# Kilowatt Ours

**Student Objective**
The student:
- will be able to explain the outcomes, both personal and global, of reducing electricity usage
- will be able to explain the consequences of using coal to produce electricity
- will be able to explain where the electricity that they use comes from in raw materials, method of production and transport
- will be able to list ways for a household to conserve electricity
- will make a list of action items to implement at home to reduce energy consumption.

**Key Words:**
asthma
Energy Star
geothermal energy
kilowatt hour
mill tailings
mountain top removal
ozone
renewable energy
uranium

**Time:**
(2) class periods

**Materials:**
- *Kilowatt Ours* video produced by Jeff Barrie
- Science Journal

**Background Information**

Electricity is an energy carrier–a secondary energy source. Electricity is generated from the conversion of other sources of energy, such as coal, natural gas, nuclear, solar or wind energy. These sources can either be renewable or nonrenewable, but electricity itself is neither renewable or nonrenewable.

The majority of our homes and businesses use electricity that is made many miles away at power plants by huge generators. Most fossil fuel power plants burn fuel (or split atoms in nuclear plants) and use the heat from this process in a boiler where water is turned to steam to turn a turbine. The spinning turbine creates an electrical current from the relative motion between a magnetic field and a coil (conductor).

The electrical power that is produced is between 138 and 765 kilovolts. This enables the power to be pushed over long distances with less loss, on very tall high-voltage transmission lines. In cities and towns, the voltage is lowered at local substations to between 2 and 35 kilovolts, then it is sent on smaller (distribution) power lines. The voltage of the electricity is reduced one more time to 240 volts, at residential transformers that are placed close to the homes

and businesses being serviced. These transformers may be seen on top of a pole or in a box on the ground. The electricity then enters the home through a meter that measures how much is consumed, goes through a service panel (breaker box) and to the lights and outlets throughout the building.

According to the U.S. Energy Information Administration, in 2014 the United States generated about 4,083 billion kilowatt hours of electricity. About 67% of this electricity was generated from fossil fuels (coal, natural gas, and petroleum), whereas in Florida, 84% of the electricity generated was from fossil fuels (coal and natural gas). The breakdown of energy sources by percent share for the country and the state of Florida for 2014 was:

| | **U.S. Total** | **Florida Total** |
|---|---|---|
| Coal | 39% | 23% |
| Natural gas | 27% | 61% |
| Nuclear | 19% | 12% |
| Hydropower | 6% | 0.1% |
| Biomass | 4.4% | 1.1% |
| Geothermal | 0.4% | 0% |
| Solar | 0.4% | 0.05% |
| Petroleum | 1% | 0% |
| MSW/Landfill gas | <1% | 0.8% |

Florida's household electricity usage is 40% more than the national average, and Florida's residential electricity usage is second only to Texas. Of the electricity used in Florida households, approximately 40% is used for cooling and heating. The remainder is divided up by: water heater 19%; refrigerator/freezer 8%; washer/dryer 9%; range 4%; and other appliances 20%.

It is also interesting to note that transformers and power plugs from battery devices (cell phones, laptops, etc) that are left plugged in after the device is removed, waste up to 10% of the total electricity usage of a household. These loads have been termed 'vampire loads' since they are draining electricity and essentially not doing anything useful at all!

**Statistics quoted in *Kilowatt Ours***

Coal Mining

- Five million pounds of explosives a day are used by the coal mining companies in Appalachia.
- More than 1,500 miles of streams in Appalachia have been buried as a result of the mountaintop-removal process.
- In the fall of 2000, over 300 million gallons of coal slurry were spilled into the Big Sandy River in Martin County, Kentucky. Although this ecological disaster was 30 times greater than the 1989 Exxon Valdez oil spill in Alaska, very few people outside of Kentucky heard about it.

Coal Burning

- Visibility in the Great Smoky Mountains National Park has declined 60% over the last 60 years, with 83% of the visibility-reducing haze in the park from sulfate particulates from coal-burning power plants.

- The EPA estimates that 33 million people in the Southeast live in bad-air areas.
- Air pollution contributes to 11,000 deaths per year in the Southeast.
- 45 of 50 states post statewide mercury advisories warning that fish are unsafe to eat.
- According to the Centers for Disease Control, 1 in 10 women of childbearing age carry unsafe levels of mercury in their tissues.
- Asthma is the number one cause of: hospitalization of children, chronic illness in children, school absences, and lost revenue to school systems.

Coal and Electricity Use

- In the Southeast 1 kilowatt-hour of electricity requires approximately 1 pound of coal.
- One pound of coal can run: 10 incandescent light bulbs for one hour, an air-conditioner for 30 minutes or a water heater for 15 minutes
- In a typical year the average home in the Southeast burns approximately 12,000 pounds of coal.
- Schools in America spend more on energy bills then they do on computers and textbooks combined.

Green Power

- Recycling one aluminum can saves enough energy to power a television for three hours. (America only recycles about half of its aluminum cans.)
- Less than one-tenth of one percent of America's energy comes from green power sources.
- Half the power needs of a city could be met if all the flat rooftop space were covered with solar collectors.

Conversions from kWh to pounds of coal, carbon dioxide ($CO_2$), sulfur dioxide ($SO_2$), and nitrogen oxides ($NO_x$):

kWh saved = pounds of coal saved (1 lb. coal required for 1 kWh)
pounds of $CO_2$ saved = lb. of saved coal x 1.4 lb. $CO_2$ / 1 lb coal
pounds of $SO_2$ saved = lb. of saved coal x 0.006 lb. $SO_2$ / 1 lb. coal
pounds of $NO_x$ saved = lb. of saved coal x 0.003 lb $NO_x$ / 1 lb. coal

**Procedure**

1. Tell the students that they will be watching the video Kilowatt Ours about electricity production and usage. Ask them where their electricity comes from (its source). At each answer (the outlet, power plant, etc), ask where the energy came from before that. You should be able to trace the energy all the way back to the sun (millions of years ago, of course)
2. If you haven't studied it previously, explain to the students that a kilowatt hour is the unit of measurement for electricity over time, as in how much electricity is produced or consumed in an hour. This is also the unit of measurement that is used in electricity bills.
3. Show the 38 minute video.
4. Allow 5 - 10 minutes for the students to complete the Science Journal.
5. Take a few minutes to discuss their reactions to the video.
   - Ask the students if the authors of the video presented a convincing argument of the hazards of mining and using coal for electricity.
   - Discuss with them what points they found most convincing and which (if any) they found irrelevant.

- Remind them that documentaries (and essays) can be one-sided or two-sided arguments. Discuss with the class if they think the video was one-sided or two-sided, and why they think the author presented it in this way. Does this method help in educating the audience about the subject?
- If the class thinks the video was one-sided, discuss with them what facts and opinions should have been added to it to make it a more two-sided argument.

6. Lead a brainstorming session on ways that we can save energy in our households. Write their ideas on the board.
   A few of the things to include might be:
   - don't stand in front of the refrigerator with the door open
   - turn off lights when you leave the room
   - unplug transformers and chargers from the wall (cell phones, laptops, etc) when not in use (these 'vampire loads' can account for as much as 10% of a family's electric usage!)
   - wear a sweater in the winter and lower the thermostat; wear lightweight clothes in the summer and raise the thermostat
   - wash clothes in cold water
   - take showers instead of baths
   - run the dishwasher when it is full; your wash machine and dryer with full loads

   Help the students to see that there are a lot of things that they can do to save electricity, and that a lot of small actions make a big difference.
7. Once the board is full of ideas, have each student pick 5 things that they think they can do at their house, and have them write them in their Science Journal.

**Follow-up**

8. A week after the students make their lists, see how they are doing on implementing the changes. Give them another week to work on their changes.
9. At the end of the second week, discuss with them how they did with their goals and in putting their ideas into practice. Discuss with them how easy or hard it was to make changes in their behavior, and help them understand that this is part of our environmental and energy problems.

**Key Words & Definitions**

- **asthma** - asthma is a disorder that causes the airways of the lungs to swell and narrow, leading to wheezing, shortness of breath, chest tightness, and coughing
- **Energy Star** - Energy Star is a government-backed labeling program that helps people identify factories, office equipment, home appliances and electronics that have superior energy efficiency, usually 20 - 30% less energy than required by federal standards
- **geothermal energy** - thermal energy generated and stored in the Earth.
- **kilowatt hour -** a measure of electrical energy equivalent to a power consumption of 1,000 watts for 1 hour
- **mill tailings** - uranium mill tailings are primarily the sandy process waste material from a conventional uranium mill which contains the radioactive decay products from the uranium chains (mainly the U-238 chain) and heavy metals
- **mountain top removal** - is a method of surface coal mining that removes a mountaintop

or ridge line

- **ozone** - an unstable, poisonous form of oxygen that is formed naturally in the ozone layer and also produced in the lower atmosphere by the reaction of certain pollutants.
- **renewable energy** - abundant fuel sources that are replenished
- **uranium** - the chemical element with atomic number 92; a gray, dense radioactive metal used as fuel in nuclear reactors

**Related Research**

1. Research your electricity provider. Do they produce their own electricity or buy it from a producer? What primary energy sources are used to produce the electricity that flows to your house, and what are the percentages of each?
2. Research if your electricity provider is adding renewable energy into their energy production. Find out what kind of renewables they are using, where they are located, how much electricity they produce, and if they have plans to expand renewables in their portfolio of energy production. Create a visual presentation of your findings.
3. Take Jeff Barrie's challenge and create a plan to cut your family's electricity use by 25%. Obtain your family's past history of electrical usage. You can use past statements, or most electric companies will allow you to get the data from their web site. Create an action plan and follow up after a month to see how well you did.
4. Compute your carbon footprint using one of the online calculators listed in the Internet Sites section. Decide on some changes you would like to make and run the calculator again to see the difference.

**Related Reading**

- **Catch the Wind Harness the Sun** by Michael J. Caduto (Storey Publishing, 2011)
  This book is a great supplemental book for science classes. It covers the topics of global warming, energy production, use and conservation (as well as solar and wind energy) with stories, humor and kid-friendly real projects.
- **The New 50 Simple Things Kids Can Do to Save the Earth** by EarthWorks Group (Andrews McMeel Publishing, 2009)
  This book includes units on recycling, water, animals, energy, and personal and social action. It covers topics such as water pollution, air pollution, climate change and disappearing animals. It also includes easy and inexpensive experiments.
- **Heroes of the Environment: True Stories of People Who Are Helping to Protect Our Planet** by Harriet Rohmer (Chronicle Books, 2009)
  This book spotlights 12 contemporary conservationists who are working to fight pollution in cities, oceans, and wetlands, from Alaska to Mexico City. Many of the featured activists are young people. Two of the stories relate directly to this lesson: Margie Richards, a middle school teacher, who confronted a big oil company with her concerns, and Judy Bonds a community activist working to stop mountaintop removal mining in West Virginia

**Internet Sites**

**http://www.kilowattours.org/curriculum.php**

Kilowatt Ours curriculum resources, including pre and post activities and energy assessments that students can use at home or their school

**http://meetthegreens.pbskids.org/features/carbon-calculator.html**

PBS kids carbon footprint calculator for kids

**http://www.energyquest.ca.gov/index.html**

California Energy Commission's Energy Quest web site includes information on energy related subjects, *Devoured By The Dark* adventure story, videos, and Ask Professor Quester

**http://www.eia.gov/kids/index.cfm**

U.S. Energy Information Administration student site includes kid-friendly information on energy sources, saving energy and the history of energy. Includes riddles, puzzles and games.

**http://footprint.wwf.org.uk/**

World Wildlife Fund carbon footprint calculator

**http://www3.epa.gov/recyclecity/**

Environmental Protection Agency's student site, includes Dumptown Game

**http://www2.epa.gov/recycle**

Environmental Protection Agency's, Reduce, Reuse, Recycle site for students

## Kilowatt Ours

| | | | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | .10 | .11 | .12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grade 7** | | | | | | | | | | | | | | |
| **Practice of Science** | **# 1** | **SC.7.N.1** | | | | | | | **X** | | | | | |
| **Earth Structures** | **# 6** | **SC.7.E.6** | | | | | | **X** | | | | | | |
| **Social Studies Standards** | **Sixth Grade: SS.6.G.3.2**<br>**Seventh Grade: SS.7.C.2.13**<br>**Eighth Grade: SS.8.G.3.2, SS.8.G.5.1, SS.8.G.5.2** | | | | | | | | | | | | | |
| **Language Arts Standards** | **Sixth Grade: LAFS.6.SL.1.1, LAFS.6.SL.1.2, LAFS.6.SL.1.3**<br>**Seventh Grade: LAFS.7.SL.1.1, LAFS.7.SL.1.2, LAFS.7.SL.1.3**<br>**Eighth Grade: LAFS.8.SL.1.1, LAFS.8.SL.1.2, LAFS.8.SL.1.3** | | | | | | | | | | | | | |

**Sixth Grade Benchmarks**

**Language Arts–Standards for Speaking & Listening**

- **LAFS.6.SL.1.1 -** Engage effectively in a range of collaborative discussions with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- **LAFS.6.SL.1.2** - Interpret information presented in diverse media and formats and explain how it contributes to a topic, test, or issue under study.
- **LAFS.6.SL.1.3** - Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.

**Social Studies–Geography**

- **SS.6.G.3.2** - Analyze the impact of human populations on the ancient world's ecosystems.

**Seventh Grade Benchmarks**

**Science–Big Idea 1: The Practice of Science**

- **SC7.N.1.7** - Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.

**Science–Big Idea 6: Earth Structures**

- **SC.7.E.6.6** - Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water.

**Language Arts–Standards for Speaking & Listening**

- **LAFS.7.SL.1.1** - Engage effectively in a range of collaborative discussions with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.

- **LAFS.7.SL.1.2** - Analyze the main ideas and supporting details presented in diverse media and formats and explain how the ideas clarify a topic, text, or issue under study.
- **LAFS.7.SL.1.3** - Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.

**Social Studies–Civics and Government**

- **SS.7.C.2.13** - Examine multiple perspectives on public and current issues.

**Eighth Grade Benchmarks**

**Language Arts–Standards for Speaking & Listening**

- **LAFS.8.SL.1.1** - Engage effectively in a range of collaborative discussions with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- **LAFS.8.SL.1.2** - Analyze the purpose of information presented in diverse media and formats and evaluate the motives behind its presentation.
- **LAFS.8.SL.1.3** - Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.

**Social Studies–Geography**

- **SS.8.G.3.2** - Use geographic terms and tools to explain differing perspectives on the use of renewable and non-renewable resources in the United States and Florida over time.
- **SS.8.G.5.1** - Describe human dependence on the physical environment and natural resources to satisfy basic needs in local environments in the United States.
- **SS.8.G.5.2** - Describe the impact of human modifications on the physical environment and ecosystems of the United States throughout history.

## Kilowatt Ours

1. In the first part of the video, describe the fact that you found most impactful. Why?

2. Why does Florida have one of the highest rates of electricity use in America?

3. What things currently do you do at home to try and save energy?

4. What things could you start doing at home that would save energy (list things that are relatively easy to do and don't cost much)?

5. If your family had extra money, what things would you like to see your family do to save energy and 'green' up your home?

6. Why does recycling save energy?

7. Why do you think more people don't recycle or try to save energy?

8. Why do you think the film was titled *Kilowatt Ours* instead of *Kilowatt Hours*?

9. After your class discussion, write the five ideas you chose from the list to try at home.