Measuring Electricity
Class Activity

Objective:

To understand what energy is, how it impacts our daily lives, and how one can become an energy steward.

Learning Outcomes:

Students will:

1. Understand where our energy comes from
2. Categorize sources of energy
3. Summarize what resources and how much of these resources contribute to our daily energy needs
4. Explain ways in which you, your family and community can save energy every day.

Materials Needed:

1. Science notebook
2. 6 Kill A Watt devices (note: these can be obtained from a variety of sources, i.e., local hardware stores, internet [average cost is $19.99; available from multiple vendors)
3. 6 different power-using devices (i.e. Fan, Laptop, Radio, Microwave, Refrigerator, Cell phone, Computer, Printer, etc.)
4. Worksheet table for each student with columns for: Device, Watts on, Cost On, Watts Off, Cost Off. (A worksheet template is provided that can be used for this lesson plan.)

Instructions:

1. **What Do the Students Know?**
   - **a.** On the white board make two columns, one for "Electricity" and one for "Energy/Saving Energy."
   - **b.** Ask the students what they know about each of these topics and write their responses on the board.

Background on Electricity

The United States is home to just 5 percent of the world's population but consumes more than 20 percent of its energy. On average, a person in America uses 10 times more energy than a person in China and nearly 20 times more than a person in India.

U.S. energy needs are met primarily by non-renewable sources including, gas, oil, and coal. Access to abundant and inexpensive energy contributes to our high standard of living, but burning large quantities of fossil fuels also has serious environmental and health consequences. These range from smog and acid rain to, most critically, the release of greenhouse gases leading to global climate.

The nation's school districts spend more than $7.5 billion a year on energy. Schools are the largest energy consumer in many municipalities. But up to 30 percent of that energy is used inefficiently or unnecessarily. By implementing energy-conservation measures and using energy-efficient technologies, schools can significantly cut their energy use. The result is financial savings as well as reduced environmental impact.

2. **Where Does Electricity Come From?**
    a. After students go through the animation, either as a class or individually, have them create a sequence of events; from coal to home. Ideas for sequences include a Flow Map (Thinking Maps®) and Foldables or other graphic organizers.

Power plants make electricity out of other forms of energy. Most electricity in the U.S. today comes from converting the heat energy released from burning fossil fuels – coal, natural gas, and oil. The rest is generated from nuclear reactors and from renewable sources, such as sunlight, wind, falling water, and geothermal heat.

In a typical power plant, a primary energy source like coal is burned to create heat, which is converted in a boiler to mechanical energy in the form of superheated, high pressure steam. The steam is directed into a turbine, where it pushes on blades attached to a central shaft or rotor. The rapidly spinning rotor powers a generator.

See this link for an excellent animation of this process:
http://www.energyeducation.tx.gov/energy/section_3/topics/where_does_electricity_come_from/energy_pathway_image.html

We burn fossil fuels to create energy. From keeping warm in our house, to fuelling our cars, to growing our food, to manufacturing our MP3 players, energy is used. Is burned directly (das is burnt in your boiler for example, and gasoline is burnt in your car) or it is burned in a power station to drive turbines which generate electricity. Fossil fuels are also burnt at various stages in the process of creating food, products and services for our consumption. The total carbon which we as individuals are responsible for is called our carbon footprint.

3. **What is Energy?**

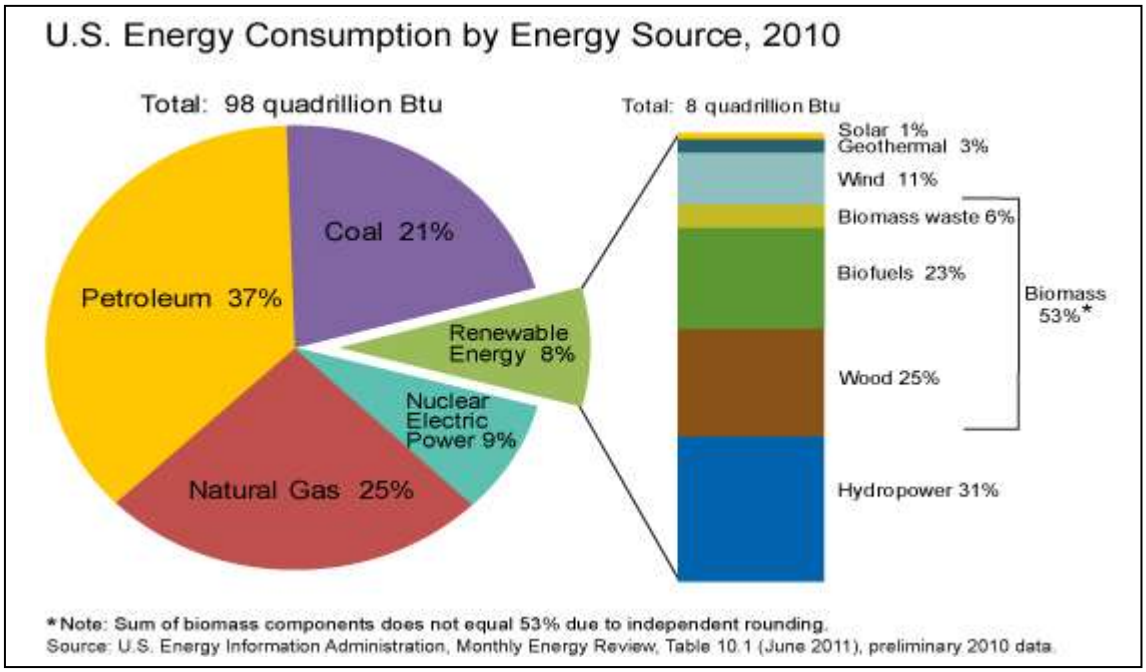
Energy is in everything. It is neither lost nor destroyed. We use energy for everything we do, from making a jump shot to baking cookies to sending astronauts into space and even sleeping. Energy comes in forms and sources. Two forms of energy: "Stored" or potential energy and "working" or kinetic energy. For example, the food you eat contains chemical energy and you body stores this energy until you use it when you work or play.

Other forms of energy include:

Thermal (heat)	Radiant (light)
Sounds	Electrical
Chemical	Nuclear

4. **What are Sources of Energy?** Ask your students to compare their state's fuel mix against several other states in the U.S. What differences do they see? Why do they think that there is so much difference state-to-state?

   The chart below shows the 2010 average breakdown of US energy consumption, by source. You will note that the bulk of the energy consumed in the US comes from non-renewable sources (coal, petroleum [oil], and natural gas).



   Electric generation fuel mixes vary from state to state and region to region, depending upon the availability and cost of fuels located there.

   You can use the national average, but to really give a perspective on the differences in electricity generation state-by-state, it's a good idea to enter your state-specific data into the carbon calculator.

   1. Click on this link: http://www.getenergyactive.org/fuel/state.htm
   2. Click on your state. The fuel mix will pop up. Make a note of the types of fuels used to generate electricity in your state and the percentages by fuel.

EXAMPLE:

California's Net Generation Fuel Mix		Nevada's Net Generation Fuel Mix	
Coal	1%	Coal	20%
Nuclear	0%	Nuclear	0%
Natural Gas	52%	Natural Gas	67%
Oil	0%	Oil	0%
Hydro	17%	Hydro	6%
Non-Hydro, Renewables, and Other*	14%	Non-Hydro, Renewables, and Other*	7%

*"Non-Hydro Renewables and Other" includes generation from solar, wind, geothermal, biomass (agricultural waste, municipal solid waste, landfill gas recovery, wood, pitch), hydrogen, batteries, chemicals, non-wood waste, purchased steam, sulfur, and miscellaneous technologies.

Sources: U.S. Department of Energy, Energy Information Administration, Power Plant Report (EIA-920), Combined Heat and Power Plant Report (EIA-920), and Electric Power Monthly (2006 Preliminary).

5. **How to Save Energy**
    a. **What is the difference between energy efficiency and energy conservation?**
        i. **Energy Efficiency** refers to the amount of work you get out of a device compared to the amount of energy put into the device – the less energy a device uses to get X amount of work, the more efficient it is.
        ii. **Energy Conservation** is essentially, not using energy: turning off your computer and monitor when not working with it saves energy, for example. Of course, building devices that do the same work with less energy [more efficient] saves energy. So in that way the two concepts are related.
        iii. **Ways to Conserve Energy:**
            1. When your cell phone is done charging unplug the charger from the wall
            2. Change to CFLs, Compact Florescent Light bulbs
            3. Use products with Energy Star labels
            4. Don't leave water running when you're not using it
            5. Turn off lights, fans, and electronics when you're not in the room
6. **Kill A Watt Device**
    a. What is a Watt?
        i. A metric unit of power, used in electric measurements, to give the rate at which energy is used.
        ii. Explain that 1,000 watts = 1 kilowatt
        iii. Show pictures of the electric devices you will be testing and have students guess how many watts each device uses.
    b. What is this device used for?
        i. It is used to act as a meter going between the item that draws the power and the power source.

c. How to use the Kill A Watt
   ii. Plug the Kill a Watt into a wall socket.
   iii. Insert the plug for the electric device you want to test and turn the electric device on.
   iv. Press the grey Watt button and record in your table the power reading.
   v. Repeat this process for when the device is turned off.

For a great video on How a Kill A Watt meter works, visit our Eco-Schools USA Energy Pathway page at www.eco-schoolsusa.org/energy

7. Calculating Energy Usage and Costs

a. Converting Watts to Kilowatts and cost per year

Electricity is measured in kilowatt-hours (kWh)

1 kilowatt = 1000 watts

KWh = kilowatts x hours the appliance is on

To get kilowatt-hours, take the wattage of the device,
multiply by the number of hours you use it, and divide by 1000.

(Dividing by 1000 changes it from watt-hours to kilowatt-hours.)

b. Electricity Cost – the cost of electricity depends on where you live, how much you use, and possible *when* you use it.

The electric company measures how much electricity you use in kilowatt-hours (kWh). Your bill might have multiple charges per kWh and you have to add them all up to get the total cost per kWh.

Electricity rates vary widely. Prices are usually highest for residential and commercial consumers because it costs more to distribute electricity to them. Industrial consumers also use more and can take their electricity at higher voltages so it does not need to be stepped down. These factors make the price of power to industrial consumers closer to the wholesale price of electricity. The cost to generate electricity actually changes minute-by-minute. However, most consumers pay rates based on the seasonal cost of electricity. Changes in prices generally reflect variations in electricity demand, availability of different generation sources, fuel costs

and plant availability. Prices are usually highest in the summer because more expensive generation is added to meet the higher demand.

The average retail price of electricity in the United States in 2010 was 9.88 cents per kilowatt-hour (kWh). The average prices by type of utility customer were:

Residential: 11.6¢ per kWh Transportation: 11.0 per kWh
Commercial: 10.6¢ per kWh Industrial: 6.8¢ per kWh

Schools would fall under the "commercial" pricing.

c. Convert each devices watt reading to kilowatts and cost per year and record the results in your table.

Here's the formula to figure the electricity cost of running a device:

Wattage **x** hours used **÷** 1000 **x** price per kWh **=** cost of electricity

d. Graphing

i. After you have converted to cost per year make a bar plot of the data with device on the X axis and cost on the Y axis. For each device make sure you plot the cost per year with the device turned on and the cost per year with the device turned off.

ii. Ask what conclusions can be made from the bar plot

Measuring Electricity Activity

Name: _____ Date: _____

1. Do you think that electrical devices (computers, Xbox, Wii, printers, cell phone chargers, etc.) use electricity and cost money when they are turned off? Why?

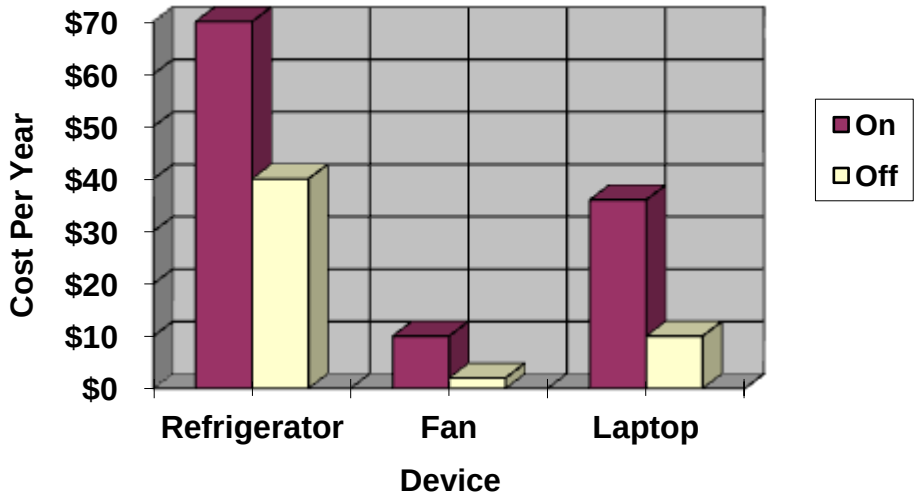
2. Use the KILL-A-WATT device to take the watt reading when the device in turned on and when the device is turned off and record it in the Measuring Electricity Table. Use a calculator to determine the cost per year when the device is turned on and when the device is turned off.

Measuring Electricity Table

Device	Watts Turned On	Watts Turned Off	Hours Used Per Day	Hours Used Per Year	kWh Used Per Year (number)	Cost per Year Turned On = kWh Annual Cost	Cost per Year Turned Off = kWh Annual Cost
Projector							
Hair Dryer							
Laptop							
Microwave							
VCR							

2. Use the data from your table to make a double bar graph. See Figure 1 for an example of how to make a double bar graph.

Figure 1



3. What conclusions can you make from your double bar graph? Is it important to unplug devices when you are not using them?

CONGRATULATIONS!

You now know that it conserves energy to turn off electric-powered devices when you are not using them! You've just increased your energy efficiency literacy! Use this lesson when you are doing our school energy audit to help you find out where you can save energy – and save money for the school!