Drexel-SDP GK-12 ACTIVITY

Activity: Carbon Footprint of Lightbulbs

Subject Area(s) **Measurement**

Associated Unit **Environments, module 4**

Associated Lesson **None**

Activity Title **Activity: Carbon Footprint Of Lightbulbs**

Grade Level 6 (4-8)

Activity Dependency None.

Time Required **40 minutes**

Group Size **30**

Expendable Cost per Group **$0-$50**

vs.

Image 1

ADA Description: Picture shows an incandescent light bulb.

Caption: An incandescent light bulb.

Image file name: light-bulb.jpg

Source/Rights: Copyright ©http://www.psdblog.worldbank.org

Image 2

ADA Description: Picture shows a compact fluorescent light bulb.

Caption: A compact fluorescent light bulb.

Image file name: compact-fluorescent.jpg

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Summary

This activity will help students to understand how small,daily activities have a big impact on the environment. Everyday, in each person makes a personal contribution to global warming. The coal that we burn to make electricity and power our personal deelectronic devices such as laptops, cell phones, portable games, even lightbulbs generate carbon dioxide (CO2), the heat-trapping gas thought to be responsible for global warming and climate change. Some statistics cite that the average American generates 20 tons of CO2 every year -- about the same amount as three cars.

In this activity, we will use an ammeter (if available) or simply the Watt rating on two types of light bulbs – one incandescent, and one fluorescent, preferable rated to emit the same amount of light – and use the factor label method to compute the carbon footprint of each if left burning continuously for a year. Many such light bulbs are left burning in our schools, ourdoor lighting, and apartment building hallways.

Engineering Connection

Electrical engineering and power engineering address the generation, storage, and distribution of electrical power to our homes and businesses. The many choices for the source of electrical power generation are ultimately selected by consumer demand. If the customer makes demand for cleaner sources of energy, and energy generated from renewable, low-emissions resources, then the supply will increase and the costs of such energy will decrease. Electrical and power engineers are continuously working toward ways to make electrical power generation, independent of its source, more efficient, that is, to generate more electricity for the same amount of resource.

Keywords

Carbon footprint, coal power, energy efficiency, fossil fuels

Educational Standards (PA)

- Environments and Ecology: Renewable and nonrenewable resources 4.2.A. Uses, 4.2.B. Availability, 4.2.C. Management, 4.2.D. Influential factors
  Environmental Health 4.3.A. Environmental health issues, 4.3.B. Human actions, 4.3.C. Biological diversity
  Humans and the Environment 4.8.A. Societal needs, 4.8.B. Sustainability, 4.8.C. Human impacts, 4.8.D. Supply and demand

- Science: Technology Education – Science, Technology and Human Endeavors – Meeting Human Needs 3.8.B, Science, Technology and Human Endeavors – Consequences and Impacts 3.8.C
- Math: Computation and Estimation 2.2

Pre-Requisite Knowledge

None.

Learning Objectives

After this activity, students should be able to:

- **Give three examples of renewable energy sources**
- **Describe what a non-renewable energy source is**
- **Name three ways that households can improve their energy efficiency**

Materials List

Each class needs:

- One 60-watt incandescent bulb
- One (60-watt equivalent) compact fluorescent bulb
- Ammeter

Introduction / Motivation

Has your Mom or Grandmother ever hollered because you left the lights turned on or the refrigerator door open? Well, then your Mom or Grandmother is being green-friendly! Have you ever considered that a pile of coal is being burned for every light bulb you leave turned on? Here in Pennsylvania, as in most parts of the country, we get most of our energy from burning coal – this makes steam that runs a generator to make electricity for us. The problem is, coal burns dirty and pollutes our air and can make us sick. Also, there's a limited supply of coal available in the world. So, what can we do? Well, first, we can listen to your Mom and turn off the lights to save some coal. In addition, we can use a different kind of light bulb that uses less energy, is just as bright as the regular ones, and requires less coal to be burned. In this exercise, we will measure the electricity consumption of two types of lightbulbs developed by engineers – the first is an old-fasioned incandescent bulb with the tungsten filament, and the next is a newer compact fluoresent bulb that's filled with a gas. We'll see which one uses less energy, and by how much

(Taking a moment to calculate the carbon footprint, that is, the amount of coal burned and carbon dioxide emitted, to use a kiloWatt of energy in our daily lives can have alarming results. This activity will help students to understand how small,daily activities have a big impact on the environment. Everyday, in each person makes a personal contribution to global warming. The coal that we burn to make electricity and power our personal deelectronic devices such as laptops, cell phones, portable games, even lightbulbs generate carbon dioxide (CO2), the heat-

trapping gas thought to be responsible for global warming and climate change. Some statistics cite that the average American generates 20 tons of CO2 every year -- about the same amount as three cars.)

(In this activity, we will use an ammeter (if available) or simply the Watt rating on two types of light bulbs - one incandescent, and one fluorescent, preferable rated to emit the same amount of light - and use the factor label method to compute the carbon footprint of each if left burning continuously for a year. Many such light bulbs are left burning in our schools, ourdoor lighting, and apartment building hallways)

Vocabulary / Definitions

Word	Definition
Carbon footprint	A measure of the impact human activities have on the environment in terms of the amount of green house gases produced, measured in units of carbon dioxide. Sometimes includes pounds of coal burned to produce the electricity.
Watt	The electrical unit of power. One Watt equals one volt times one amperes.
Volt	The force required to send amperes of electrical current.
Ampere	The unit of measure of the rate of flow of electric current.
Ammeter	An instrument that measures electric current in amperes.
Incandescent bulb	A lightbulb that emits light due to the glowing of a heated filament inside it.
Fluorescent bulb	A lightbulb that emits light because the gas inside it glows when it is charged by electricity.

Procedure

Background

World statistics paint a frightening picture. 1992 World Energy consumption, as measured by USEIA, is as follows: Oil 38 %, Coal 26 %, Gas 22 %, Hydro 7 %, Nuclear 6 %. It is immediately noteworthy that almost 90 % of the consumed energy of the world came from non-renewable, fossil fuels.

For this exercise, use the statistic that the majority of our energy (almost 90%) is produced from fossil fuels, the non-renewable resources that, when burned, contribute to our planet's climate crisis and the rise in global warming.

A fossil fuel power plant burns fossil fuels such as coal, natural gas or oil to produce electricity. Fossil fuel power plants are designed on a large scale for continuous operation. In many countries, such plants provide most of the electrical energy used. A fossil fuel power plant always has some kind of rotating machinery to convert the heat energy of combustion into

mechanical energy, which then operates an electrical generator. Electricity from this generator is then delivered to our home and businesses.

Other forms of renewable energy being developed and introduced with increasing frequency into our power supply includes wind power, nuclear power, hydroelectric power, and solar power. These forms of energy produce little or no emissions.

Procedure:

Step 1: Obtain two household lightbulbs of equivalent light output: e.g. an 11 Watt fluorescent bulb and a 60 Watt incandescent bulb

Step 2: Using a clamp-style ammeter (if available), measure the current drawn by each lightbulb, and multiply it by the wall voltage supply of 110 volts to obtain the Watts of power used by the lightbulb. If an ammeter is not available, simply use the rating on the lightbulb.

Step 3: Use the following factor label conversion to calculate the pounds of coal used to power the lightbulb for one year continuously.

For example, we measured an 11 Watt fluorescent lighbulb rated to emit as much light as a 60 Watt incandescent bulb:

$$\frac{0.0.9 \text{ Amps. (measured)} \quad 110 \text{ Volts} \quad 1 \text{ Watt}}{\qquad\qquad\qquad\quad 1 \text{ Amp* Volt}} = 9.9 \text{ Watts}$$

$$\frac{9.9 \text{ Watts} \quad 1 \text{ kW} \quad 1 \text{ ton coal} \quad 2{,}000 \text{ lbs.} \quad 24 \text{ hrs.} \quad 365 \text{ days} \quad 1 \text{ year}}{\qquad\quad 1000 \text{ Watts} \quad 2{,}460 \text{ kwH} \quad \text{ton} \quad 1 \text{ day} \quad 1 \text{ year}} = 71 \text{ lbs. coal}$$

Step 4: Extend the exercise to compute the pounds of carbon dioxide emitted into the air to power the same lightbulbs:

$$\frac{9.9 \text{ Watts} \quad 1 \text{ kW} \quad 2.5 \text{ lbs. } CO_2 \quad 24 \text{ hrs.} \quad 365 \text{ days} \quad 1 \text{ year}}{\qquad\quad 1000 \text{ Watts} \quad 1 \text{ kwH} \quad 1 \text{ day} \quad 1 \text{ year}} = 216 \text{ lbs. } CO_2$$

Safety Issues

- Keep children away from wall socket and
- Supervise handling of the ammeters

Troubleshooting Tips
None

Activity Extensions
Follow with the Activity: Visit the EIA's website hosted by the DOE

http://www.eia.doe.gov/kids/energyfacts/saving/efficiency/moresavings.html
http://www.eia.doe.gov/kids/energyfacts/saving/recycling/solidwaste/wastetoenergy.html

http://www.ngkids.co.uk/fun_stuff/other/23/carbon_footprint

References
Department of Energy website:
http://www.eia.doe.gov/cneaf/electricity/page/co2_report/co2report.html

Investigating Questions
How many pounds of coal do you think you could save by replacing every light bulb in your house with a compact fluorescent? Estimate how many hours per day each light in your house is turned on.

Assessment

Pre-Activity Assessment
None

Activity Embedded Assessment
Each student completes worksheet of problems during class.

Post-Activity Assessment
If you've asked the students to take notes, ask to see the students' notebooks to ensure they have recorded the lesson notes – design a short quiz of 5-6 questions to see if the students were listening. In addition, you may use the rubric below to evaluate the students based upon your classroom observations.

Students will be evaluated on a scale from 0 to 4 on:

_____	_____
Attentiveness	Participation

Contributors
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