



Eco-Efficiency Centre

Committed to Excellence and Efficiency

Fact Sheet: Eco-Efficiency and Responsible Lighting Use

Introduction

Businesses are facing increasing pressure to improve energy efficiency to minimize their environmental impacts, while at the same time, be fiscally responsible and competitive. Energy use, directly or indirectly, is estimated to cause 60-65% of greenhouse gas (GHG) emissions. Increased concentrations of GHG may be accelerating climate change and resulting in a warming trend called global warming. Global warming could cause shifts in rainfall and weather patterns, increase sea level, create risks to wildlife and humans, and alter growing seasons.

Lights consume energy (20% of electricity in the United States is used in lighting), but many companies overlook lighting as an area for potential savings. Lighting can be the highest business energy cost in a company - in an industrial facility, lighting can account for 15-25% of the electricity bill. In offices, the figure is 40-50%.

Without proper lighting in a business, productivity, safety, security and overall aesthetics can all be compromised. However, technologies developed over the past few years can help cut lighting costs 30-60% while enhancing lighting quality, improving employee productivity by 5-7%, maintaining safety, and reducing impact on the environment. And, even small changes in practices can contribute to making big differences.

By incorporating more energy-efficient lighting technologies and practices in the workplace, businesses can decrease the amount of greenhouse gases being produced, minimize the amount of energy wasted and significantly cut energy costs. And, by taking a "green" approach to how they operate their business, companies improve their public image and demonstrate good corporate citizenship.

Did you know?

Staff awareness programs help to reduce energy use. Savings of around 15% can be realized just by making staff aware of the need for switching off lights!

Eco-Efficiency

What is Eco-Efficiency?

Eco-efficiency is a practical and systematic approach that businesses can adopt in setting and achieving environmental and business performance objectives. It is very closely associated with and complementary to other



concepts such as Occupational, Health and Safety (OHS), Total Quality Management (TQM), and Pollution Prevention (also known as source reduction). It involves changing processes, finding alternatives, and reducing or eliminating the generation of toxic wastes instead of dealing with problems of cleanup or disposal after the fact. It also includes extending product liability, enhancing material recyclability and maximizing the use of renewable resources. Eco-efficiency means doing more with less, creating and providing quality products and services while reducing resource use, waste and pollution along the entire value chain. It is not only about managing waste after it is created, but strives towards preventing and minimizing waste in the first place.

This fact sheet was prepared by the *Eco-Efficiency Centre* - a non-profit, non-government educational and environmental management support centre for small and medium-sized enterprises in Nova Scotia. The Eco-Efficiency Centre was established in 1998 as a partnership between Dalhousie University and Nova Scotia Power Inc., and is supported by private corporations, governments and foundations. The Centre assists companies to achieve better environmental and economic performance through resource conservation, pollution prevention, recycling, reuse, and general good environmental practices.

Decisions on Retrofitting and Replacements

There is an array of light sources, light bulbs and lighting systems on the market, with attributes suitable for a variety of applications in a business. While re-lamping (substituting one lamp for another to save energy) may seem to be straightforward, not all lights are created equal. A partial or full lighting retrofit or upgrade requires a company to first consider a number of questions, including:

- What is the type of space, and what jobs are being performed in the space? (Examples: high-use or low use areas; commercial, retail, industrial or warehouse space; indoor vs. exterior lighting)
- What are the occupants' requirements?
- Is the colour of the light an issue?

- Are there maintenance issues? Are fixtures difficult to reach and bulbs difficult to replace?
- What's the temperature of the space?
- Are automatic lighting controls appropriate?
- Are there disposal considerations for the bulbs and ballasts?
- What are the possible energy savings and paybacks?

A lighting audit or inspection is always a good first step, so consult a lighting specialist or electrician. Some guarantee a return on investment of better efficiency and cost savings. Programs can often involve financing a lighting retrofit through the savings generated by the retrofit. There are many local companies that can provide auditing services for businesses. The NS Dept. of Natural Resources website provides a list of contractors trained in and committed to energy efficient lighting - <http://www.gov.ns.ca/natr/>

The ABC's of Lighting

Incandescent lights are inexpensive to purchase, but are by far, the most expensive lights to operate. A life-cycle cost analysis almost always determines significant savings, with more expensive (to purchase), but much more efficient lighting. They are inefficient compared with other lighting types, with greater than 90% of the energy wasted as heat (the light is generated by heating a tungsten filament). They are also the most short-lived. Although you can purchase long-life incandescent bulbs, they are longer life because they are less efficient.

Rule-of-thumb: Incandescent

If an incandescent light is on for more than 10 hours a day, upgrading to fluorescents makes economic sense!

Q. Why is the new incandescent light bulb I just put into my fixture to replace a burned-out incandescent bulb so much brighter?

A. Lighting systems become less efficient as they age. Standard incandescent light bulbs will lose up to 45% of their light output with use. However, you continue to pay for the full wattage of the bulb! That is the full electric cost for less light!

The new energy saving bulbs lose only 10 to 15% of their light output and last almost 2 1/2 years when on 12 hours a day. If you used these bulbs less than one hour per day, they would last over 27 years!

Halogens (tungsten halogen or quartz halogen) are a type of incandescent commonly used for display lighting, floor lamps and track lighting and also in outdoor security and flood lighting (they're valued because of their crisp white light and outstanding natural colours). Bulb life and energy-efficiency is better than in standard incandescents, but much less than in fluorescents. Halogen bulbs are very hot, increasing risk of fire. They are very expensive to operate.



Fluorescent lamps have been around for many years - they contain mercury under low pressure and light is generated when the mercury is ionized by an electric arc,

producing ultraviolet energy, which in turn, causes the phosphors coating the inside of the lamp to fluoresce. Different fluorescent tubes which produce different colours of light (for example, standard warm or deluxe cool) to suit a facility's requirements can be purchased.

Fluorescent strip lighting is the standard indoor lighting source for both general and task lighting in many commercial and industrial settings (especially with ceilings of relatively low height). In most settings, 4 or 8-foot strip lighting is either the standard T-12s (1-1/2-inch in diameter) or the more energy-efficient T-8s (1-inch in diameter) (less common are T-5s, T-9s, and T-10s).

The conventional T-12 lamps are about 3 to 4 times more energy-efficient than incandescent lighting, and last 10 - 20 times longer than incandescents - from 10,000 - 20,000 hours! However, T-8 fluorescents are rapidly becoming the standard in strip fluorescents in new construction, and are being increasingly used in retrofits. They save 15-20% of the wattage used by T-12s. While still slightly more expensive, they last just as long as T-12s and produce light of a higher quality than T-12s.

T-12s and T-8s use the same "bi-pin base" so they fit the same fixtures. However, retrofitting from T-12s to T-8s almost always requires changing existing **ballasts**. Fluorescent tubes are connected to a power source through a ballast that regulates the conditions (voltages and currents) to start and operate the fluorescents. There are two types of ballasts used for fluorescent lamps, either a magnetic ballast or an electronic ballast. Older fluorescent lighting systems operate with magnetic ballasts, but electronic ballasts are replacing magnetic ballasts as the standard. The newest T-8 technologies use the more efficient, high frequency electronic ballast. (T-8s with electronic ballasts use about 35-40% less energy than T-12s with magnetic ballasts). The electronic ballast has no hum, no perceptible flicker, is lightweight, and has lower power losses. It operates the lamps more efficiently but is more costly than a magnetic ballast. As many as four lamps can be operated on a single electronic ballast as well. The typical electronic ballast lasts up to 25 years.

Rule-of-thumb: T-8s

For maximum performance and savings, a T-8 fluorescent lighting system should include energy-efficient electronic ballasts, appropriate light distribution and lighting controls.

Compact Fluorescent (CFL) bulbs are one of the latest developments in fluorescent lights. They are much smaller than fluorescent tubes, but are available in many different shapes and sizes for different applications. They are designed to replace incandescent bulbs - they use 60-75% less energy while providing the same amount of light. Most screw into existing lamp sockets. CFLs cost more initially, but the energy savings, long life (up to 10,000 hours), and maintenance savings make them cheaper to own and operate in the long-term. Most CFLs now use electronic ballasts, making them flicker-free, as well as making dimming possible.

Rule-of-thumb: Compact fluorescents

These are most economical in situations where lighting operates for a long period of time (greater than 1500 - 2000 hours per year) and areas that are not subject to frequent on-off cycles: corridors or security lighting are often good examples. Especially look for opportunities to replace flood and spot lamps with CFLs.

High-Intensity Discharge (HID) lights are the most energy efficient option for many applications, particularly indoor industrial (high-bay/warehouse) settings, security and exterior lighting. HIDs have long service lives, minimal maintenance costs, and high efficacy (they convert electric power to light very efficiently). There are several types of HIDs: **Metal Halide** and **High and Low Pressure Sodium** (HPS and LPS) are the most efficient. Where the colour of light in an application is important, metal halides are often chosen. These lamps are compact and powerful. Lasting for 10,000-15,000 hours, they also have quick start-up. HPS lamps require a ten-minute warm-up and are usually chosen where colour is less critical (the light tends to be a yellow-orange colour). But, they last up to 24,000 hours and have the highest efficacy among lamp types. Their energy requirement is about half of the mercury vapour lights. Unlike metal halides, HPS lamps don't require enclosure, so they are easy to use in many fixture types.

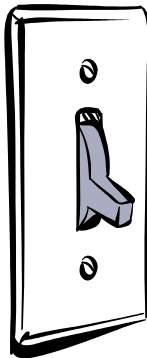
Did you know?

While HID lighting has long been considered to be better for industrial settings, new high output T-5 fluorescents may be an effective alternative, with energy savings exceeding 50%. When fitted with occupancy and photocell sensors, energy savings were boosted to over 90%! And, the T-5s provided better light quality. Retrofitting can yield a payback of less than a year. (From Environmental Building News July, 2000 www.buildinggreen.com/)

Exit Signs - Standard incandescent exit signs have a high operating cost and a short life. Newer LED (Light-Emitting Diodes) exit lamps use less than 2 watts and are almost maintenance free since they last for decades (they last 300 times longer than incandescents!). Most exit lights can be easily upgraded with LED conversion kits. LEDs offer considerable energy savings (75-95%) and a quick payback - often around 1.5 years.

Myth: It uses less electricity to leave the lights on than to turn them off when they are not in use.

Fact: While there's no question that it is an advantage to turn off incandescents at every opportunity, the question of turning off fluorescent lights when leaving a room has been much debated. The effects on lamp life and energy use when turning lights back on are negligible. So, promote the practice among employees of turning off lights every time someone leaves a room.

**Automatic Lighting Controls**

It's estimated that installing lighting controls typically achieves savings of 10-45% of lighting costs in a

business. These devices can ensure that lighting energy use is not wasted. Many controls are simple and relatively low cost, with many different types for different room sizes, applications, and needs available. Consider the following options:

Occupancy/Motion Sensors - These detect the presence or absence of people in an area, and prevent the overuse of utilities to light workspaces. Several technologies are available with a wide price range. Motion sensors are often a good choice for areas where occupancy is unpredictable and sporadic (storerooms, for example). They are compatible with incandescent and fluorescent lights but not with HIDs.

Photocells - These sense the ambient light conditions and switch off lights in spaces with adequate natural lighting. They are compatible with most types of lamps (but not all ballasts), and are used for both indoor and outdoor applications - often with security lighting and commercial settings. (Tip: these are considered to be most effective in areas with banks of lights containing more than ten tubes).

Timers - These devices switch on and off according to a preset schedule. Many are easy and inexpensive to purchase and install. Timers are appropriate for incandescent and most fluorescent lights. If placed in appropriate spaces, they can result in significant savings.

Tip

For larger commercial buildings, consider installing an Automatic Building Management System, which can be programmed to efficiently control lighting and HVAC load to suit your needs and save energy.

Maintenance of Lighting Systems

Clean and inspect lamps and fixtures regularly. Dirt and dust accumulation may reduce light output by 30%. Clean and inspect your lighting systems for surface dents, scratches, and burns that can lead to rust formation. Rust can affect the reflectance on the inside surfaces and decrease lamp life.

Improperly selected or over-used cleaning compounds can deteriorate fixture surfaces. For best results, follow the manufacturer recommendations for each application. Here are some suggestions for cleaning:

Aluminium fixtures

Apply very mild soaps and cleaners followed by a thorough rinse with clean water. Never use strong alkaline cleaners.

Glass

For lenses, use detergents or nonabrasive cleaners and rinse after. Glass reflectors may be wiped dry.

Plastics

Use anti-static compounds rather than ordinary detergents. Do not wipe plastics dry after application of a rinse solution, as this will form electrostatic charges. Vacuuming is the most effective method of drying plastics.

Keep in mind that lighting controls need to be maintained as well. Calibration of occupancy sensors/photocells alone can reduce energy use by 5%!

Lighting Waste Disposal

Both lighting upgrades and routine maintenance entail the removal of lamps and ballasts, which results in waste. The US-EPA estimates that about 600 million fluorescent lamps are discarded each year in the US. All fluorescent and HID lamps have mercury content (although in recent years, lamp manufacturers have been reducing the amount of mercury in fluorescent lamps). When bulbs are broken (or incinerated) they release mercury that can be damaging to the environment and to human health. In 1995, the mercury from discarded fluorescent and HID lamps accounted for over 13% of the mercury found in municipal solid waste landfills in the US. Perhaps of more concern are ballasts manufactured and distributed in the United States and Canada prior to 1979 which contain polychlorinated biphenyls (PCBs), which is a highly hazardous material. Since many magnetic ballasts can enjoy a service life of 25 years or longer, many of these ballasts are still in existence. If a ballast label is marked "NO PCBs," then it is not a PCB ballast; if there is no such marking, then the ballast is assumed to contain PCB fluid.

Businesses are encouraged to keep lamps and ballasts out of the regular waste stream. Companies can minimize their impact by managing this waste in a way that is safe to the environment.

- Do not break or crush lamps. Store unbroken used lamps in a protected area in a box or drum, to prevent breakage. Label appropriately.
- If a lamp is accidentally broken, store all of the debris in a sealed, airtight container and label appropriately ("Broken Fluorescent Lamps - Contains Mercury"). Mop area. Do not vacuum as this vaporizes the mercury.
- There are commercial lamp crushers on the market that capture mercury vapour. Please see the contact information for The Bin Doctor for disposal in HRM.
- Contact local hazardous waste haulers for information on collection, disposal, and fees associated with regular or occasional pick-ups.
- Watch for changes in the regulations that affect mercury-containing lamps. Get the latest information and specific requirements from the appropriate municipal, provincial and federal authorities for handling, storage, transportation and disposal of mercury-containing lamps.

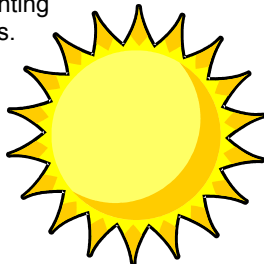
Did you know?

T-12 lamps contain significantly more mercury than T-8s.

Saving \$\$\$ by Day-lighting

Day-lighting means using natural light for indoor lighting. Modern buildings designed for day-lighting typically use 40 to 60% less electricity for lighting needs than do conventional buildings.

By using natural lighting wherever possible, a business reduces their energy use and costs, and improves their workers' comfort and productivity. You can also reduce heating and cooling costs



by increasing your use of natural light. However, there are some things to keep in mind to avoid glare and minimize overheating a building.

Create opportunities for using natural light by considering some of the following tips:

- Install skylights wherever possible.
- Situate desks/work stations near windows and skylights.
- Open window blinds/curtains during the day.
- Keep windows clean.
- Move objects that are obstructing windows.
- Window glare can be avoided by using windowsills, walls, louvers, reflective blinds, and other devices to reflect light deep into the building.
- There are new window technologies such as films and glazes that let in light but not heat, and "smart windows" whose transparency can be adjusted by an electric current.
- Using natural light won't reduce energy consumption unless users turn off or reduce the use of unnecessary artificial lights.

Lighting Conservation Tips

- If you have strip fluorescent lights, modify the fixtures by removing one bulb from a two-tube fixture (or 2 bulbs from a four-lamp fixture.) Disconnect ballasts when tubes have been removed. Fit an aluminium or silver reflector in the fixture, if available.
- Use energy-efficient lamps and ballasts. Replace incandescent light bulbs with compact fluorescent lights (CFL). Energy saving bulbs use 75% less energy than a standard bulb. They come in a variety of shapes and sizes as well as varying brightness.
- Avoid over-lighting areas, use smaller task lights in specific areas where more intense light is required instead of flooding the entire area with light.
- Keep light fixtures clean to maximize the amount of light output. Consider reflective fixtures in combination with smaller wattage bulbs to maximize light output.
- Install timers or motion sensors to control lighting. Consider photocells to turn on or off lights based on the natural light levels.
- Make use of the sun. If lights can be controlled separately, turn them off whenever there is enough natural light available.
- Turn off lights when leaving your office/cubical/area and other unoccupied areas; place "switch off" stickers above light switches and increase awareness of staff that they all have a role in saving energy.
- Matching replacement lamps to existing fixtures and ballasts can be tricky, especially with older fixtures. Buying new fixtures made for new lamps produces superior energy savings, reliability and longevity compared with re-lamping.
- If a total lighting retrofit is not financially feasible, upgrading the lights in segments may be a solution. But, group re-lamping can save approximately 20% annually over a "spot re-lamping" maintenance program.

- Encourage 'lights out when you go out' and 'last one out/lights out' practices in the office. Turn lights off where they are not needed (e.g., storage areas).
- Install local switches so that a single switch does not control all fixtures in a multiple work space area. Label switches.
- Clean walls or repaint with light reflective, non-glossy colours. Replace dark carpet with light colour carpets.
- Make sure your employees are comfortable with their lighting. If employees aren't satisfied, they'll modify their space (for example, bring in less efficient lamps from home) and inadvertently increase energy use.

Did you know?
30% - 40% of computers are left on overnight & on weekends. Turning off one PC (with an average load of 200W) each night & weekend will save an average of \$60.00 annually.

Did you know?
Lighting typically accounts for about 20% of energy costs.

Getting Your Employees Involved

There are many ways of getting employees to participate in newly established energy conservation programs. To help with the implementation of a new program, consider the following steps:

Define Intentions of the Program.

- Explain the reasons for adopting an environmental program to the employees.
- Announce top management commitments to reduce energy waste and your intent to take action. Have the owner or another member of senior management take the time to speak to employees directly about the benefits of the program.

Keep it simple and make it convenient.

- Remind employees that programs don't need to take a large amount of extra effort, as well as being environmentally and economically sound.
- Place appropriate signage/messages in work areas and around switches. "Turn off lights when leaving your workspace" or "It's always cheaper to turn lights off than to leave them on".

Communicate clearly.

- Give employees the opportunity to prepare for a new program.
- Regular, clear communication of both motivational and operational information to employees is vital to the success of any green office effort.
- An example of communicating clearly is offering informal information sessions, as they are an effective educational technique.



Encourage feedback.

- Keep asking employees for their suggestions. Add a suggestion box to the lunch room.

- Always give credit and company-wide (and public) recognition to the employees involved.

Keep the program alive.

- Don't stop communicating after the program is launched. E-mail or post a tip of the week. Clearly marked containers and signs should always be maintained to act as visual reminders to the employees.
- Send an environmental message or reminder with pay checks.
- Participate in special events for Earth Day and Environment Week. Events can range from roadside clean-ups and waste-less barbecues to waste reduction days and car pool events.
- Monitor your progress regularly.

Share your progress results.

- Share up-to-date information with the employees on a regular basis.
- Employees want to see the benefits of their efforts to keep motivated.

Share with your customers.

- Include environmental communication on the business web site or post environmental policies in noticeable areas for customers.

Thank employees.

- Remind employees that the success of the program is a result of their individual efforts.

Did you know?
If all consumers in the US switched to ENERGY STAR® - labelled fixtures and bulbs, 70 billion-kilowatt hours would be saved along with the prevention of 11 million tons of carbon dioxide emissions every year.

Energy-Efficiency and the Regulatory Environment
The pressure on business to improve energy efficiency will increase in the near future in response to Canada's commitments on climate change. In April 1998, Canada signed the Kyoto Protocol which commits Canada to achieving greenhouse gas (GHG) reductions of 6% from 1990 levels by the period 2008-2012. For Nova Scotia, this means cutting projected GHG emissions by over 3 million tonnes from the projected 2010 level. Halifax Regional Municipality is also a member of the Partners for Climate Protection program of the Federation of Canadian Municipalities, whose goal it is to reduce greenhouse gas emissions by 20% of 1990 levels. Aggressive reduction efforts will be needed in the form of legislative and enforcement tools. Businesses have an opportunity to comply through voluntary programs now.

Interested in Calculating your Electrical Energy Consumption?

To find the power consumed by various items in your business, find the number of watts the item consumes. For electrical appliances, this is found on a nameplate on the back or bottom of the item. For lights, this is simply the power (wattage) of the light. This number will be known as "P". Electricity is billed in kilowatt hours, so to determine how much energy an item is using, estimate

the number of hours the item is used on an average day. This will be known as "t". The daily energy used by that item is then found by multiplying the power and time, then dividing this number by 1000 to get kilowatt-hours. This is known as "E_{day}".

$$E_{\text{day}} = \frac{P * t}{1000}$$

To determine the item's monthly energy consumption, multiply the daily energy by the number of days in the month (28, 29, 30 or 31). Annual energy consumption is found by multiplying the daily energy consumption by 365.

References and Resources

We have summarized information from many sources - publications, fact sheets and web sites - to compile this fact sheet. We would like to acknowledge these companies, organizations, and agencies, and refer you to them for additional information:

- **Atlanta Gas Light Company** - Energy Tools www.atlantagaslight.com/
- **B & B Ventures, Inc.** - Energy Hotwire.Com website <http://www.energyhotwire.com/legal.html>
- **BC Hydro Power Smart** www.bchydro.com
- **Energy Efficiency Department of the Environment, UK** - (Focus - The Manager's Guide to Reducing Energy Bills) <http://www.thecarbontrust.co.uk/energy>
- **Energy Efficient Lighting Association** www.eela.com
- **Energy Efficiency and Renewable Energy Network (EREN)** <http://buildingsdatabook.eren.doe.gov/default.asp/>
- **Energy Ideas Clearinghouse (EIC)** www.energyideas.org/
- **EnergyStar Buildings** - Building Upgrade Manual (May, 1998) http://www.energystar.gov/index.cfm?c=business.bus_upgrade_manual
- **Environmental Building News** - Issues October, 1997 & July, 2000 www.buildinggreen.com
- **Environment Canada** www.ec.gc.ca/
- **Energy Efficient Light Bulbs** <http://www.lightingsale.com/enefligbulbr.html>
- **Illuminating Engineering Society of North America** www.iesna.org
- **NS Dept of Natural Resources** (Light Better for Less and Improving Your Lighting Overhead publications) <http://www.gov.ns.ca/natr/>
- **Nova Scotia Power** - Energy Efficient Lighting www.nspower.com
- **Office of Energy Services, Utah** (Institutional Conservation Program) www.aste.usu.edu/docs/audit.htm
- **Pennsylvania Dept. of Environmental Protection** <http://www.depweb.state.pa.us/dep/cwp/view.asp?a=3&q=461086>
- **Powercon Inc.** www.pwrcon.com/facts.htm
- **Southern Alliance for Clean Energy** - Energy Switch Newsletter, Fall, 2000) www.cleanenergy.org/
- **The Eco-Efficiency Resource Manual (EDCO)**

- **The Bin Doctor**, 462-7468 www.bindoctor.com
- **US Dept. of Energy** - Office of Energy Efficiency and Renewable Energy - Buying Energy Efficient Products <http://www.eere.energy.gov/>

Telephone and Website Guide

Eco-Efficiency Centre

Tel - 902-461-6704

Website - www.dal.ca/eco-burnside

Atlantic Canada Opportunities Agency (ACOA)

Tel - 902-426-6743

Website - www.acoa-apeca.gc.ca/e/index.shtml

Atlantic Region, Environment Canada, P2

Tel - 902-426-7231

Website - www.atl.ec.gc.ca/epb/pollprev/

NS Dept of Environment and Labour

Tel - 902-424-5300

Website - www.gov.ns.ca/enla

NS Materials Exchange

Website - www.nsmaterials.com

RRFB Nova Scotia

Tel - 1-877-313-7732 (toll-free)

Website - www.rrfb.com

Directory of Solid Waste, Reuse,

Recycling and Composting

Contacts in Nova Scotia

<http://www.gov.ns.ca/enla/emc/wasteman/contents.htm>

For more information, contact:

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<http://www.dal.ca/eco-burnside> (website)



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