Watts Up With Energy?

- **Grade Level**
  4-9
- **Subject Areas**
  Science
  Earth/Environmental
  Math
- **Duration**
  30-60 minutes
- **Setting**
  Classroom
- **Skills**
  Interpreting and analyzing data
- **Vocabulary**
  Renewable
  Nonrenewable
  Watts
  Kilowatt hour
  Green power
- **Related Activities**
  Measuring Lung Capacity
  Bioaccumulation
- **Related Websites**
  www.epa.gov/energy
  www.eia.doe.gov/

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Summary
Students will learn where energy comes from and the differences between renewable and non-renewable sources of energy. Students will use watts meters to measure electricity use and explore ways they can reduce energy consumption.

Objectives:
Students will:
1. Distinguish between renewable and non-renewable sources of energy.
2. Measure electricity use of common household appliances.
3. Determine how they can reduce energy consumption

Materials:
- Student handout (1 per student)
- Watts meters
- Common appliances (examples include hair dryers, toasters, light bulb with incandescent and CFL bulbs, etc)
- Calculators

Background:
Energy use is necessary for our daily lives. However, the creation and the use of energy can impact the environment. Energy can be created from two categories of sources: renewable and non-renewable.

Non-Renewable Sources of Energy
Non-renewable sources of energy include fossil fuels (coal, natural gas, oil), which cannot be replenished in a human lifetime. Fossil fuels are burned to create electricity. The burning of coal for electricity generation releases emissions of carbon dioxide, mercury, sulfur dioxides, and nitrogen oxides. Carbon dioxide is a greenhouse gas and contributes to climate change. Mercury deposits into waterways and bioaccumulates through the food chain (see Bioaccumulation activity). Sulfur dioxides reacts with moisture in the atmosphere to form acid rain and nitrogen oxides are a key component in the formation of photochemical smog.
Burning oil for electricity generation releases many of the same gases as burning coal, including carbon dioxide, mercury, nitrogen oxides, and sulfur dioxides. Additionally, burning oil for electricity also releases methane, a potent greenhouse gas.

Burning natural gas for electricity generation releases nitrogen oxides and carbon dioxides, but in much smaller quantities than burning either coal or oil. Methane is also a by-product of burning natural gas when not burned completely.

All of the above are considered pollutants by the EPA and can have negative impacts on human health. See Table 1 for the average emissions of gases from fossil fuels. See the Measuring Lung Capacity activity for more information on air quality and health.

Nuclear power generates electricity through a process called fission. Uranium atoms are split in fission and this process releases energy that can be used to make steam. That steam is used in a turbine to make electricity. Uranium is a non-renewable resource: once it is used, it cannot be replenished in a human life time. There are no emissions of air pollutants from nuclear power plants. The main issue with nuclear power plants is the storage and disposal of radioactive waste, a by-product of the fission process. The United States produces approximately 2,000 metric tons of radioactive waste per year.

Renewable Sources of Energy
Renewable sources of energy are those that can be regenerated quickly and include: solar, wind, hydropower, biomass, and geothermal. Renewable sources are also known as “green power” or “clean energy”

Table 1: Average U.S. Emission Rates from Burning Fossil Fuels (lbs/MWh)			
	Coal	Oil	Natural Gas
Carbon Dioxide	2249	1672	1135
Sulfur Dioxide	13	12	0.1
Nitrogen Oxides	6	4	1.7

Data from www.epa.gov/energy

in that they release little to none air pollutants. However, each technology may have other environmental implications.

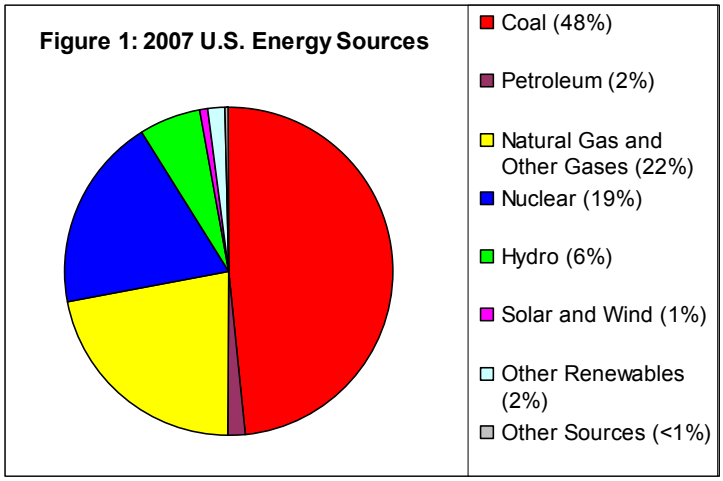
Solar power uses the sun's energy to create electricity. Solar energy is captured through two technologies: photovoltaic and sun-thermal. Photovoltaic technologies contain wafers made of conducive materials so that when sunlight strikes the wafers, a chemical reaction occurs, creating electricity. Solar thermal technologies concentrate the sun's rays with mirrors to heat a liquid, creating steam. This steam is used to turn a generator and create electricity. While there are no emissions of air pollutants from using solar power, there are other drawbacks. Since the sun is not always shining (such as at night or on cloudy days), generation and storage of electricity is limited.

Wind is created because the sun heats the earth unevenly, which, in addition to the Earth's rotation, causes warmer air to move toward cooler air. Wind turbines capture the energy in the wind to create electricity. The blades of the turbine spin a generator, creating the electricity. The availability of wind power is limited to highly windy areas, such as the Midwest and Great Plains areas of the United States. There are no air emissions associated with wind power, but wind farms typically require a large area of land, which can interrupt bird migration patterns and soil erosion problems.

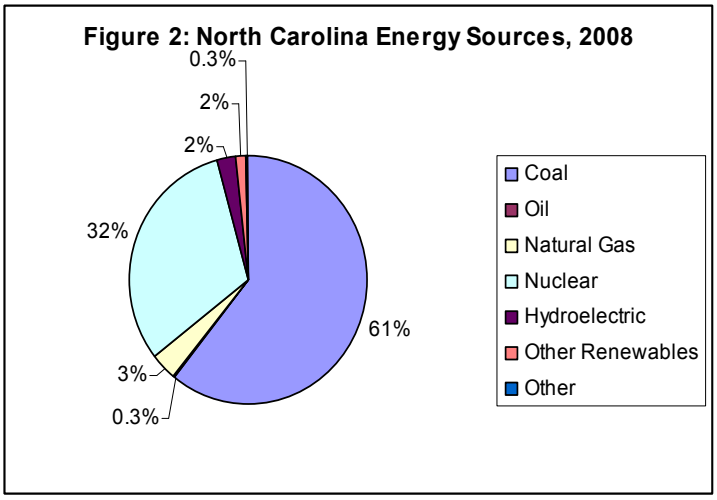
Geothermal power uses the heat of the earth below the surface to power steam turbines and thus creating electricity. Geothermal power is available everywhere, but difficult to capture unless close to the surface. The greatest potential for geothermal energy is in the Southwestern United States. There are no air emissions from geothermal power, but groundwater contamination is possible when drilling wells or extracting hot water and steam from the Earth.

Biomass is the collection of many fuel types including: trees, agricultural wastes, fuel crops, and manure. Biomass from trees and fuel crops can be replenished fairly quickly, and biomass from human activities (such as sewage sludge, manure and agricultural wastes) are continually produced by the human population. This makes biomass a renewable energy source. The biomass is burned, using the heat to create electricity. Burning biomass releases carbon dioxide, and small amounts of nitrogen oxides and sulfur dioxides. However, since biomass is a key component of the carbon cycle, the carbon dioxide released causes no net increase. Contrarily, carbon dioxide released from burning fossil fuels had been stored in the earth for thousands of years, and releasing it causes a net increase in the atmosphere.

Hydropower uses the natural water cycle to create electricity. Water moves downstream, and this creates kinetic energy that can be captured and converted to electricity. Hydroelectric power typically force water, often at dams, through a turbine, and then is returned



(Source: Energy Information Administration, 2009)



(Source: Energy Information Administration, 2009)

to the water source below. No air emissions are associated with hydropower, but dams can disrupt fish migration patterns and have negative impacts on the wildlife ecosystem of the river or stream that is dammed.

Energy Sources in the United States
Nearly half of the electricity in the United States is generated from coal-fired power plants. See Figure 1 for a breakdown of the sources of U.S. energy.

Energy Use in North Carolina
Over 60 percent of the electricity in North Carolina is generated from coal-fired power plants (see Figure 2). This is greater than the national average.

Electricity Units
When you buy gas, you are charged by the gallon. When you use electricity, you are charged by the kilowatt-hour (kwh). When you use a 1 kilowatt appliance for 1 hour, that equals one kilowatt-hour. If you used it for 2 hours, that would be 2 kwh. The rate of electricity at any given moment is measured in watts. 1000 watts equals 1 kilowatt.

Electricity/Energy Conservation
Ways to conserve electricity at home or at school include:
1. Turn off appliances and lights when not in use
2. Invest in energy efficient appliances and technology, including energy-saving light bulbs.
3. Use cold water in the washing machine instead of warm or hot
4. Take shorter showers.
5. Set the thermostat to a higher temperature in the summer and cooler temperature in the winter.
6. Unplug chargers when not in use.
7. Plug electronic equipment (TVs, VCRs, DVD players, etc) into a surge protector and turn off when not in use.
8. Close curtains on hot summer days to block the sun.
9. Visit www.epa.gov/energy for more tips and information on what you can do to conserve energy.

For More Background Information
Visit the EPA's Energy site at www.epa.gov/energy. The Energy Information Administration (EIA) collects data on sources of electricity generation and emissions. Visit eia.doe.gov to learn more.

Activity Procedure:

Introduction & Discussion:
Use the following questions to introduce the topic of energy. Encourage students to use the student page to take notes.
1. What is energy?
2. How do you use energy?
3. Where does energy come from? (Discuss both renewable and non-renewable sources of energy).
4. How much energy do you think you use?

Measuring Electricity
Energy is measured in watts—the more you use, the more you pay. Students will be measuring how many watts various appliances use.

1. Set-up: Place watts meters around the classroom, and place various appliances near the meters. Make sure each meter reads "watts" as the unit. If it does not, press the button labeled "watts."
2. Demonstrate for students how to use the watts meters. Plug an appliance into the front of the watts meter. Make sure the unit says "watt". Turn on the appliance and read the number. Note, appliances that generate heat will use a varying amount of electricity. Try to have students estimate the highest number it reaches for their data table.
3. Allow students to explore and use the watts meters, measuring the appliances from the kit as well as from the classroom. Instruct students to fill in the second column labeled "watts."
4. Calculate the cost of using these appliances as time allows. See "Notes on Grade Levels" for appropriate grade levels for calculations.

To Calculate Costs:
1. After collecting data for Column "Watts", estimate with students how many hours per day the average person would use these appliances. Have students fill in the third column "Hours per Day" with their estimates.
2. Multiply Column "Watts" by Column "Hours per Day" to find "Watts/Day".
3. To convert to KW Hours, divide "Watts/Day" by 1000. (1 kilowatt = 1000 watts).
4. Multiply "KW Hours" by the cost of electricity. The national rate is 12.05 cents per kilowatt-hour. This is given to students in the paragraph below the data table.

5. To convert "Cost/Day (in cents)" to "Cost/Day in $" divide by 100.
6. Finally, multiply by 365 to roughly estimate how much these appliances would cost to use each year (Column "Cost/Year").

Wrap-up:

Brainstorm with students ways that they can use less electricity. In school? At home? What are the benefits of conserving electricity? How does conserving electricity help protect the environment?

Notes on Grade Levels:

When using this activity with younger grade levels, focus on the activity and the idea that conserving electricity helps the environment. Skip the calculating the costs, but allow more time for students to brainstorm ways they can conserve electricity at home and at school. Do not use the student page. Instead, encourage students to write down the watts per appliance on a spare piece of paper.

When using with older grade levels, focus on the differences between renewable and nonrenewable resources, including trade-offs between technologies, and the cost calculations.

Further Extensions:

For further extension in the classroom:

1. Suggest to teacher that students bring in a copy of their electric bill to analyze.
2. School "mapping" of energy use—Have students explore what areas of the school use the most energy.
3. Home Inventory of Energy - Allow students to check out watts meters and explore energy use at home.

Note on Background Information:

All background information was generated from the EPA's energy website at www.epa.gov/energy unless otherwise cited.

Watts Up With Energy? Worksheet

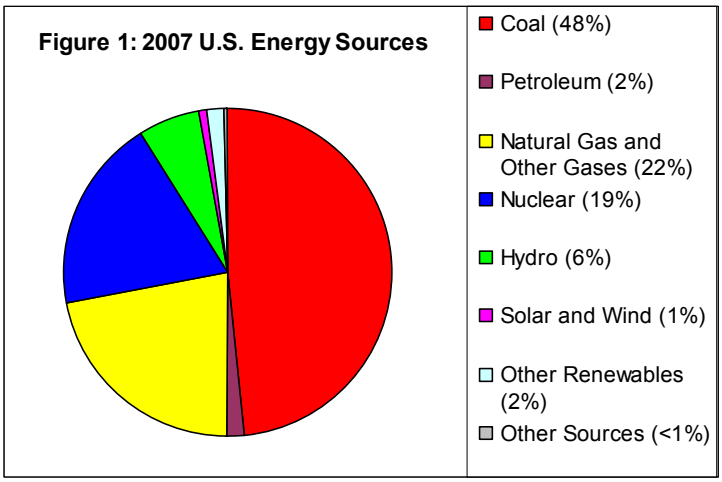
Examples of **Non-Renewable** Energy
1.
2.
3.
4.

Examples of **Renewable** Energy
1.
2.
3.
4.

How do you use electricity?
1.
2.
3.
4.
5.
6.
7.
8.

Electricity use can cause pollution!

The chart below shows where the United States gets its electricity. Note that nearly half is from burning coal!



(Source: Energy Information Administration, 2009)

Electricity is measured in Watts.

When you buy gas they charge you by the gallon. When you buy electricity they charge you by the kilo-watt-hour (kWh). When you use a 1 kilowatt appliance for 1 hour, that's a kilowatt-hour. If you used it for two hours that would be 2 kWh. The rate of electrical use at any moment is measured in watts. For example:

- A 100-watt light bulb uses 100 watts.
- A typical desktop computer uses 65 watts.
- A central air conditioner uses about 3500 watts.

Measuring Energy Data Page

Appliance	Watts	Hours / Day	Watts / Day	KW Hours*	Cost/Day** (in cents)	Cost/Day (in $)	Cost/Year
Clothes Dryer (example)	4400	2	8800	8.8	106.04¢	$1.0604	$387.05
Cell Phone Charger (example)	1.17	24	28.08	.02808	.338¢	$.00338	$1.24
Toaster							
Incandescent Bulb							
CFL Bulb							
Fan							
Wireless Router							

How much does it cost to use these appliances?

First, we need to convert to Kilowatt Hours*. To do this, divide the Watts by 1000 to get KW Hours. To calculate the Cost/Day**, multiply this by the national average of 12.05 cents per Kilowatt Hour. You can divide by 100 to get results in dollars per day.

What can YOU do to save money on electricity?

1.

2.

3.

4.

5.

6.

7.

8.