An Energy Expedition:

Teacher's Guide

Seeking Out Our Lighting Choices

Suggested Grade Level:
- Grades 6-8

Subject Focus:
- Science
- Energy
- Environment
- Climate Change

Materials & Preparations:
- A lamp
- One CFL bulb, 13 watt
- One incandescent bulb, 60 watt
- A kilowatt meter
- A thermometer
- A calculator

Time:
- Demonstration: 10 to 15 minutes
- Mathematic portion: 15 to 25 minutes

Summary of Lesson:
The teacher will demonstrate temperature differences between two types of light bulbs and then introduce other energy efficient actions that save money and energy at home. Students will learn about ideas related to energy use and energy efficiency. Students will link and connect these concepts to what actions can be taken at home.

Objectives:
Students will:
1. Learn the connection between energy use and global climate change topics.
2. Learn that different appliances and technologies with similar output vary in the amount of energy they consume.
3. Identify and list technologies and other practical ways to be more energy efficient in a home.
4. Observe and compare an energy-efficient light bulb to an incandescent light bulb that uses energy less efficiently, and use specific data, facts, and ideas to support their findings.
5. Report information and convey ideas logically and correctly.

Introduction & Background:
Most of the electricity we use at home comes from burning fossil fuels like coal and oil. This releases greenhouse gas emissions into our earth's atmosphere, which can cause global climate change. Most people don't know that the average home is responsible for twice as many greenhouse gas emissions as the average car. We can each play a role in reducing these emissions by using energy more efficiently.

One of the easiest ways to learn about energy efficiency and put it into practice at home is through the light bulb. The most common light bulb today is the incandescent light bulb, invented by Thomas Edison 125 years ago. New compact fluorescent light bulbs (CFLs) use 1/3 the energy of Edison's bulb and last at least as much as 10 times longer.

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	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Brightness	850 lumens	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	3,000 hours	10,000 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	$0.50	$3.00	$3.00	$40.00

In fact, only 10% of the electricity required by an incandescent bulb is used for light, and the other 90% escapes as heat. CFLs create the same amount of light, but generate a lot less heat – about 70% less. CFLs are more energy-efficient than incandescent lights because fluorescent technology does not require a metal filament to create light, but instead uses contained gases, which require less electricity to create the same amount of light. To save the most energy and do the most good for the environment, it makes sense to use CFLs in frequently used areas of the home.

There are many other appliances and technologies where energy efficiency is very important. For example, two different refrigerators may keep food cool equally well, but the amount of energy they use to do so may vary significantly. Appliances and other technologies are considered energy efficient when they provide as good or better performance as other technologies but use less energy to do the job.

While a few kilowatt hours of energy wasted here or there may not seem much to worry about, over time that wasted energy is adding up substantial greenhouse gas emissions. Think about this: using a CFL instead of an incandescent light bulb can prevent 750 pounds of coal from being burned, and that lighting accounts for about 20% of total residential energy use. The potential savings is enormous and that's just with how we light our homes.

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Procedures:
1. Brainstorm with students how energy is wasted in homes and how they might help stop the waste.
2. Conduct the following demonstration project in class using:
   - A thermometer
   - A lamp
   - A kilowatt meter (provided by the program)
   - One CFL bulb and one incandescent bulb (a 60 watt incandescent bulb and a 13 watt CFL will generally produce equivalent light levels).
3. Teacher Demonstration: Place the CFL bulb in the lamp and turn it on (use the kilowatt meter to measure kWh output). Have students observe and write descriptive notes about the light that is produced. Hold a thermometer six inches above the bulb for one minute and have students guess and record the temperature. Turn off the lamp and let the bulb cool. Remove the CFL bulb, place the incandescent bulb in the lamp and turn it on (use the kilowatt meter to measure kWh output). Again, have students observe and write descriptive notes about the light that is produced. Do the same with the thermometer holding it six inches above the bulb for one minute and have students guess the change in temperature, record the actual temperature.

Discussion:
Ask the students if they could tell any difference in how much light the two bulbs produced, which bulb produced more heat than the other, and which bulb is more energy efficient.

Conclusion:
Encourage students to think about wasted energy and time, on a daily basis, monthly basis or even yearly basis. Have students consider how many hours they use a light bulb each day. For example, using a bulb 4 hours a day would equal 1,460 hours of light in a year and 14,600 hours in 10 years! Using the formulas provided in the boxes (based on the NEED graphic at the end of the section) compare or compute the following:

A. Calculate the number of bulbs needed for X hours of light and how much the bulbs would cost to light for those hours.
   *Note: incandescent 1,000 hours vs. CFL 10,000 hours

Number of bulbs needed

Incandescent: X hours/1,000 hours = X bulbs CFL: X hours/10,000 hours = X bulbs

Cost of bulbs

Incandescent: X bulbs x $.050 = $ cost CFL: X bulbs x $3.00 = $ cost

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B. Calculate the cost of electricity.

*Note: To find total kWh consumption watts must be in terms of kilowatts so divide by 1,000

Watts to kilowatts

Incandescent: 60 watts/1,000 kW = 0.060 kW
CFL: 13 watts/1,000 kW = 0.013 kW

Total kWh consumption

Incandescent: X hours/0.060 kW = kWh consumption
CFL: X hours/0.013 kW = kWh consumption

Cost of electricity

Incandescent: kWh consumption x price of electricity per kWh $0.12 = $
CFL: kWh consumption x price of electricity per kWh $0.12 = $

C. Calculate the life cycle cost

*Note: Use answers from A. and B.

Incandescent: cost of bulb + cost of electricity = life cycle $
CFL: cost of bulb + cost of electricity = life cycle $

D. Calculate the environmental impact (pounds of CO_2)

*Note: Use answers from B.

Incandescent: total kWh consumption x 1.6 lb./kWh = lbs. of CO_2
CFL: total kWh consumption x 1.6 lb./kWh = lbs. of CO_2

NEED Graphic Example:

Cost of 25,000 Hours of Light

All bulbs provide about 850 lumens of light.

	COST OF BULB	INCANDESCENT BULB	COMPACT FLUORESCENT (CFL)
	Life of bulb (how long it will light)	1,000 hours	10,000 hours
	Number of bulbs to get 25,000 hours	25 bulbs	2.5 bulbs
x	Price per bulb	$0.50	$3.00
=	**Cost of bulbs for 25,000 hours of light**	**$12.50**	**$7.50**
	COST OF ELECTRICITY	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**
	Total Hours	25,000 hours	25,000 hours
x	Wattage	60 watts = 0.060 kW	13 watts = 0.013 kW
=	Total kWh consumption	1,500 kWh	325 kWh
x	Price of electricity per kWh	$0.12	$0.12
=	**Cost of Electricity**	**$180.00**	**$39.00**
	LIFE CYCLE COST	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**
	Cost of bulbs	$12.50	$7.50
+	Cost of electricity	$180.00	$39.00
=	**Life cycle cost**	**$192.50**	**$46.50**
	ENVIRONMENTAL IMPACT	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**
	Total kWh consumption	1500 kWh	325 kWh
x	Pounds (lbs) of carbon dioxide per kWh	1.6 lb/kWh	1.6 lb/kWh
=	**Pounds of carbon dioxide produced**	**2,400 lbs carbon dioxide**	**520 lbs carbon dioxide**

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Web Resources & Tools:
The video link below is a useful introduction to lighting choices either in class before the activity or the night prior to the activity for homework.
Energy 101: Lighting Choices. From U.S. Department of Energy. Video length 1 minute 47 seconds. http://www1.eere.energy.gov/multimedia/video_lighting_choices.html

Extensions – Possible Essay Questions:
1. How does using less energy help our environment?
2. What are other examples of energy efficient technologies or energy-saving practices?
3. Taking it a step further (Homework): Students will participate and learn how to be energy efficient at home by doing the carbon footprint calculator. http://alcoa.c2es.org/challenge

For a social sciences or language arts class:
Have the students write a persuasive essay promoting the importance of using energy efficiently at home. Or, students could take the material they learned in the demonstration and create a children's book that explains what energy efficiency is, why it is important, and how individuals taking energy-saving steps can help.

For a science or environmental club:
Encourage club members to prepare a presentation for a lower grade level class or the community about the importance of our environment and using energy efficiently. Suggest using the CFL light bulb demonstration to illustrate energy efficiency. Students can hypothesize and then calculate the differences.

What would happen if:
a. Everyone in their class changed one light at home to a CFL,
b. Everyone in their school did the same, and then
c. Everyone in their city followed suit.

Helpful formulas:
Electricity saved (kWh) = bulb lifetime (how many hours it lasts) x (wattage difference of bulbs divided by 1000) x number of bulbs
Greenhouse Gas Emissions Prevented (pounds of pollution) = kWh x 1.58 pounds/kWh
Emissions equivalency in trees planted (acres of trees) = emissions prevented ÷ 8,066

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Curriculum Guidelines:
This lesson and activity has been aligned with National Science Education Content Standards for grades 6 through 8. Below are the specific content standards this lesson and activity targets. For further State or Regional information please refer the Teacher Resources.

- Content Standard A - Science as Inquiry
- Content Standard B - Physical Science
- Content Standard E - Science and Technology
- Content Standard F - Science in Personal and Social Perspectives

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Sources:
This lesson and activity has been taken from the Environmental Protection Agency which based the lesson and activity on the Alliance to Save Energy's Green Schools Program activities. Materials were also incorporated from the "Comparing Light Bulbs" activity by the National Energy Education Development (NEED) Project.

For information about:

The Environmental Protection Agency Teacher Resources, go to http://www.epa.gov/students/teachers.html

The Alliance to Save Energy, go to http://ase.org/

NEED's educational materials, go to http://www.need.org/energy-infobooks