotlights.

**IEQ Credit 6.1: Controllability of Systems—Lighting (1 point):** Research has demonstrated that personal dimming control provides modest energy savings but typically is accompanied by an increase in occupant job and environmental satisfaction. Multilevel switching, meanwhile, has been demonstrated to achieve energy savings as high as 22 percent in private offices—even higher when combined with occupancy sensors. The intent of this



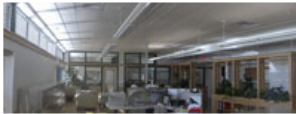
The Institute of Electrical and Electronics Engineers Inc. upgraded the lighting in its 24/7 command center with a DALI-based lighting system with personal dimming control.

credit is to provide control of light levels to individuals and groups in multioccupant spaces.

To obtain this point, LEED 2009 requires individual lighting controls to be provided to 90 percent of the occupants, while also providing similar controls in all shared multioccupant spaces.

The following are options for individual lighting control:

- On/off or dimmable undercabinet or desktop task lighting
- Multilevel switching using wall switches
- Individually dimmable overhead light fixtures with continuous or step-dimming ballasts, controllable by users with a PC interface, handheld remote or wall-mounted dimmer-switch
- Architectural dimming controls in conference rooms



**Vermont-based NRG Systems'** 46,550-squared-foot headquarters is one of only a handful of manufacturing facilities to earn a LEED gold certification. The rows of fixtures are dimmed according to daylight contribution to the space.

**IEQ Credit 8.1: Daylight and Views—Daylight (1 point) and IEQ Credit 8.1: Daylight and Views—Views (1 point):** Numerous research studies have demonstrated that daylighting can improve user satisfaction/performance and retail sales, which can make daylighted buildings more valuable and marketable. These LEED points require providing a minimum daylight level in at least 75 percent, and a view to perimeter glazing in at least 90 percent, of a regularly occupied spaces.

While daylight is not electric, it can present significant impacts on the electrical lighting design. For example, increasing daylight penetration may entail installation of high-reflectance ceiling tiles, which work well with indirect/direct lighting. Ensuring views for open office occupants may require lower partitions, which can affect the lighting design as well.

In particular, daylighting creates opportunities for daylighting controls, which can generate 35–60 percent energy savings, according to the New Buildings Institute. In fact, daylight harvesting, which saves energy, is what makes daylighting a truly sustainable strategy.

Things to look for in good daylighting design are as follows:

- Direct sunlight penetration is avoided except in circulation areas.
- Daylight is captured using sidelighting or toplighting—generally from as high a point as possible, with penetration increased using features, such as light shelves.
- View windows are shielded properly to prevent direct glare.
- Window glass should be as neutral as possible in color.
- Space uses light-colored surfaces, with brighter surfaces kept out of the line of sight as direct sunlight.

The following are tips for integrating electric and daylighting design:

- Electric light should be distributed on the same surfaces as the daylight.
- Use lamps with a neutral or cool color temperature.

The following are tips for establishing a daylighting control system are as follows:

- Consider automatic dimming for applications where occupants perform critical tasks in stationary locations, where the daylighting conditions are highly variable, and/or where the lighting fixtures are within the field of view for the occupants; consider switching otherwise.
- Control systems in sidelighting applications often present more complex requirements than systems in toplighting applications.
- Keep the system as simple as possible, and temper its goals.
- Commission the control system after installation to ensure it meets the design intent.

**EA Prerequisite 2: Minimum Energy Performance (Required) and EA Credit 1: Optimize Energy Performance (1–19 points):** LEED 2009 requires new buildings to achieve a 10 percent improvement in energy performance and existing buildings, a 5 percent improvement, compared to a baseline building that complies with ASRHAE 90.1-2007. To secure points, the building then can demonstrate, again through a building simulation, a 12–45 percent improvement in new construction and 8–42 percent improvement in existing building energy performance compared to 90.1-2007 to earn up to 19 points on a sliding scale.

Alternately, if the building is a small office, retail, or warehouse or self-storage building, it can adhere to applicable criteria established in the appropriate Advanced Energy Design Guide. A third option is that it can comply with the

Advanced Buildings Core Performance Guide published by the New Buildings Institute.

While it is not terribly difficult to meet ASHRAE 90.1-2007's lighting requirements, it can be difficult to exceed it by a significant amount, forcing the designer to take risks with the lighting to achieve desired reductions. The following are recommendations on how to comply with the mandatory requirements of Standard 90.1-2007 and maximize energy efficiency:

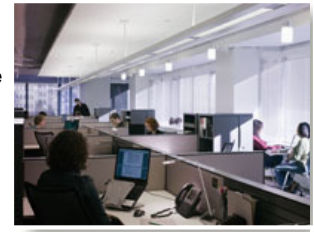
- Avoid incandescent lighting wherever possible.
- Use automatic shutoff controls to turn off lights when they are not being used, including manual-on occupancy sensors when sensors are used.
- Maximize daylighting and capitalize on it by using daylighting controls.
- Use highly efficient interior light fixtures with high-performance T8 lamps and NEMA premium ballasts.
- Use multilevel switching.
- Use ambient/task lighting design.
- Specify factory setting of calibrations for controls to reduce field labor.
- Use 90 percent ceiling reflectance for indirect fixtures and daylighting.
- Consider indirect/direct fixtures, recessed basket-type or lensed curved (so-called premium troffer) recessed fixtures.
- Place light on walls and ceilings for improved visibility, visual comfort and perception of brightness.
- Use light-emitting diode (LED) exit signs that draw no more than 5 watts per face.
- Use LED task lighting with automatic shutoff.
- Use efficient exterior lighting that is automatically shut off when it is not in use.
- Commission all lighting controls.

Be sure the light fixture itself is efficient and designed to avoid glare, as some of the most efficient light fixtures can be "glare bombs." Energy-efficient lighting always should be energy-effective: it should achieve its design intent and serve people, all for less energy.

If the building is an existing building, also ensure lamps minimize consumption of mercury (1 point) and consider lamp recycling (possibly 1 point, combined with other recycling). Finally, for all LEED projects, the owner should take advantage of other LEED points, such as having a LEED-accredited professional on the project (1 point), enhanced commissioning of building systems (2 points), measurement and verification (3 points), and innovative ideas (1–5 points).

As the green building market continues to grow in importance, it will pay for electrical contractors to be aware of its electrical requirements and ways these can be implemented. But LEED is not necessary to deliver "sustainable lighting" to a new or existing building. The lighting practices in this article can be learned and delivered individually or all together to add value to a project without learning LEED; even without the label and expense of LEED, a green building can provide good lighting; lower operating costs; and higher building value, asking rent, occupancy rate and overall return.

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The design of the U.S. Green Building Council's new 22,000-square-foot Washington, D.C., office space includes generous daylighting, highly efficient lamping and ballasting in indirect/direct lighting, automatic lighting controls, views, and LED task lighting.

