

A Comprehensive Guide to
**SUSTAINABLE
LIGHTING**

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CIRALIGHT

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Introduction

Since 2003, energy costs in the U.S. have been steadily rising. Electricity now costs 62% more than it did 12 years ago. New energy efficient technologies have been developed to protect businesses from these rising costs. Electrical lighting presently comprises up to 40% of a commercial or industrial facility's energy use. One of the best ways to save energy is by properly incorporating sustainable lighting into the facility's design. Sustainable lighting will reduce electrical costs for facilities by nearly 56%. Daylighting is one of the most effective sustainable lighting options on the market today, because it harnesses the sun's natural rays and uses them to replace or supplement electrical lighting. After reviewing many energy efficient lighting technologies, the U.S. Navy concluded that daylighting provides the greatest savings; a properly installed daylighting system reduces the cost of electricity in a facility by 40-80%.

Businesses have a profound impact on the world we live in: commercial and industrial facilities consume an estimated 40% of the world's energy, they generate 40% of global waste, and they contribute to 40% of global greenhouse gas production. Installing sustainable lighting systems would lessen our reliance on the electricity generated from fossil fuels. Daylighting devices, in particular, reduce utility costs and benefit the environment. With rising energy prices and a plethora of options on the market, incorporating sustainable lighting into buildings is no longer a novelty, but a necessity.

What Options Exist for Sustainable Lighting?

Once you've chosen to invest in more sustainable lighting, you must then decide what option is best for your building's design and specifications.

Daylighting (Natural Lighting)

Centuries ago, an idea emerged of harnessing the sun's light and bringing it into a structure as a way for a building's inhabitants to brighten dark interiors. Traditionally, this practice has been known as daylighting or natural lighting. To accomplish this, architects and builders would simply design a hole in the roof or include large and plentiful windows. There are two common types of daylighting:

- **Passive daylighting:** This brings sunlight into a building using a static and non-tracking device. Examples of passive daylighting include skylights, windows, and glass doors.
- **Active daylighting:** This system mechanically tracks the sun throughout the day and redirects sunlight inside buildings at an intensity that allows artificial lighting to be turned off. Active daylighting systems outperform passive systems when compared with the amount of light directed into a building—upwards of 300 percent more.

When building design allows, natural lighting is the most energy-efficient option and also provides significant health and productivity benefits. However, designers and architects have become reliant on Thomas Edison's development of a practical, commercially viable electric lighting system, which historically, over time, created our dependence on artificial lighting.

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Artificial Lighting

Artificial lighting has become a prominent source of illumination for industrial and commercial buildings, as it is obviously needed when the sun goes away. In light of rising energy costs, several advances have been made to reduce energy consumption and implement sustainable lighting options, including:

- **LED lighting:** LED lights use significantly less energy than traditional incandescent bulbs and compact fluorescent lights (CFLs), but they can be limited in their usage because they emit only directional light. This means that the light generated by LED bulbs will not spread effectively over a designated area. Most, if not all, LED installations require the use of diffuser lenses to alleviate their direct light limitations, which adds to the cost of the initial setup. Still, with the amount of energy saved, LED lighting solutions can be economical over time, and as LED technology improves and becomes more accessible, the cost of equipment will continue to drop. Additionally, the initial installation typically requires minimal conversion of existing light fixtures.

If LED fixtures appear to be the best option for artificial lighting, plan on waiting a while before realizing the savings. LED bulbs do not save a significant amount of money when compared with CFL bulbs, but they do last much longer. Savings will be realized instantly when compared with operating traditional incandescent bulbs; however, that savings won't occur until the need for replacing CFLs comes around. LED lighting does not significantly reduce costs in areas where lighting is not needed for long periods during the day.



- **Solar-powered lighting:** Solar-powered lighting is a good, convenient, and inexpensive solution, especially for a remote area. However, reliability can suffer during seasons when daylight does not last long; therefore, coupling the lighting with photovoltaic cells that help store the energy gained from the sun is a good idea. Brightness can also become an issue with solar lighting because brighter lights require more energy. Using the bright lights during shorter nighttime applications in the summer will work great, but when long winter nights arrive, these lights will drain the charge gained during the day more quickly.

The upfront costs of solar lighting are significant and vary wildly across the United States, depending on the amount of incentives available from state governments and the requirements of permitting. This obviously extends or reduces the time needed for return on investment, which is typically 15 to 20 years. Acquiring a detailed quote on the specific needs of the lighting project from an experienced solar contractor is critical. Don't rely solely on personal research alone.

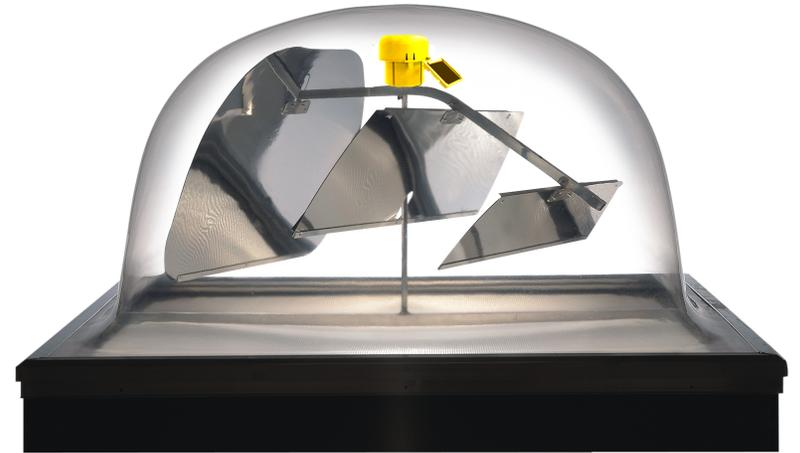
LEDs and solar-powered lighting require sending power to the lights around the clock. Daylighting and natural light solutions give property owners the ability to completely shut the lights off for significant periods of the day.



Skylights

Skylights, a daylighting solution, offer simplicity by allowing daylight to come into a building with sealed glass, plexiglass, or plastic panes covering an opening in the roof or high on a wall. It's a familiar technique used in residential and industrial applications and can be effective for brightening the interior of a structure. A skylight will also give a building's inhabitants the feeling of the outdoors, which will improve mood. Although most skylights and windows traditionally act only as a lens between the outdoors and indoors, several advances have been made in skylight systems. Here is an overview of the most common types:

- **Traditional skylights:** Though they are a viable natural lighting solution, the performance of traditional skylights compared with newer technologies will be unreliable and inflexible for a number of reasons. First, they generate heat where it is not wanted. They also rely on the sunlight being overhead, so illumination can be unreliable, especially when the weather hides the sun. Finally, if the roof on the structure is separated from interior rooms, such as with a pitched roof typically found in a home, a traditional skylight simply isn't feasible.
- **Tubular skylighting:** This skylight pipes in sunlight through tubes and fixes the issue associated with a roof that does not immediately connect to the interior. Tubular skylights are designed to accommodate the movement of the sun's position throughout the day by diffusing its light rather than creating an extreme spotlight effect like traditional skylights. They also reduce the amount of glare from direct sunlight. Tubular lighting gives designers more flexibility because the skylight can be placed more effectively, even into walls and pitched roofs.



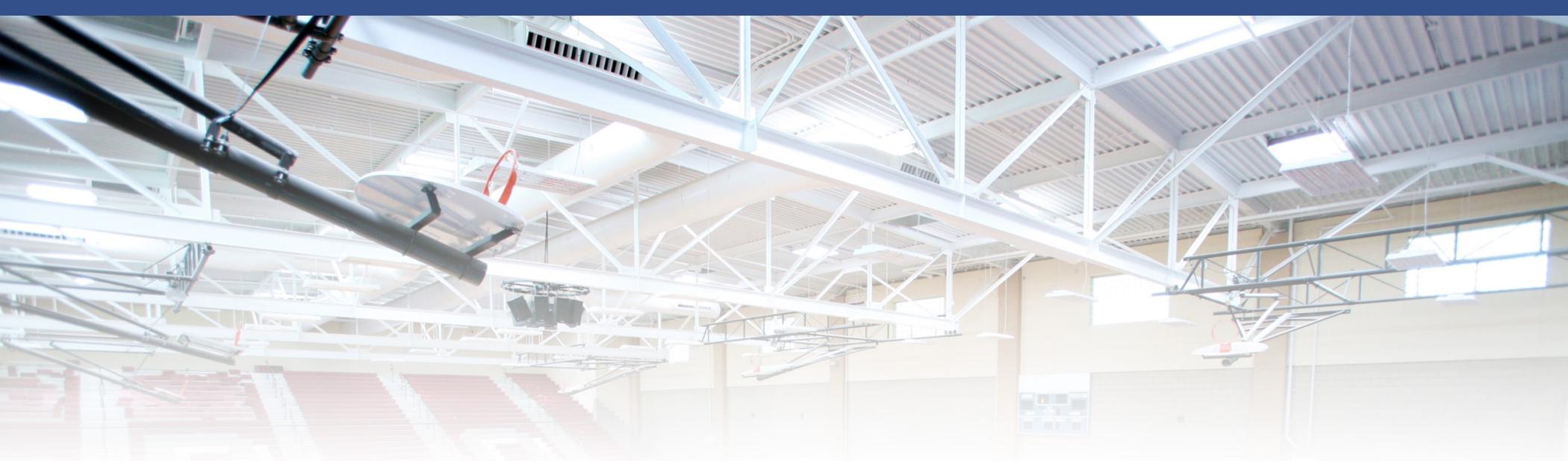
Like traditional skylights, the light from tubular skylights can be inconsistent. Although the use of diffusers in tubular skylights will help to decrease glare and spotlight effect, light level will still fluctuate as the sun moves throughout the day. Essentially, tubular skylights allow for some flexibility, but due to their limited size, typically 14 to 21 inches in diameter, they do not capture sufficient natural light and thus require many more units to meet required light levels. In addition, the tubular skylighting market has grown to accommodate residential applications, but commercial and industrial solutions are few and far between, since businesses must purchase a large number of smaller tubular skylights to sufficiently light larger commercial buildings.

- **Solar-tracking skylights with GPS technology:** One advanced and active daylighting solution rapidly making its way into the construction industry is the solar-tracking skylight with GPS tracking technology.

The technology driving this solution uses simple components that track and respond to the sun's natural movement and delivers higher level of quality of light and more consistent illumination to the interior of the building throughout the day. Diffusers can deliver a bright light, without glare, that supplies excellent visibility and spreads the light around evenly without additional heat gain or loss. This is an excellent solution for an industrial setting where good vision and a reduction of glare can dramatically improve working conditions and performance for employees. Since Solar-tracking skylights utilize solar power technology, they receive additional tax and utility company incentives which are not available for traditional and tubular skylights.

Solar-tracking skylights address the issue of the sunlight's movement by using GPS tracking technology combined with mirrors which follow the sun and capture light for longer periods. The light generated by these systems remains absolutely free, just like traditional skylighting and tubular skylights.

Of course, solar-tracking skylights—and skylights in general—are limited due to their reliance on the sunlight. Though they provide the best-quality light and, in the case of solar-tracking skylights, up to 10 hours of it, artificial lighting is still needed during the night. However, coupling solar-tracking skylights with artificial sustainable lighting methods such as LED lights gives you the best sustainable solution.



Weighing Your Options: Daylighting vs. Artificial Lighting, or Both?

At the beginning of almost any lighting upgrade or installation, the question of daylight versus artificial light will no doubt arise. The answer, like most things in life, will be some sort of compromise that combines technologies to meet the needs of the building's inhabitants and lighting requirements while staying within budget constraints.

Drawbacks of LEDs and Other Sustainable Artificial Lighting Solutions

The options for lighting solutions that use less electricity and drive down energy costs have expanded dramatically over the last decade. Some LED and compact fluorescent bulbs can use up to 90 percent less electricity and have a much longer usable life than incandescent bulbs. This is good news for anyone running an industrial or commercial facility, where good lighting is needed around the clock.

The quality of artificial light, however, still does not promote a good working environment because these lights often cast a blue hue over the areas they illuminate, so the definition of objects in the area is not clear enough for some tasks. For a workforce in which poor vision can lead to issues with quality and even safety, substandard artificial

lighting can actually damage the bottom line. All artificial lighting will generate heat as well, which can increase the cost of cooling a busy production area. LEDs and compact fluorescents also may not achieve a strong return on investment in areas where lighting is not needed throughout the day.

Drawbacks of Daylighting

Realistically, not all daylighting is good. As previously mentioned in reference to stationary skylights, it can create glare, heat, and bright spots, all of which are difficult on eyes and waste energy when trying to keep an area cool. Studies by the Heschong Mahone Group discovered that daylighting effectively improved attention span and performance in schools and productivity in office settings, but the type of light directly affected the results. Harsh light entering the building horizontally created a distraction from the glare, and heat generated from traditional overhead skylights made indoor temperatures uncomfortable.

According to the Heschong Mahone report, a conclusion can be made that for daylighting to produce the desired results, it must be fully diffused and distributed evenly while preventing heat generation. Failing to consider all of the factors involved with sustainable lighting, commercial facilities do not capitalize on the full benefits of human performance, temperature control, energy savings, and the quality of light necessary to achieve their desired objectives.

Natural Light Provides a Better Quality of Light

The biggest benefit of daylighting may not even become apparent from the reasons listed above. Natural light literally brings the natural, outdoor world indoors. Think about the feelings of freedom and calm that comes with being outside. Those feelings move inside a building with a daylight design, which works brilliantly to improve production, focus, and the mood of any workplace. At some point, artificial lighting may be needed each day—and that need won't completely go away—but you can reduce the amount of time that employees are exposed to this type of lighting with a properly implemented daylighting solution.



Natural lighting improves visibility and creates a brighter, cleaner-looking workplace that will greatly enhance employee morale. Better visibility from daylighting will also reduce the fatigue that comes from eye strain, thus giving everyone more energy to complete their work well and boost productivity.

A great application of daylight promotes:

- A reduced risk of occupational incidents
- Better focus and accuracy at work because fatigue is reduced
- A more active workplace environment
- Improved visibility that leads to more accuracy and speed, which will boost production numbers across the workforce.

LEDs and Other Sustainable Artificial Lighting Solutions Work Around the Clock

As mentioned prior, daylighting systems rely on sunlight, which makes them an unfit solution when lighting is needed during the nighttime. In these cases, LED lights and solar-powered lighting are necessary; however, daylight systems should not be ruled out altogether. When working in combination, daylighting systems and a sustainable artificial lighting system can greatly reduce energy consumption and costs.

The Most Sustainable Option

Ultimately, what is the most sustainable lighting option? Which option will contribute the most to your effort in reducing energy consumption and utility costs? The answer varies from product to product and is also dependent on a number of factors related to your project. To evaluate and identify the most sustainable option, ask yourself the following questions:

- What are the typical energy and cost savings for the product?
- When will the solution pay back the investment?
- Are there ongoing maintenance costs associated with the solution?
- Will the solution add unwanted costs in other areas? For example, some daylighting systems generate heat, which means your cooling bill may rise.
- What other added benefits are there in the lighting solution (e.g., productivity, health, performance, and so on)?





Tips for Selecting a Sustainable Lighting Product

In addition to the questions listed above, here are some additional, more in-depth, factors to consider:

1. Obtain Accurate Energy and Cost-Savings Projections

Most manufacturers selling a sustainable lighting product will show you the best possible scenarios and outcomes in relation to their products. Look for a manufacturer that can provide an accurate assessment of the potential energy savings. Without that information, the dealer really can't offer an accurate quote or cost-savings projection.

2. Know the Units of Illumination

Knowing the details about factors such as how much light is needed, what times of day the lights can be turned off, the amount of people working in each area, and what type of work is taking place will help with the decision-making process. This is a good start, but what's missing is an understanding of exactly how light is measured. Building a familiarity with the terminology used by designers, manufacturers, and lighting dealers will help everyone involved with the project. The dealer can help find the right products when they know how much light is needed for the working areas.

- **Lumens and candelas:** While exploring the data associated with lighting levels, lumens and candelas will likely pop up. A lumen refers to the total amount of visible light emitted by a single source in all directions. The candela is the base unit of the lumen broadcast in a particular direction. The measurement comes from the intensity of light emitted from one common candle. For example, candelas can be used to compare two lights with the same beam angle.
- **Lux and foot-candles:** Lux is also a unit of light measurement; it takes the area in meters into account, and measures “light intensity” on a surface. A foot-candle measurement also quantifies the intensity of light falling on an surface, but in feet instead of meters. Simply put, lux and foot-candles measure brightness of light at the illuminated surface, and lumens measure the power of the light from its source.
- **Wattage doesn’t equal illumination needs:** A wattage rating of a light bulb is easily confused with the amount of light produced from the source (lumens). Wattage refers only to the amount of energy that the bulb will consume and not its output capability. If you have a wattage measurement, it can be used to help determine how much energy will be saved if you replace traditional lighting with daylighting, but it cannot be used to determine illumination needs.

3. Check for Testing and Certifications

Globally, the push to implement green designs for sustainable buildings is stronger than ever. The basic facts about buildings and energy consumption have motivated the construction industry to change their designs.

Selecting the right product will help meet the requirements of the certifications; therefore, evaluating the certifications and testing that the product has passed is important. Some of the common certifications to review include:

- **AAMA** – test for air leak, water penetration, load deflection and structural pressure
- **Solar Heat Gain Coefficient (SHGC)** – measures how well a product blocks heat caused by sunlight (the lower the better)
- **U-Value** – measures how well a product prevents heat from escaping (the lower the better)
- **Visual Light Transmittance (VLT)** – measures how much light comes through a skylight (the higher the better)
- **Other important product information includes:** OSHA Fall Protection report, and a Life Cycle test

Common Green Design and Sustainable Building Standards

LEED

The movement to construct more sustainable buildings in America is being driven by the U.S. Green Building Council (USGBC) and its national standard known as the Leadership in Energy and Environmental Design (LEED). Achieving LEED certification requires that a building designer incorporate “green technology” throughout the structure in order to meet the standards set by the USGBC. The standards to attain LEED certification are measured by a scientifically proven criteria and point system.

The certification cannot be achieved by implementing only a few of the recommendations; rather, a holistic approach is required. Nonetheless, a significant part of this certification involves the lighting considerations of the structure, and the use of daylighting will score certification points in many areas. Though daylighting cannot guarantee certification by itself, it is a critical component of the building’s overall plan and LEED certification.

International Code Council (ICC)

The ICC is an association dedicated to developing codes that support safe, sustainable, affordable, and resilient structures. Though federal, state, and local governments don’t directly enforce these codes, they do pattern their own codes after the ICC guidelines making the ICC a major force in regulation.

With each revision of the ICC codes, greater energy savings are required, and no stone can be left unturned if you want to stay within compliance. Also, with each revision, sustainable lighting becomes less of a unique alternative and more of an absolute necessity. In fact, the most recent revisions demand that big-box and warehouse-type stores maintain at least 50 percent of the space in their buildings within a daylight zone by using daylight controls in those areas.

Conclusion

Government requirements and a need to deliver cost savings has made sustainable lighting an essential aspect of building design and maintenance. When the time comes to make your lighting systems more sustainable, rely on the information provided in this eBook to guide you through the process.





About Ciralight Global

Ciralight is dedicated to a green, sustainable future. We offer a clean, natural alternative light source that simultaneously reduces carbon emissions and electrical spending while promoting a greener, healthier, more energy-efficient way of life. We are determined to carry out our mission to make active daylighting an industry staple and to help provide the world with healthy, affordable, natural light.

Our Ciralight SunTrackers™ deliver more natural sunlight for more hours a day than any passive skylight on the market. Using solar-tracking GPS technology, Ciralight SunTrackers™ naturally illuminate building interiors with up to 63,000 lumens of natural light for up to 10 hours a day. Ciralight SunTrackers™ have been installed in corporate facilities all over the world, including prominent companies such as Google, LG, Boeing, Toyota, Johnson & Johnson, Eaton, IKEA, Whole Foods Market, Walgreen's, Disney, ACE Hardware, PetSmart, Staples, and Office Depot, Ford, Procter & Gamble, BMW, as well as airports, schools, and universities.