Saving Energy through Lighting and Daylighting Strategies

Lighting accounts for over 20% of the energy used by commercial buildings.[1] If you are a facility or project manager seeking to reduce your energy costs, put lighting energy reduction at the top of your list. Your best ally in this endeavor is the sun, for the free and abundant daylight it produces.

Many net zero energy (NZE) and low energy buildings have achieved their energy goals partly by using natural daylight as a substitute for electrical lighting. While none have eliminated electrical lighting completely, the best proven strategy is to employ layers of light – using daylight for basic ambient light levels while providing occupants with additional lighting options to meet their needs.

This guide discusses key elements of a comprehensive strategy to use lighting and daylighting to minimize energy use while maximizing occupant comfort and performance. This strategy is based on energy research conducted by GSA and the National Renewable Energy Laboratory at the Fort Carson Army Base near Colorado Springs, CO.[2]

Layers of Light

Set Lighting Goals

To start down the path of successfully slashing facility lighting energy use, set two goals as early as possible in project planning[3]:

1. Set a Maximum Lighting Power Density goal

   Lighting Power Density (LPD) is the electrical load of lighting per area lit, measured in watts per square foot. Many spaces are overlit (i.e., LPD too high), leading to wasted energy and potential occupant discomfort. Getting LPD right is therefore critical to resolving multiple challenges.

2. Set a Daylight Sufficiency Goal

   With the LPD established, the daylight sufficiency goal specifies the amount of daylight needed to provide adequate light to perform typical tasks appropriate to each space, without additional electric lighting. It is measured in lumens or foot-candles. The optimal daylighting level needed to perform most tasks in the space will provide the appropriate balance between too little daylight (resulting in eyestrain or unnecessary electric light usage) and too much (resulting in excess glare or heat).

[1] US Department of Energy (2012). *Buildings Energy Data Book*. http://buildingsdatabook.eere.energy.gov/TableView.aspx?table=3.1.4

[2] General Services Administration (2015). *Strategies to Achieve Net Zero Energy: The Fort Carson Energy Research Project*. www.gsa.gov/fortcarson

[3] At Ft. Carson office buildings, 25-30 foot-candles (269-323 lux) was an effective LPD for mixed-use office spaces, while a base illuminance as low as 5 foot-candles (54 lux) was appropriate for other uses. For more information on calculating lighting goals, see:
US Department of Energy (2012). *Lighting: Development, Adoption, and Compliance Guide*. http://www.energycodes.gov/sites/default/files/documents/Lighting_Resource_Guide.pdf
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) (2013). *Standard 90.1*. https://www.ashrae.org/resources--publications/bookstore/standard-90-1
Illuminating Engineering Society (2011). *IES Lighting Handbook (10th ed.)*. http://www.ies.org/handbook/

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Developing a Lighting Strategy

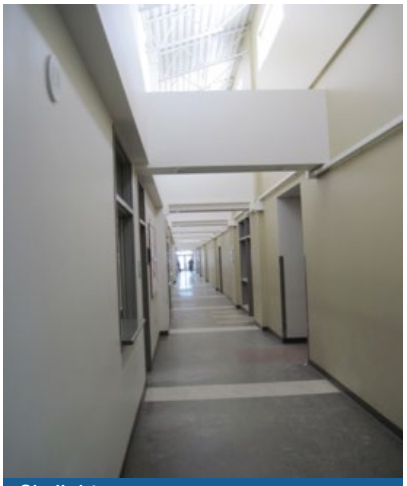
With your lighting and daylighting goals established, craft a lighting strategy to achieve them, consistent with your facility's needs and circumstances. Core elements of an effective strategy include:

1. Best practices to harvest sufficient daylight to supply ambient light for each space type
2. Techniques and technologies to supply occupants with additional lighting options beyond that provided by daylight

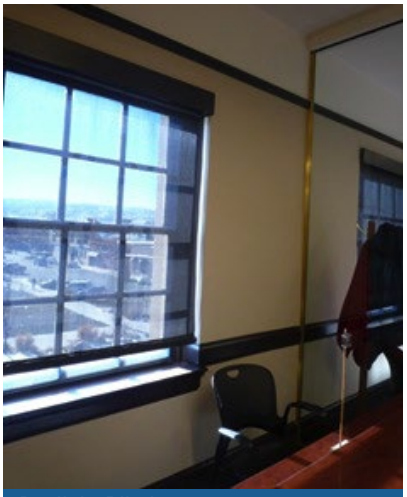
Harvesting Daylight

An effective daylighting strategy appropriately illuminates the building space without subjecting occupants to glare or major variations in light levels, which can impact comfort and productivity. Opportunities vary depending on whether a building is new or existing and can include proper placement and use of interior walls, windows, overhangs, window coverings, and furnishings.

- New construction and major renovations present significant design opportunities to optimize daylight capture, including:
  - As windows provide both daylight and views, the upper portion of windows – as well as arched windows, skylights and transom glass – can be used to bring in high levels of daylight with fewer glare issues, while reserving the lower portion of windows for views, with proper shading. Place exterior overhangs just above eye height (about 7.5 feet) on windows on the south and west sides of your building to maximize daylight and reduce glare.
  - Consider adjacent buildings when placing windows. If there are glass buildings nearby, determine the amount of reflective glare and its direction into the building.
- Additional strategies can be applied to either existing or new buildings, including:
  - Ensure that the space is optimized to disperse daylight well. Consider using light interior surface colors and low cubicle partition heights to allow daylight to penetrate interior areas.
  - Position interior blinds just above eye level (at the overhang) instead of at the top of the window. This allows daylight to enter the space through the top of the window with minimal glare. If glare is still a problem, hang daylight blinds on the top portion of the window. Daylight blinds are designed to block glare while still allowing daylight into the space.
  - Ensure that occupants can meet their lighting needs. Passive strategies, such as mechanical shades or blinds that do not close completely, may achieve daylighting goals but should provide options to override default conditions.
  - Occupant engagement requires steady effort and feedback but can yield major rewards as occupants are educated and reminded to open and close blinds and shades as needed.



Skylights



Daylight Blinds

Providing Occupants Lighting Options to Meet their Needs

With daylight providing basic lighting levels, aim to build in layers of additional electric lighting options to ensure that occupants gain the lighting they need for the varieties of tasks they perform.

- Maximize the efficiency of electric lighting systems through control systems that ensure that electric lighting is used only for the time, location, and quantity needed by occupants for a typical task[1].
- Upgrade electric lighting fixtures to more efficient fluorescent and LED fixtures. These new technologies emit more light per watt than conventional fixtures, enabling you to maintain light levels while meeting a lower LPD goal and thereby saving energy and money without impacting performance.
- Provide occupants with options for additional lighting, e.g.:
  - Provide task lighting at individual workstations and desks. LED lamps and fixtures with movable arms provide even greater energy savings and positive ergonomics.
  - Use vacancy sensors (manual on, automatic off) instead of occupancy sensors (automatic on, automatic off). In other words, turn lights off automatically when not in use but require occupants to opt in for more light as needed, by flipping a switch.
  - Divide the space into fine-grained electric lighting zones to direct lighting where it is most needed and allow for appropriate variations within the workspace.
  - Provide intuitive control displays that are easy and convenient for occupants to use.

[1] For guidance on choosing lighting controls, see: Whole Building Design Guide. *Electric Lighting Controls*. http://www.wbdg.org/resources/electriclighting.php

To read GSA s Fort Carson Lighting Study, and other studies from the Fort Carson Energy Research Project, go to www.gsa.gov/fortcarson.