



Smart Purchases Big Impact

Sustainable Purchasing Guide
Light Bulbs

Sustainability... your university, your world

A stylized black silhouette of a tree with many leaves.



Introduction

This section provides information on currently available options for **light bulbs** that can help to move the University of Saskatchewan toward its sustainability goals. Living within the boundaries of our sustainability goals requires us to apply two main strategies:

- Dematerialization** requires that we reduce the amount of materials as much as possible; and that we continually move toward the use of 100% recycled content.
- Substitution** requires that we find less harmful materials to replace those that currently damage and are not recyclable.

Sustainable purchasing is about including social, environmental, financial and performance factors in a systematic way. It involves thinking about the reasons for using the product (the service) and assessing how these services could be best met. If a product is needed, sustainable purchasing involves considering how products are made, what they are made of, where they come from and how they will be used and disposed.

Finally, remember that this is an evolving document – it will change with new information as our understanding of sustainability impacts and potential solutions improves.

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**Smart Purchases
Big Impact**

Wherever possible **CHOOSE** products that employ a combination of characteristics listed in the left hand column, and **AVOID** products that demonstrate characteristic in the right-hand column.

CHOOSE	AVOID
<ul style="list-style-type: none"> Eco-Logo certified Reduced use of light bulbs Controlled by occupancy/lighting sensors Energy efficient designs 	

Option: Optimize Daylight Strategy: Dematerialization (SO 1, 2, 3, 4)

Building design that employs natural daylight to reduce reliance on artificial lighting is an important dematerialization strategy. Daylight in buildings reduces the demand for light bulbs, the demand for electricity and reduces building cooling requirements. The goal of daylight-focused design is to minimize energy use and maximize human comfort. Preferable building designs orientate the building to maximize the potential to use solar energy, incorporate skylights and clearstory windows and engineer floor plates and inner partitions to allow daylight to penetrate deep within the building.

Option: Employ Smart Lighting Design Strategy: Dematerialization (SO 1, 2, 3, 4)

Lighting design within a building is also an important consideration for dematerialization. For instance, task lighting on desks and at workstations can help to reduce the need for excessive overhead lighting. Lighting can also be designed to bounce off reflective wall or ceiling surfaces, allowing relatively fewer lighting fixtures to provide more illumination.

Option: Use Energy Efficient Light Bulbs Strategy: Dematerialization (SO 1, 2, 3, 4)

Different types of light bulbs vary greatly with respect to energy efficiency. Light emitting diode (LED) bulbs are the most energy efficient option available and also last the longest. Compact fluorescent (CFL) bulbs are the next best option, followed by halogen and then incandescent options. It is essential to calculate total lifetime costs when assessing these options since many LED bulbs will last for roughly twenty-five years while incandescent bulbs will last for only one.

Option: Use Long-Lasting Light Bulbs Strategy: Dematerialization (SO 1, 2, 3, 4)

Similar to the above option, LEDs have the longest lifespan, followed by CFLs, then halogen and incandescent. Not needing to replace these lights reduces the impacts associated with lighting manufacturing (extraction, processing and assembly of materials), sales (packaging, transportation), replacement (transportation) and disposal.

Option: Choose Take Back or Recycling Programs

Strategy: **Dematerialization – Less Waste (SO 1, 2, 3, 4)**

For applications where LED lighting is not yet available or appropriate, compact fluorescent lighting is, from the perspectives of energy efficiency and lamp longevity, preferable. At the same time, because of the embedded mercury content these lamps

could potentially pose a human health hazard. Therefore it is important to purchase CFLs from manufacturers or distributors who will effectively steward the mercury and recycle the lamps. Take back and recycling increases the likelihood that the sustainability impacts associated with the end-of-life management of fluorescent lamps will be reduced or eliminated. SaskPower has a list of a list of CFL recycling locations.

Arriving at the currently preferred options

1. Identify the service

Light bulbs employ electrical energy to provide artificial illumination (and heat), both indoors and outdoors. They provide illumination for work, sporting, entertainment, leisure, travel, art, information and safety.

2. Assess the need

Meeting the needs of a successful and sustainable university requires the service of illumination, for safety, work, entertainment and other purposes. Lighting for certain purposes, such as aesthetics, could be reassessed and reduced, but lighting for illumination will always be required to a certain degree.

3. Identify the contents

The main material contents of light bulbs are metal, glass and inert gas. There are three main types of light bulbs: (1) incandescent lamps (including halogen), (2) fluorescent lamps, and (3) light emitting diodes (LEDs).

Incandescent Lamps

An incandescent lamp (conventional light bulb) is comprised of a **metal** socket with a lead bead on the end, a **tungsten** filament attached to two metal wires anchored in the base, and glass bulb coated with a diffusing material and filled with an **inert gas**, such as argon or nitrogen to prolong the life of the filament. The most efficient incandescent lamp is a halogen lamp, which is an ordinary incandescent bulb with a few modifications. The fill gas in this lamp includes traces of **halogen** to extend the life of the tungsten filament. These lamps produce more light per watt, last longer, and run substantially hotter than normal incandescent bulbs, which requires the bulb to be small and made of either quartz or a high-strength, heat-resistant grade of glass known as "hard glass".

Fluorescent Lamps (including compact fluorescent lamps)

The main component of a fluorescent lamp is a sealed glass tube. The tube contains a small bit of **mercury** and an inert gas, typically **argon**, kept under very low pressure. The tube also contains a **phosphor powder**, coated along the inside of the glass. The tube has two electrodes, one at each end, which are wired to an electrical circuit. Phosphors are substances that give off light when they are exposed to light. Overall, a typical fluorescent lamp is four to six times more efficient than an incandescent lamp. A fluorescent light bulb is designed to produce light without heat. Electrons collide with mercury atoms to produce an atomic emission of ultraviolet light. This ultraviolet light is then converted to visible light by the layer of white phosphor powders on the inside of the lamp's glass envelope. In principle, this whole activity can be performed without creating any thermal energy. However, many unavoidable imperfections cause the lamp to convert some of the electric energy it consumes into thermal energy. Nonetheless, the lamp only becomes warm rather than hot. To generate more ultraviolet light, a small amount of mercury is added to each lamp. All fluorescent lamps contain a small amount of elemental mercury for this reason. When lamps are cold, most of the mercury in the lamp is in liquid form, but while the lamp is operating, or when the lamp is hot, some of the mercury is in a gaseous or vapor state.

LEDs (Light Emitting Diodes)

An LED is a **semiconductor** (a device that can conduct electricity under some conditions but not others) that emits light when an electric current passes through it. Unlike an incandescent conventional light bulb, LEDs do not have a filament. LEDs have been used for many years as tiny red, green or yellow indicator lights in computers and other electronics. LEDs are also becoming commonplace in building exit signs, traffic lights, roadway construction signs, automobile tail lights, Christmas lights and flashlights. In a flashlight, for example, a small number of white

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3. Identify the contents (con't)

LEDs are arranged to create the desired light intensity. In applications for which they can be applied, LEDs have several advantages over conventional incandescent light bulbs. They don't have a filament that will burn out. They have a low power requirement, and most of the power supplied to a LED is converted to light with minimal heat. LEDs have a long life; they can function for decades if installed properly. They are small, thus requiring less material, and their small **plastic** bulb makes them durable.

4. Identify sustainability impacts

i.systematically increasing concentrations of substances from the earth's crust?

- Light bulbs need **electricity** to operate. If the electricity is derived from the combustion of fossil fuels, it leads to an increase in concentration of substances extracted from the earth crust in nature (CO₂, CO and SO_x). Increasing concentrations of these substances in nature can contribute to a number of negative effects such as **climate change**, and **acid rain**, as well as negative human health impacts.

ii.systematically increasing concentrations of substances produced by society?

- Fossil fuels are also combusted to provide **energy during the extraction of raw materials, transportation, and the production** of light bulbs.
- **Heavy metals** such as mercury are toxic to humans and bio-accumulate if they are released into nature and not recycled. Since many of these metals appear in relatively small traces they are difficult to recapture for recycling, and there is a high risk of release into nature through light bulb disposal.
- The petroleum or natural gas used as **feedstock for most plastics** is extracted from the earth's crust at a rate much greater than its redeposit back into the earth's crust.

iii.systematically degrading nature by physical means?

- The **combustion of fossil fuels** produces a number of chemical compounds (e.g. nitrogen oxides) that build up in the atmosphere.
- **Light bulb waste** is a growing concern. In addition to the potential release of toxic and persistent materials described above and the downstream effects of this on land, water and human health, discarding of light bulbs in landfills contributes to the physical degradation of nature caused by a dependence on ever-increasing amounts of land for waste disposal.

iv. ...systematically undermining people's ability to meet their basic human needs?

- The **extraction of fossil fuels** and **virgin metals/minerals** (for constituents of light bulbs) may systematically degrade nature, particularly cases where land disturbed in mining is not reclaimed.
- Some **materials used in light bulbs cause various negative health effects**. For example, mercury is known to be toxic to humans, and lead is known to cause damage to the nervous, endocrine, and cardiovascular systems and the kidneys.
- A number of the **compounds produced by the combustion of fossil fuels** (e.g. nitrogen oxides, carbon monoxide, sulfur oxides, particulate matter) have a negative effect on **human health**.
- There is a basic human need for the regenerative properties of night-time sleep, which can be jeopardized by **light pollution**. Exposure to light at night suppresses human melatonin production from the pineal gland, which should naturally produce melatonin at night in darkness. Melatonin regulates hormone secretions from the hypothalamus which then regulate the secretions of pituitary hormones that control our endocrine glands like the thyroid, pancreas, ovaries, testes, and adrenals. Humans need to sleep in total darkness to allow the pineal to naturally produce melatonin.

5. Envision sustainable light bulbs

In principle, sustainable lighting would feature:

- No **materials** that are derived from the earth's crust (e.g. **petrochemicals** and metals), unless these are 100% captured and reused in **technical cycles**.
- No **components** that are **persistent** in nature, unless those substances are 100% captured and reused.
- A **production process** that:
 - o does not contribute to the increased concentrations of substances from the earth's crust or the buildup of persistent compounds in nature,
 - o uses only sustainable renewable energy or energy produced in a carbon-neutral manner;
 - o does not rely on practices that systematically physically degrade land and ecosystems; and
 - o does not rely on practices that undermine people's capacity to meet their basic needs.

Electricity derived only from sustainable renewable energy that is produced in a carbon-neutral would power the light bulbs.

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6. Identify and prioritize alternatives

Step 6 helps identify the product or service that offers the best pathway toward meeting all four of our Sustainability Objectives by using the following three criteria for assessment:

- a) Does the product or service move us in the right direction with regards to our four Sustainability Objectives?
- b) Does the product or service create a flexible platform for the next step toward sustainability?
- c) Is the decision financially viable?

Resources and Additional Information

1. Daylighting Guide for Canadian Commercial Buildings
http://www.architecture.uwaterloo.ca/faculty_projects/terri/powerpoint/daylighting_canada.pdf
2. Sask Power: Light Bulb Comparison
http://www.saskpower.com/save_power/residential/tools/led_buying_guide.shtml



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