Teacher Guide: Household Energy Usage

Learning Objectives

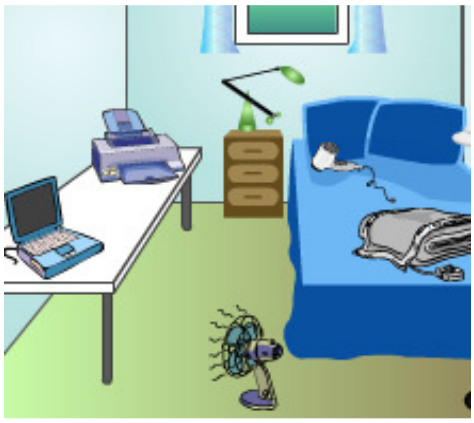
Students will…

- Learn how to calculate energy consumption based on wattage and usage.
- Compare the efficiency of three types of light bulbs.
- Estimate the daily, monthly, and yearly cost of electricity for a household.
- Explore ways that energy can be conserved effectively.

Vocabulary

current, energy consumption, fluorescent lamp, halogen lamp, incandescent lamp, lumen, usage, voltage, wattage

Lesson Overview



As nonrenewable energy resources are used up and global warming threatens the health of our planet, conserving energy becomes essential. The *Household Energy Usage* Gizmo™ allows students to estimate the energy consumed by the appliances in a house in an hour, a day, a month, or a year.

The Student Exploration sheet contains two activities:

- Activity A – Students compare the wattage, energy consumption, efficiency, and cost of three types of lights.
- Activity B – Students estimate their usage of various appliances, and use this data to approximate their total household energy usage and cost. (Note: Wattages given in the Gizmo are averages only. Appliances in a student's home may use more or less energy.)

Suggested Lesson Sequence

1. **Pre-Gizmo activity: Hot lights!** (10 – 15 minutes)
   Bring in an example of an incandescent light, a halogen light, and a compact fluorescent light. Turn on each light and ask students to compare the brightness of each bulb. Have students hold their hands close to each light (but NOT touching the bulb) to compare the amount of heat given off by each bulb. (Efficiency may be reduced if energy is converted to heat rather than light.) Discuss which type of bulb produces light most efficiently.

2. **Prior to using the Gizmo** (10 – 15 minutes)
   Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

3. **Gizmo activities** (15 – 20 minutes per activity)
   Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (15 – 30 minutes)
   As students are working or just after they are done, discuss the following questions:
   - How do you calculate the wattage of an appliance?
   - What is the best way to compare the efficiency of different light bulbs? (Is it enough to just compare their wattages?)
   - Which type of light bulb provides the most light for the dollar?
   - Look at the appliances with the highest wattages. What do many of these devices have in common? [Many of these "energy hogs" are used for heating. Examples include the hair dryer, electric stove, clothes dryer, and water heater.]
   - Given what you have learned about energy consumption, what strategies would save the most energy?

5. **Follow-up activity: Energy savers** (2 months)
   A lot of energy can be saved by making simple changes. See how much energy your students can save in a month by holding an energy-saving contest in your class.

   At the start of the contest, have each student bring in a copy of his or her family's most recent electricity bill. Record the energy consumption listed on the bill, and then brainstorm ways to save energy. For one month, it is up to the students and their families to save energy any way they can. (Note: Teachers are also encouraged to join the contest!)

   The contest winners are determined by the next electricity bill. Prizes go to the family with the lowest overall energy consumption and to the family who reduced their energy consumption the most. After awarding prizes, discuss what the most effective energy-saving strategies were.

Scientific Background

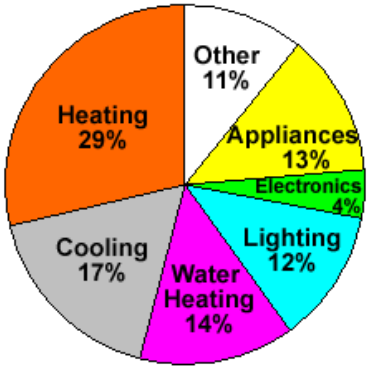
The origin of electrical power is found in the structure of the atom, in which a positively charged nucleus is surrounded by negatively charged electrons. Negatively charged particles are attracted to positively charged particles, and repelled by other negatively charged particles. In metals, the outermost electrons are held rather loosely by atoms and will flow if there is an excess of positive or negative charge nearby. (Electrical wires are made of metals for this reason.) The amount of excess charge determines the *voltage* of the circuit. Increasing the voltage causes the current in the wire to increase as well. Current is also influenced by the resistance of the wire through which it flows. Increasing the resistance decreases the current. Voltage (V), current (I), and resistance (R) are related by *Ohm's law*: $V = IR$.

Electricity is transmitted from power plants to homes via a vast network of transmission lines and substations. Transmission lines carry an alternating current (AC) at high voltages to reduce energy loss. Voltages are reduced in substations. In the United States and Canada, residential power lines carry voltages that are close to 120 volts.

The *wattage* of an appliance such as a toaster is a measure of how much electrical energy it uses each second. (One watt is equal to one joule per second.) Wattage is calculated by multiplying the current drawn (in amperes) by the voltage. The wattages of home appliances vary widely, from a 5,000-watt electric stove to a cell phone that uses less than one watt. In general, devices that use electricity to produce heat often have very high wattages.

The total energy consumed by a device is found by multiplying the wattage (kilowatts) by the usage (hours). Energy consumption is measured in kilowatt-hours (kWh).

In the United States, residential use accounts for approximately one-fifth of energy consumption. As the pie chart at right shows, heating and cooling usually make up the largest portions of energy consumption within the house. (Data courtesy US DOE, see the **Selected Web Resources** below.)



Environmental Connection: Energy conservation

In the US and worldwide, about 85% of energy is produced by the burning of fossil fuels (natural gas, oil, and coal). This is a problem for two main reasons. First, fossil fuels are nonrenewable resources—once they are used up, they are gone for a *very* long time. Second, the burning of fossil fuels releases carbon dioxide into the air. Carbon dioxide is a *greenhouse gas*, a gas that traps heat in Earth's atmosphere and causes global warming.

There are two ways to reduce the burning of fossil fuels. The first is to switch to alternative energy sources such as nuclear, hydropower, biofuels, solar, and wind energy. Many countries have significantly reduced their reliance on fossil fuels. For example, France derives over 80% of its energy from nuclear power plants. Canada produces about 25% of its energy with hydropower. Wind power accounts for over 20% of energy production in Denmark, and Germany and Japan satisfy over 10% of their energy demand with solar power.

The second solution is to reduce the demand for energy. Methods of reducing consumption in the home range from major renovations to simple changes in behavior. Insulation and double-paned windows can reduce costly heating and cooling bills, and energy-efficient appliances and lighting can help as well. Simple changes such as turning off the lights when you leave a room, unplugging the TV and computer at night, drying clothes outside, and turning up the thermostat in the summer (or down in the winter) all can help to reduce energy consumption.

Selected Web Resources

Energy saving facts and tips: http://www1.eere.energy.gov/consumer/tips/
Energy saving products: http://www.energysavers.gov/
Energy consumption: http://www.need.org/needpdf/infobook_activities/IntInfo/ConsI.pdf
Household energy consumption: http://www.energystar.gov/index.cfm?c=products.pr_pie
Renewable energy: http://www.eia.doe.gov/kids/energyfacts/sources/renewable/renewable.html

Related Gizmos:
Circuits: http://www.explorelearning.com/gizmo/id?398
Energy Conversions: http://www.explorelearning.com/gizmo/id?651
Water Cycle: http://www.explorelearning.com/gizmo/id?435