GUIDE TO ENERGY EFFICIENT LIGHTING FOR WAREHOUSES AND DISTRIBUTION CENTERS

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Introduction

Lighting accounts for approximately 20% of all electricity use in the United States, and about 40% of energy consumption in the commercial building sector. Within that sector, retail and warehouse facilities are among the biggest consumers. Much of that energy is wasted, resulting in higher than necessary utility bills and carbon emissions.

However, lighting retrofits can reduce energy costs by as much as 50% in some buildings, thanks to rapidly evolving technology. An outdated T12 fluorescent fixture with four 4-foot lamps and two magnetic ballasts uses 160 to 180 watts of power, while new T8 fixtures with special thin-diameter lamps and electronic ballasts use about 115 watts. In addition to retrofitting fixtures, a warehouse or distribution center can also achieve savings with lighting controls that dim or shut off lighting in unoccupied spaces.

The challenge during a lighting retrofit is to achieve significant energy savings while maintaining a safe, well-lit environment that meets ASHRAE standards and enhances employee productivity. Fortunately, the newer lighting technology provides the same or better light levels as older equipment. It also reduces glare, produces more natural-looking light, and does not flicker or hum.

In sum, if your lighting system is more than eight years old, a retrofit could provide the following benefits:

- Save an average of 20%-50% a month in energy bills
- Save on maintenance costs with lamps and ballasts that don't need to be replaced as frequently
- Reduce your energy consumption and peak demand charges
- Improve your work environment, employee safety, and quality control with better lighting
- Improve CRI with color corrective lighting to makes tasks easier and make your product look even better
- Increase your property and business value
- Have a positive impact on the environment by decreasing emissions
- Take advantage of tax deductions and utility company rebates

Implementing a Project

Initial Meeting

The first step in the process is to meet with an energy services company to determine whether your facility would be a good candidate for a lighting retrofit and whether the company would be able to meet your needs. Ask for references and determine how much experience this vendor has had in serving your market and territory. Depending on the outcome, you would then schedule an energy audit.

Identifying Savings Opportunities

A retrofit project starts with a lighting audit, which identifies the retrofit opportunities in a facility by creating a detailed profile of lighting energy use and lighting quality throughout the building.

The audit identifies which lighting areas are present (office, hallways, bathrooms, lobbies, parking lots, auditoriums, closets and maintenance areas, etc.). It describes the existing lamp types and wattages in each application area, the number of lamps per fixture, the average time of use (estimated daily hours), and the energy use (wattage) for each lamp. The auditor also notes how old the current lighting is, the condition of the fixtures, and whether automated controls are in use. This information reveals whether it will be necessary to replace the entire fixture and all its lamps, or retrofit the original fixtures with new lamp and ballast components.

The following information about existing lighting is recorded during the audit:
- Map location number
- Location description
- Annual hours of run time per group of fixtures
- Fixture quantities
- Footcandle readings
- Lamp & ballast types
- Ceiling height measurements
- Notes (mounting considerations, etc.)
- Requested change in lights levels (more or less light)

Designing a Plan

Information gathered during the audit as well as a current copy of the electricity bill and the existing cost of lighting maintenance facility-wide is entered into a computer program, and a project design is generated. Each project is crafted to strike a balance between energy savings and light levels, as well as existing conditions, the type of activities that take place in the facility, and any specific customer requests. Project designs should be reviewed by a master electrician within the energy services company or an independent consultant. Once the plan is designed, it should be formally presented to you with all the information you need to make an informed

purchase decision. You should have a written confirmation of the savings, the return on your investment and the payback period.

Financing the Project

- Generally, capital investment in energy conservation measures results in the highest return on investment and is the best financing option if funds are available. If not, the second best return on investment would be through third party financing.

- Another option would be shared savings/ performance contracting. This option is a long-term agreement between you and your energy services company. The company would maintain ownership of the system and receive a percentage of the savings, allowing the building to use the equipment. The shared savings payment is considered an operating expense.

- Your state energy office may be able to help identify incentive programs or connect you to other organizations for assistance.

- Many public utilities offer rebate programs for energy-efficient retrofits. This can help offset the initial cost of implementing a lighting retrofit program. The details of these types of programs will vary from utility to utility, but can be explored by either calling the local utility or searching its web-site. State-by-state information on incentive programs is also available at: http://dsireusa.org/incentives/.

Project Installation

Once the proposal is accepted and you have signed a contract, materials are ordered and shipped from manufacturers. The project manager assigned to you will visit the site to do a walk-through, meet with key staff members, and answer any questions you may have. The manager will address any specific concerns, such as fragile equipment, sterile areas, or days and times when certain areas can be entered. Then a schedule will be created based on the project size and complexity. Upon project completion, PCB ballasts and fluorescent lamp containers are removed from the site, ballasts and discarded lamps are recycled, and you will be given all applicable documentation as well as a warranty for each component of the project. If there are any lamp or ballast failures after installation, the energy services company will often work with the manufacturer to remedy the problem. The company will also monitor the energy savings to make sure they match the projected savings that was guaranteed at the start of the project.

Timing a Project

With new technologies available all the time, it can be difficult to gauge the right time to invest in lighting retrofits. Should a company wait for the next advancement before making upgrades? The answer depends largely on the payback period. In some cases, the energy savings, plus utility company rebates and federal tax credits, may allow the project to pay for itself in less than two years. In addition, better lighting results in a better space, greater comfort and control, higher productivity and safety, and greater property value. Taking all these factors into consideration, it would actually cost more to delay some projects than to implement them.

Ten Effective Lighting Efficiency Strategies

The following are examples of strategies that might be recommended in a lighting retrofit design:

1. Incandescent lamps, one of the most inefficient types of lighting, can be replaced with compact fluorescent lamps (CFLs), resulting in a 75% energy savings. CFLs also last longer than incandescent lamps, which will reduce maintenance and labor costs while reducing inventory demands.

2. Many buildings have areas that are unoccupied much of the time, yet the lights remain on almost constantly, needlessly consuming energy. This problem can be eliminated by installing occupancy sensors, devices that are integrated into the lighting circuit and turn the lights off when the space is left unoccupied for a predetermined period of time. Sensors reduce energy use as well as maintenance costs by shortening burn hours for lamps. Most small interior spaces can be controlled through wall-mounted sensors. Larger offices may require the use of a ceiling mounted sensor for greater coverage. The delay can be adjusted to maximize energy savings while minimizing any inconvenience.

3. Another way to cut down the time that lights need to be on is through a daylight harvesting system, which uses photosensors to detect light levels in a room. As daylight becomes available, the artificial lighting will be reduced. When it becomes cloudy or dark outside, the level of artificial lighting will be increased.

4. Exterior lamps that operate during daylight hours should also be fitted with photocells to turn them off when daylight reaches a preset level. Alternatively, timer switchers can be installed, which turn the lights on and off according to an inputted schedule.

5. Outdoor fixtures may also need upgrading to reduce both energy and operational costs. Repairing a single post top light entails at least two hours of labor, a bucket truck and other equipment. This is a fixed cost that can run in the millions of dollars, a daunting burden for facilities facing tight operating budgets. There are several options for replacing outdated high-intensity discharge (HID) lamps with energy efficient, low-maintenance lamps such as LED or induction.

6. T12 lamps, a type of linear fluorescent lamp, are outdated and inefficient compared to the newer technology provided by T8's, which offer superior lighting quality and longer life while cutting energy consumption by 30 percent. T8 lamps also operate on electronic ballasts that are more efficient than older magnetic ballasts.

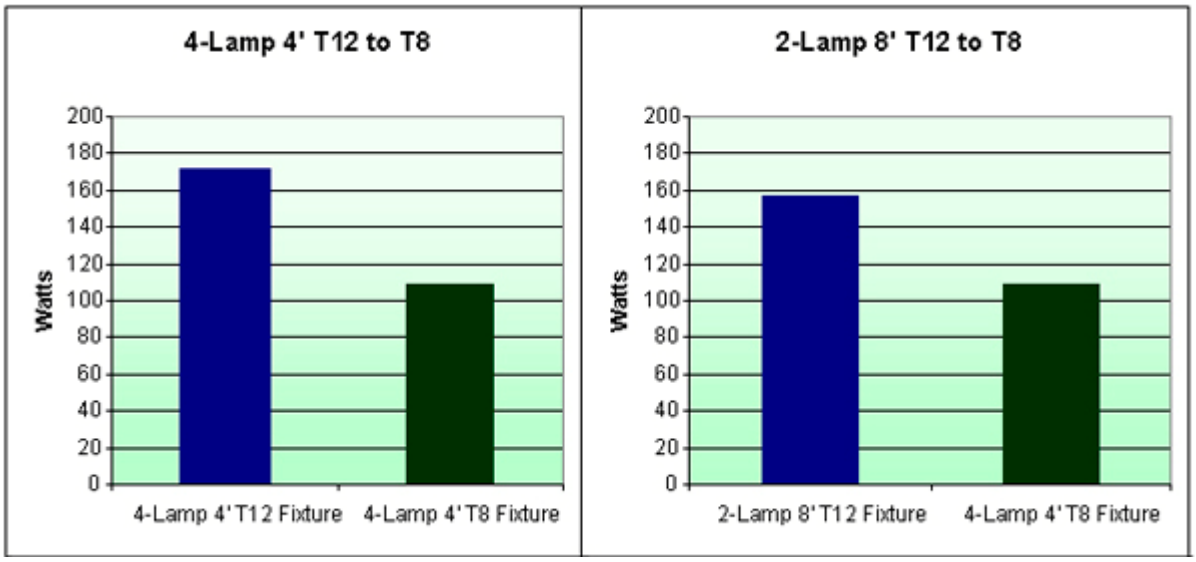
7. Different types of lamps on the same fixture or interior space can create an unattractive, uncomfortable environment. In some cases, fluorescent lamps may look the same but cast different color light depending on their "color temperature" (ranging from warmer colors like yellow to cooler colors like blue). Flickering is another common problem detracting from the

aesthetics of a space and even safety levels, depending on what function the space serves. In offices, glare can also be a problem, leading to fatigue and eyestrain. All these conditions can be addressed by lighting retrofits.

8. Using low-wattage fluorescent task lights in an office can reduce the energy needed to maintain light levels by making it possible to turn off or reduce the overhead lighting. This also reduces glare from both overhead lights and computer screens, and provides greater control over distribution and intensity of light on the task.

9. Exit signs offer one of the easiest ways to reduce costs and save energy due to their long operating hours. Exit signs that utilize incandescent sources should be replaced by LED-sourced exit signs, which involve lower maintenance, higher reliability, energy savings, reduced costs, and a shorter payback period.

10. Maintenance is a key element of lighting efficiency. When fixtures, lamps and lenses collect dust and dirt, their light levels decrease while they continue to draw the same amount of energy. They should be dusted every 6-24 months, and rooms should be cleaned or repainted every couple of years, since dirt on the surface of the walls reduces the amount of light they reflect.



Case Studies

Berwick Offray
Bloomsburg, PA

Berwick Offray, an affiliate of CSS Industries, is the world's largest manufacturer and distributor of decorative ribbons and bows. The company hired GreenTech Energy Services to help reduce energy usage and operational costs in its South Centre Wholesale Warehouse in Bloomsburg, PA. GreenTech did a lighting retrofit that produced significant savings as well as a reduction in pollutants.

GreenTech Energy Services did a lighting retrofit project during third shift with minimal disruption to production activities. The project significantly improved lighting quality; our facility is a lighter and safer place to work.- Joe Roush, Berwick Offray General Manager

SAVINGS

Program Costs…….. $133,627
Payback……..1.7
KW Saved……..…60
KWH Saved……..843,639
Energy Savings…….$74,851
Operational Savings……...$4,218
Total Savings…….$79,070

ENVIRONMENTAL IMPACT

Reduction in Carbon Dioxide (pounds)…….…. 1,265,458
Reduction in Sulfur Dioxide (grams)……..…. 4,724,378
Reduction in Nitrogen Oxide (grams)…….…. 2,109,097

Cambell's Soup
Plainfield, New Jersey

Campbell's Soup Company contracted with GreenTech Energy Services to help reduce energy costs in its 50,000-square-foot warehouse in South Plainfield, NJ. GreenTech replaced 83 outdated T12 fixtures and 67 metal halide fixtures with T8's, and installed sensors that switch lights off in unoccupied areas of the warehouse.

Results:

- 40% Reduction in Energy Use
- Savings of 24 KW and 172,099 KWH
- Utility Rebate - $6440
- Payback – 1 year
- TOTAL SAVINGS: $21,729

With the help of Greentech Energy Services, Campbell's Soup Company was able to cut its energy bills and improve the quality of lighting in its warehouse, as well as reducing environmental emissions.

BEFORE

AFTER

DEL MONTE
Bloomsburg, Pennsylvania

Del Monte, one of the country's largest producers, distributors and marketers of food and pet products, hired GreenTech Energy Services to do a lighting retrofit for its processing plant and distribution center in Bloomsburg, PA. GreenTech replaced outdated T12 lamps with state-of-the-art T8's, replaced 1000-watt metal halide high bays with T5 lamps, and installed occupancy sensors in offices and aisles.

"This project was driven both by Del Monte's own "Lean Manufacturing" program, which sets company-wide goals for reducing costs and environmental impact, as well as by expectations on the part of its largest single customer, Walmart, which has been seeking 'green suppliers' as part of its corporate social responsibility program. This lighting retrofit will go a long way toward meeting both sets of goals." - Mark Shute, Senior Supervisor

SAVINGS

Payback……1.0
KW Saved……252
KWH Saved……2,371,845
Energy Savings……$128,080
Operational Savings……$4,218
Total Savings……$134,401

ENVIRONMENTAL IMPACT

Reduction in Carbon Dioxide (pounds)……3,557,767
Reduction in Sulfur Dioxide (grams)……13,282,329
Reduction in Nitrogen Oxide (grams)……5,929,611

NINE WEST DISTRIBUTION CENTER,
West Deptford Township, New Jersey

In 2008, Nine West contracted with GreenTech Energy Services to design and implement an energy savings system in its West Deptford, NJ Distribution Center. Its warehouse is a 500,000-square-foot facility that operates 24 hours a day, 5 days a week. The goals of the project were to increase the uniformity and quality of lighting throughout the warehouse, reduce energy usage, and maintain system reliability. GreenTech replaced outdated 400-watt high pressure sodium lamps with state-of-the-art Westinghouse T5 fluorescent fixtures and lamps, which provide energy efficiency, long lamp life, easy switching, high lumen maintenance and even light distribution. GreenTech also installed sensors in the office areas to turn individual lights off when the rooms are unoccupied.

Results of the project include higher light levels, improved light quality, lower energy costs, and lower life-cycle costs. Employees report that spaces appear brighter and more evenly lit, with less glare. The occupancy sensors in the warehouse have cut energy usage. The program is expected to pay for itself in well under two years.

THE SAVINGS

Total Program Costs…… $390,092
Total Payback Period…….. 1.3 years
KW Saved…… 265
KWH Saved…….. 1,770,366
Energy Savings…… $168,740
Operational Savings……$11,703
Total Savings……$180,443

ENVIRONMENTAL IMPACT

Reduction in Carbon Dioxide (pounds)……..2,655,550
Reduction in Sulfur Dioxide (grams)……9,914,052
Reduction in Nitrogen Oxide (grams) …….4,425,916

Rodale

Allentown, Pennsylvania

THE CHALLENGE:

Rodale, a global media company that publishes health and wellness magazines such as *Prevention* and *Runner's World*, is dedicated to the health and wellness of the individual, community and planet. In keeping with this mission, Rodale wanted to upgrade the lighting in its Allentown, PA warehouses, where outdated lights were not only wasting money and energy, but were positioned in a way that made it difficult for forklift drivers to clearly see the products lining the shelves.

RODALE
LIVE YOUR WHOLE LIFE

THE SOLUTION:

GreenTech Energy Services re-wired and installed new energy-efficient T5 fluorescent fixtures with motion sensors in the warehouse aisles, and also retrofitted fixtures in the production area. By re-positioning the lights to run parallel to the aisles, GreenTech was able to improve the safety and efficiency of operations, while improving the overall aesthetics and workplace environment for the warehouse employees.

ENERGY & COST SAVINGS:

- Total Cost of the Energy Efficient Lighting Project=$128,613
- Payback 2.7 years
- KiloWatt Usage Reduced From 122 to 52 (57% reduction)
- KiloWatt Hours Saved =386,451
- Annual Energy Savings=$34,781
- Operational Savings=$3,858
- Total Annual Energy Savings=$38,639
- Ten Year Projected Savings =$548,938

The lighting project is complete and looks good. The crew was prompt and professional, and did a great job on the install. Hope to work with your company again and we would be happy if you would like to use us as a reference site for other prospective clients.

Tim Wehr, Manager of Engineering /Maintenance, Rodale Inc.

ENVIRONMENTAL IMPACT:

- Reduction in Carbon Dioxide =579,677 LBS
- Reduction in Sulfur Dioxide=2,164,127 grams
- Reduction in Nitrogen Oxide=966,128 grams

BEFORE

AFTER

Skanska
Carteret, New Jersey

Skanska, one of the world's leading construction groups, has a 66,000-square-foot warehouse in Carteret, NJ, where GreenTech Energy Services did a lighting retrofit. All 400-watt high pressure sodium lamps were replaced with new 2 x 4 surface-mounted T5 fluorescent fixtures with occupancy/photocell sensors. The efficiency of the fluorescent lamps with the sensors resulted in lower operating costs and a longer life expectancy than the previous fixtures.

In addition, all fixtures with two 96-watt 8-foot T12 lamps with standard magnetic ballasts were replaced with 32-watt four-foot T8 lamps with new reflector lenses. These lamps, combined with low wattage electronic ballast, increased light levels, provided energy savings and improved aesthetics.

PROJECTED SAVINGS

- Program Cost - $84,565
- Utility rebate - $29,145
- EPACT Tax Savings - $9,900
- Payback Period - 0.93
- KW Saved - 71
- KWH Saved - 258,363
- Energy Cost Savings - $46,505
- Operational Savings - $2,537
- Total Savings - $49,042
- Estimated 10-year Savings (purchase) - $562,214

SKANSKA

ENVIRONMENTAL IMPACT

- Reduction in Carbon Dioxide (pounds) - 387,544
- Reduction in Sulfur Dioxide (grams) - 1,446,831
- Reduction in Nitrogen Oxide (grams) - 645,907

Glossary of Lighting Terms

Ambient lighting – provides general illumination indoors for daily activities, and outdoors for safety and security

Accent Lighting – draws attention to special features to enhance the aesthetic qualities of an indoor or outdoor environment.

Ballasts – a fluorescent ballast is the part of a light fixture that controls voltage to the light bulbs. There are two types of ballasts, magnetic and electronic. Electronic ballasts can hold multiple bulbs and are better able to convert incoming electricity to the proper amount needed to power the bulbs, leading to less wasted energy.

Ballast Factor – a measure of the actual lumen output for a lamp-ballast system as compared to the light output on a reference ballast used as an industry standard.

Color Rendition Index (CRI) – how colors appear when illuminated by a light source. The CRI is a 1-100 scale that measures a light source's ability to render colors the same way sunlight does.

Color Temperature – the color of the light source. Yellow-red colors (like the flames of a fire) are considered warm, and blue-green colors (like light from an overcast sky) are considered cool. Color temperature is measured on a Kelvin Scale. For example, the warm, reddish color of candlelight measures about 1,000 on the scale, while cold, bluish light measures about 10,000.

Demand – The rate at which electricity is being used at any one given time (or averaged over any designated interval of time). Demand differs from energy use, which reflects the total amount of electricity consumed over a period of time. Demand is often measured in kilowatts (1 kilowatt =1000 watts), while energy use is usually measured in kilowatt hours (kilowatts x hours of use = kilowatt hours).

Efficacy – the radio of light produced to energy consumed; measured in lumens per watt

Electric Distribution Company – The utilities that provide regulated services for the distribution of electricity to customers.

Electric Supplier – An entity licensed to provide electric generation services to customers. With electric choice, customers can choose their electric supplier. The customer's electric distribution company then delivers the power.

Energy Audit - An inspection, survey and analysis of energy flows in a building, to seek opportunities to reduce the amount of energy input into the system without negatively affecting the occupants' comfort, health and safety.

Energy Efficiency – Using less energy to provide the same level of energy service, primarily by means of a more efficient technology or process.

Fluorescent Lighting - A fluorescent lamp is a gas-discharge lamp that uses electricity to excite mercury vapor. The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to produce visible light. Fluorescent lamps generally cost more initially than incandescent lamps, but because they convert electrical power into useful light more efficiently, they result in lower energy costs.

Footcandle – measurement of the intensity of illumination. A footcandle is the illumination produced by one lumen distributed over a 1-sq-ft area. For most home and office work, 30-50 footcandles is sufficient.

Generation – The act or process of transforming other forms of energy into electric energy.

Glare – the excessive brightness from a direct light source that makes it difficult to see what one wishes to see. A bright object in front of a dark background will usually cause glare as will bright lights reflecting off a screen or printed page.

Illumination– distribution of light on a horizontal surface

Incandescent Lighting - the incandescent light bulb is a source of electric light that works by heat-driven light emissions. An electric current passes through a thin filament, heating it to a temperature that produces light. The enclosing glass bulb contains either a vacuum or an inert gas to prevent oxidation of the hot filament. Incandescent bulbs are made in a wide range of sizes and voltages, from 1.5 volts to about 300 volts. They require no external regulating equipment, have a low manufacturing cost, and work well on either alternating current or direct current.

Induction Lighting - An induction light is similar to a fluorescent light in that mercury vapor inside the bulb is excited, emitting UV radiation that in turn is converted into visible white light by the phosphor coating on the bulb. Unlike fluorescent lamps, where voltage supplied by the ballast causes electrodes to initiate the flow of current through the lamp, induction lamps have a generator with a power coupler that produces a radio frequency magnetic field to excite the gas-fill. With no electrodes, the lamp lasts longer – up to 100,000 hours. (In a fluorescent, each time voltage is supplied by the ballast and the arc is struck, the electrodes degrade a little.)

Kilowatt (kW) – rate of using electricity. Example: ten 100-watt lamps consume electricity at the rate of 1,000 watts, or 1 kilowatt (kW)

Kilowatt-hour (kWH) – electrical energy actually used. Example: ten 100-watt lamps, when on for one hour, consume 1 kilowatt-hour (kWh).

LED Lighting - A Light Emitting Diode (LED) is a semiconductor device which converts electricity into light. Until recently, most LED light bulbs had significant drawbacks. They used too much energy, were not bright enough, were too directional (lacked a good light spread), were too expensive, and ran too hot. But the latest products produce over 150 lumens per watt. They are brighter, with a longer life, use constant current instead of pulse modulation, and never rise above 110 degrees Fahrenheit. They are also dimmable and come in AC currents ranging from 90 to 277 volt.

LEED EB Certification – The Leadership in Energy and Environmental Design (LEED) Green Building Rating System, developed by the U.S. Green Building Council (USGBC), set standards for environmentally sustainable construction. LEED EB stands for Existing Building and uses a system of points to certify a facility into one of several pre-designated categories.

Load – The term "load" is often considered synonymous with demand. Load also can be defined as an end-use device or an end-use customer that consumes power. Using this definition of load, demand is the measure of power that a load receives or requires.

Load Factor – a measure of energy use equal to the ratio of total kilowatt-hours (kWh) used in a given time period divided by the peak kilowatt (kW) use during that time, multiplied by the hours in the time period. In other words: (actual kWh used) / (peak kW) x Time. Load factor expresses how well or poorly a given electric system is being utilized. Electricity users strive for a better load factor, or the most efficient usage of their installed electric equipment. The closer to a load factor of 1, the better the system's efficiency.

Lumen – measurement of light emitted by a lamp. For example, a 100-watt incandescent lamp emits about 1700 lumens.

Lumen Degradation – the percentage of lumen loss over the life of a lamp

Performance Contracting – using energy savings that result from an energy efficiency project to pay for the work over a period of time.

Task Lighting – facilitates particular tasks that require more light than is needed for general illumination, such as table lamps or bathroom mirror lights.

Watts – the rate of electrical use at any moment is measured in watts. For example, a 100-watt light bulb uses 100 watts.

Watt-Hours - To calculate how much energy is being used, consider how long an appliance is being run. When a 100-watt appliance is run for five hours, it is using 500 watt-hours (WH).