

# Power and Energy in the Home



TCIP Educational Development  
TCIPG: Trustworthy Cyber Infrastructure for the  
Power Grid

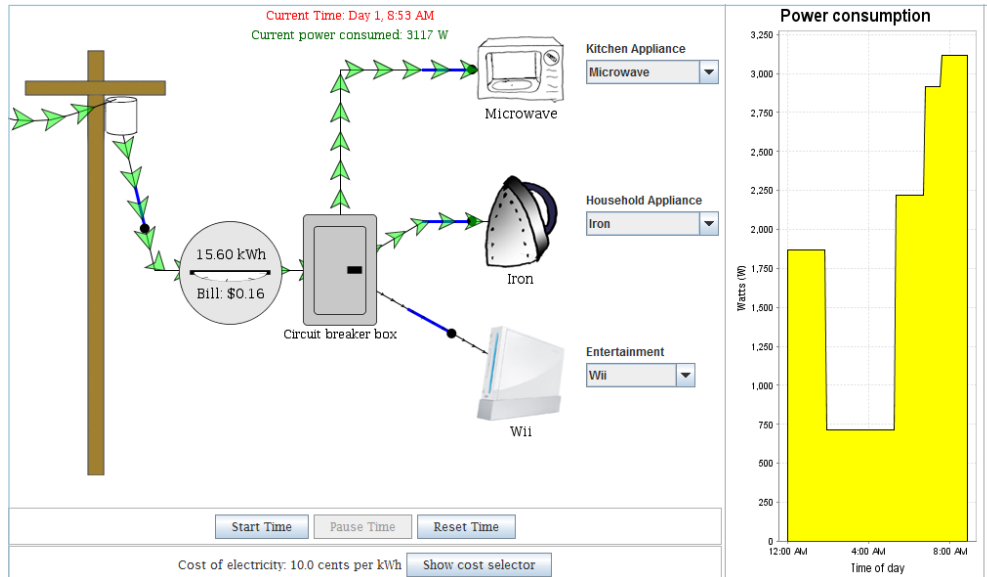


# Power and Energy in the Home

Lesson 1

Comments for  
Teachers

This lesson uses the applet at <http://tcipg.mste.illinois.edu/applet/peh>



The applet shows power flowing through the transformer drum, the kilowatt-hour meter and into the circuit breaker panel. From the panel it powers various appliances including video game consoles, kitchen appliances, and light bulbs.

When the applet opens time is passing

and the kWh meter is running. The meter shows the energy used since time started and the cost of that energy at \$.10 per kWh. **Elapsed time** (hours and minutes) and **Current power consumed** are displayed near the top. Remind students that energy use and cost are determined by the amount of power used **and** the amount of time it's used. The graph shows power consumed over time. The yellow area represents the energy used.

Encourage students to explore the applet. There are blue switches to open and close by clicking with the mouse. Choose appliances from the drop down menus and see the flow of power increase and decrease. Use the mouse to click the blue switches near the appliances. These switches act like the circuit breaker switches in the circuit breaker panel. In your home, however, one circuit breaker switch may control the flow of electricity to an entire room of appliances. When you click open the blue switch nearest the transformer all of the power stops flowing. Students can explore various combinations of appliances with opened and closed switches and view the changes in **Current power consumed**, the meter readings and in the arrow sizes.

## More Resources

- Home Energy Saver <http://hes.lbl.gov/>
- Energy Savers Website <http://www.energysavers.gov/>
- Energy Information Administration's Energy Kid's Page <http://www.eia.gov/kids/>

# Power and Energy in the Home

## Lesson 1

Use the applet at <http://tcipg.mste.illinois.edu/applet/peh> to explore power usage in the home. Open and close the blue switches and use the drop down menus to change the appliances. Watch how the flow of power changes. What do you see?

Electricity comes from a power plant to your home through a system of power lines, power substations, and transformers that make up the power grid.

Read about the power grid here.



Power flows through a transformer drum on a power pole into a kilowatt-hour meter. The meter measures the amount of energy going into the home so

the power company knows how much to bill the people who live there. An apartment building may have a meter for each apartment.

1. List three of these appliances that you might use for an hour or more. (1 \_\_\_\_\_ (2 \_\_\_\_\_ (3 \_\_\_\_\_)
2. Set the blue switches so only the Energy Star refrigerator (E-Star Fridge) is on. What is the **Current power consumed**? (It's the green number near the top.) \_\_\_\_\_
3. Compare the Energy Star refrigerator with the standard refrigerator. About how much more power does the standard refrigerator use? \_\_\_\_\_
4. How much power does the plasma television use? \_\_\_\_\_
5. Which of the three video game systems uses the least power? \_\_\_\_\_
6. Energy is sold by the kilowatt hour. A kilowatt is one thousand watts. If you use the 1000 watt hair dryer for one hour, you use 1 kWh (one kilowatt hour) of energy. How much energy is used if you dry your hair for 15 minutes? \_\_\_\_\_
7. Using a 100 watt light bulb for one hour uses 0.1kWh of energy. How many kilowatt hours do you use when you leave a standard 100 watt light bulb on for two hours? \_\_\_\_\_ for six hours? \_\_\_\_\_
8. If your XBOX 360 and 40" LCD TV are on for ten hours, how much energy is used? \_\_\_\_\_

# Power and Energy in the Home

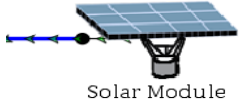
Lesson 2

Comments for  
Teachers

This lesson uses the applet at <http://tcipg.mste.illinois.edu/applet/peh>

The applet shows power flowing through the transformer drum, the kilowatt-hour meter, the circuit breaker panel, and into various appliances. If you keep the blue switch to only one of the appliances closed, the **Current power consumed display** shows the power needed for that one appliance. If you **reset** and **start time** the meter shows the energy used and the bill. Energy use and cost depend on both the amount of power needed and the time it is used.

There is a solar module in the list of **household appliances**. A homeowner would typically have several (10-20 can provide a significant portion of the needed power for most homes) modules of this size, commonly on the roof of the house. In this applet the solar module is **grid-connected**. This means that the solar module is a contributor to the power needs of the household when it is needed, but if the household needs more than the solar module is producing, additional electricity is delivered from the power utility, and if the solar module is producing more power than is needed, the excess flows into the power grid to be used by others.



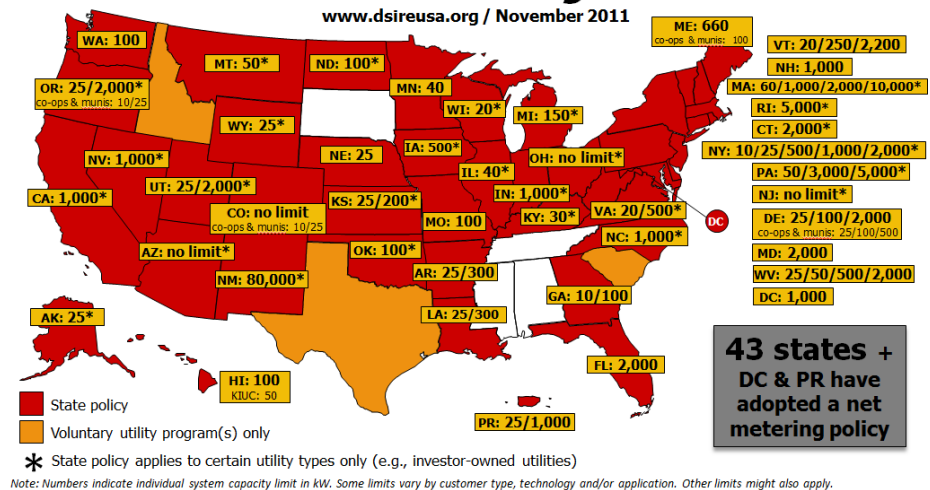
Household Appliance  
Solar Module

Federal law requires utilities to allow this connection to the grid and also requires utilities to purchase the excess power. Most states have **net metering** programs that allow the meters of power customers to turn backward when the solar module (or wind turbine) is producing excess energy. The details of these arrangements vary by state and by utility.

## Database of State Incentives for Renewables & Efficiency

### Net Metering

www.dsireusa.org / November 2011



43 states +  
DC & PR have  
adopted a net  
metering policy

## More Resources

Information from the U.S. Department of Energy, Energy Efficiency and Renewable Energy Office

- Solar Energy <http://www1.eere.energy.gov/solar/>
- Green Power Marketing and Net Metering <http://apps3.eere.energy.gov/greenpower/markets/netmetering.shtml>
- Small Solar Electric Systems [http://www.energysavers.gov/your\\_home/electricity/index.cfm/mytopic=10710](http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10710)



# Power and Energy in the Home

## Lesson 2

Use the applet at <http://tcipg.mste.illinois.edu/applet/peh> to explore power usage in the home. Open and close the blue switches and use the drop down menus to change the appliances. Which appliances need a lot of power?

Some appliances need a lot of power, but we don't often use them for a long time period so they don't use much energy. Other appliances may not need as much power, but they are used for more time. Energy use and cost depend on both the amount of power needed and time it's used. Which appliances use a lot of power and are on for longer time periods?

1. Set the blue switches so only the toaster is on. What is the **Current power consumed**? \_\_\_\_\_

2. Click on the **Pause Time**, **Reset Time** and then **Start Time** buttons. Watch the energy use and energy cost change on the kWh meter. You should also see the **Elapsed time** total changing. If you use the toaster for ten minutes how much energy do you use? \_\_\_\_\_

When the cost per kWh is 10 cents per kWh, how much do you pay to use the toaster for ten minutes? \_\_\_\_\_

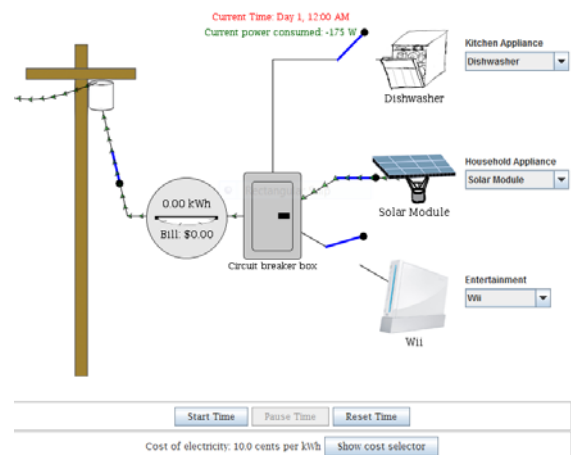
3. Use the applet to fill in the table.

Appliance	Power needed	Time	Energy used	Bill
Microwave		15 minutes		
40" LCD TV		3 hours		
Vacuum		30 minutes		
Iron		2 hours		

4. Set the switches so only the solar module is connected. What happens?

5. Switch on the LCD TV. Now what happens?

6. Which appliances need less power than the solar module can supply?



7. If there were twenty of these solar modules producing electricity, how much power could they supply?

# Power and Energy in the Home

Lesson 3

Comments for  
Teachers

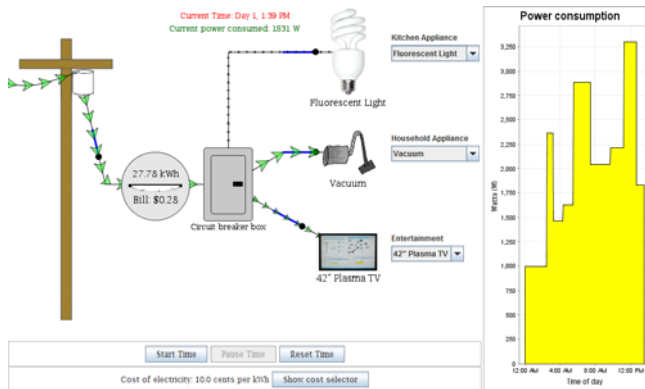
This lesson uses the applet at <http://tcipg.mste.illinois.edu/applet/peh>

In the applet the meter between the power pole and the circuit breaker box measures the energy being used as time passes. **Elapsed time** and **Current power consumed** are shown near the top. When the applet opens, the dishwasher, ceiling fan and the personal computer are demanding a total of 1341 watts of power. After one hour the meter shows 1.35 kWh's of energy used and the bill is \$.13. The meter continues to run for 3 days, 59 minutes unless the **Pause Time** button is clicked. When you change the appliances or open and close the blue switches, the demand for power changes and is shown in the **Current power consumed** tabulator.

If you change the appliances, the power demand will increase or decrease and the meter will adjust and spin faster or slower just like the wheel that spins in the meter at your home. The meter shows the cost of the energy at a rate of ten cents per kilowatt hour. If the only appliance you are using is a 100 watt light bulb, the cost of the energy is one cent per hour. Disconnecting the power pole stops energy usage and power demand. The meter stops but doesn't reset to zero. Time is still passing.

There are buttons at the bottom of the applet.

- Clicking **Pause Time** pauses the **Elapsed time** clock. The meter stops measuring kWh and cost because energy is only consumed as time passes.
- Clicking **Start Time** starts the meter and the **Elapsed time** clock to begin tabulating again from where they were paused.



- Clicking **Reset Time** sets the meter and **Elapsed time** back to zero.
- The **Print** button allows you to print the applet.
- Clicking **Show cost selector** opens a slider that allows you to change the retail price.
- The **Power consumption** graph shows how the energy use changes.

**Power and Energy units**  
Watt—basic unit of power

Watt hour—a unit of energy; one watt of power delivered over one hour

Kilowatt—1000 watts

Kilowatt hour—one kilowatt of power delivered over one hour

Megawatt—1,000,000 watts

## More Resources

- Energy Star Products [http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product](http://www.energystar.gov/index.cfm?fuseaction=find_a_product).
- Wisconsin Public Service Electric Appliance Calculator <http://www.wisconsinpublicservice.com/home/appcalc.asp>
- U.S. Department of Energy's educator's page <http://energy.gov/science-innovation/science-education>

# Power and Energy in the Home

## Lesson 3

Use the applet at <http://tcipg.mste.illinois.edu/applet/peh> to explore power usage in the home. Close some or all of the switches and then click on the **Pause Time**, **Reset Time** and then **Start Time** buttons. You should see the energy use and energy cost change on the kWh meter. You should also

Much of the electricity that we use is produced



by steam-powered turbines. Coal or natural gas is burned to make the steam. When we conserve energy in our homes, schools and businesses, less fuel is burned so fewer greenhouse gases are released into the air and the power company charges us for fewer kilowatt hours so we save money too.

see the **Elapsed time** total changing at the top of the applet. (Click the **Pause Time**, **Reset Time** and **Start Time** buttons to start over.)

1. How does the bill change as you change appliances and open and close the various switches?

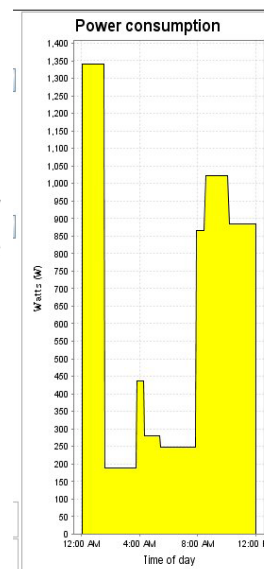
Click **Show cost selector** and change the cost of the electricity to ten cents per kilowatt hour. Use the questions below to explore the applet more.

2. Turn on the incandescent light, the room A/C and the XBOX 360. What is the **Current power consumed** by these three appliances? **Reset** and **Start Time** and then keep them all on for six hours. Read the meter to find the total energy usage. \_\_\_\_\_ What is the cost of that energy? \_\_\_\_\_

3. Turn on the incandescent light bulb, the Energy Star ceiling fan and the 40" LCD television. **Reset** and **Start Time** and then **Pause** the time at one hour. What is the total energy consumed?

\_\_\_\_\_

4. Notice the graph of Power Consumed Over Time. Since you **Paused** time in the previous exercise, you should see a graph for 341 watts used for one hour. Change the appliances and **Start Time**. (Click **Reset Time** to start over.) How does the graph change as you change appliances and open and close the various switches?



# Power and Energy in the Home

Lesson 3 page 2

Comments for  
Teachers

This lesson uses the applet at <http://tcipg.mste.illinois.edu/applet/peh>

At the very bottom of the applet is the **Show cost selector** button. Clicking on this button shows a slider that allows you to change the cost of a kilowatt hour of electricity. The average retail price of electricity in the U.S. is around \$.10 per kWh. Electricity in the Midwest and Plains states is less expensive than on the coasts. The three states having the highest average rates are Hawaii, Connecticut and New York. Find the Electricity Monthly Update from U.S. Energy Information Administration at [www.eia.gov/electricity/monthly/update/end\\_use.cfm](http://www.eia.gov/electricity/monthly/update/end_use.cfm).



This is what the Earth looks like at night. You can see areas where lights are on outdoors at night. The image is actually a composite of hundreds of pictures made by the orbiting satellites. [http://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth\\_lights\\_lrg.jpg](http://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth_lights_lrg.jpg)



## Information about Using Compact Fluorescent Light bulbs (CFL bulbs)

- The average U. S. household spends 15% to 20% of its energy dollars on lighting.
- Incandescent bulbs produce as much as nine times more heat than light.
- CFL's produce almost no heat. They won't burn you if you touch them and they also reduce cooling costs.
- The purchase price of a CFL bulb is more, but it lasts about ten times as long as an incandescent bulb.
- CFL bulbs contain a small amount of mercury. Get the Mercury Fact Sheet from Energy Star at [http://www.energystar.gov/index.cfm?c=cfls.pr\\_cfls\\_mercury](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls_mercury)
- Saving energy saves money and also reduces carbon dioxide produced by fossil fuel powered power plants.
- National Geographic has produced a video, [This Bulb](#), promoting CFL bulbs. You can see it on YouTube at <http://www.youtube.com/watch?v=dvUVXwJQcco>

## More Resources

- The winner of best overall app at the Environmental Protection Agency's (EPA) [Apps for the Environment](#) is called [Light Bulb Finder](#). It helps users choose the energy efficient bulbs that best match their home's current lighting conditions. <http://www.epa.gov/appsfortheenvironment/>
- Energy Savers offers tips for shopping for energy efficient lighting [http://www.energysavers.gov/your\\_home/lighting\\_daylighting/index.cfm/mytopic=11976](http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=11976)
- LUMEN Coalition offers information about various lighting choices There is also information about The Energy Independence and Security Act (EISA) of 2007, signed by President George W. Bush on December 18, 2007. ENERGESTAR@home allows the user to click on areas of the home and learn about saving energy <http://www.energystar.gov/index.cfm?fuseaction=popuptool.atHome>
- Energy Star products pages [http://www.energystar.gov/index.cfm?c=cfls.pr\\_cfls](http://www.energystar.gov/index.cfm?c=cfls.pr_cfls)
- Change a Bulb. Change Everything. <http://green.yahoo.com/18seconds/>

This site tracks the number of CFL bulbs purchased in the United States since January 1, 2007. It also gives information for individual states and specific zip codes.



# Power and Energy in the Home

Use the applet at <http://tcipg.mste.illinois.edu/applet/peh> to explore power usage. Click on the **Show cost selector** button. Set the applet so the cost of electricity is \$.10 per kilowatt hour. The average cost of electricity in your state may be higher or lower.

1. Turn on only the LCD TV and the Wii. **Reset** and **Start Time**. After 40 minutes turn on the standard fridge. How much energy is used when the elapsed time is one hour? \_\_\_\_\_ What is the cost of that energy? \_\_\_\_\_

2. Compare the incandescent light bulb with the fluorescent bulb. If a lamp is on for six hours, how much energy is saved by using the CFL bulb? \_\_\_\_\_ How much money? \_\_\_\_\_

3. How many light bulbs do you think there are in your home? \_\_\_\_\_  
 How many hours are light bulbs on per day? \_\_\_\_\_ per month? \_\_\_\_\_  
 How much energy could you save per month if you replaced them all with CFL bulbs? \_\_\_\_\_ How much money? \_\_\_\_\_

The website <http://green.yahoo.com/18seconds/> tracks the number of CFL light bulbs purchased since January 1, 2007 and shows equivalency information for coal saved and CO<sub>2</sub> emissions prevented

4. Find out if your local electric utility offers discounts or incentives for purchasing energy saving light bulbs. Describe it here.

Energy Star is a joint program of the U. S. Department of Energy and the U. S. Environmental Protection Agency. A product with an Energy Star label has met strict energy-efficiency criteria set by EPA and DOE. Energy Star promotes using energy wisely, and offers information for using less energy. Visit Energy Star Kids [www.energystar.gov/index.cfm?c=kids.kids\\_index](http://www.energystar.gov/index.cfm?c=kids.kids_index)

5. One household can save energy and money by changing incandescent bulbs for CFL bulbs, and if many households change their light bulbs, the energy savings per month or per year is more dramatic.

A chart can help us organize the information for large numbers.

Complete the chart.

"If every American home replaced just one light bulb with an ENERGY STAR qualified bulb, we would save enough energy to light more than 3 million homes for a year, more than \$600 million in annual energy costs, and prevent greenhouse gases equivalent to the emissions of more than 800,000 cars." - [www.energystar.gov](http://www.energystar.gov)

Hours of Use	Energy Consumed by One incandescent bulb (kWh)	Energy Consumed by One comparable CFL (kWh)	Energy Saved by replacing one bulb (kWh)	Energy Saved by replacing 1,000,000 bulbs (kWh)	Cost of the energy at \$0.10 per kWh (1,000,000 bulbs)	Cost of this energy at \$0.18 per kWh (1,000,000 bulbs)
1	0.1	0.033	0.067	67,000	\$6700	\$12,060
2	0.2	0.066	0.134	134,000	\$13,400	\$24,120
3	0.3	0.099				
10						
300						
3600						





# Power and Energy in the Home

Lesson 4

This lesson uses the applet at <http://tcipg.mste.illinois.edu/applet/peh>

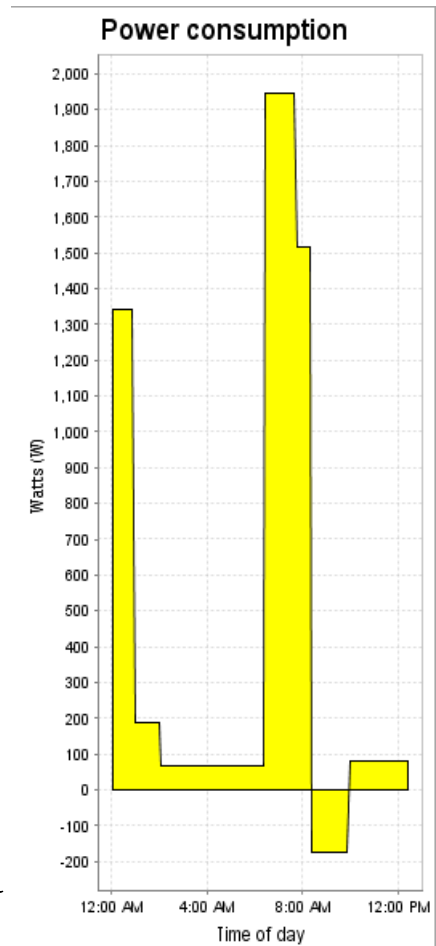
The graph on the right side of the applet shows time in hours on the horizontal axis and power demand on the vertical axis. As energy is used in the applet, the amount of energy being used appears as a yellow area. As the energy use changes the area changes. Time can continue to run for 3 days, 23 hours, 59 minutes.

## One possible story for this graph

At midnight on Day 1 the dishwasher, fan and PC were all on. They all remained on for about one hour. Then the dishwasher turned off, but the fan and the PC remained on for a little more than another hour. Next the PC was turned off, the fan remained on and a CFL was turned on. Nothing changed un-

The yellow area in the Power Consumed Over Time graph is the amount of energy consumed. A rectangle 1 hour wide and 1000 watts tall indicates one kilowatt hour. Find the number of kWh consumed by finding the total yellow area.

til approximately 6:30 AM when the microwave and LCD TV were turned on. At 7:45 the fan and the TV were off and the solar module was producing power, and at 8:15 no appliances were using power. From 9:30 to about 12:30 the solar panel continued to produce while the PC and one CFL bulb were on. .



## More Resources

- Safe Electricity <http://www.safeelectricity.org/>
- Consumer's Power Incorporated, a rural electric cooperative in Oregon, has useful information about home energy usage. Check out the Bill Estimator with Online Usage Calculator and the Home Energy Use Guide. [http://cpi.coop/home\\_energy/](http://cpi.coop/home_energy/)
- General Electric Energy Cost Calculator - This site has a variety of calculators. <http://www.csgnetwork.com/elecenergycalcs.html>
- Official Energy Statistics from the U. S. Government <http://www.eia.gov/>



