Energy Savers

Activity Book

Part of the SMECO Energy Efficiency Kit for Kids

EmPOWER MARYLAND

SMECO
People. Power. Progress.

Hello!

Welcome to your **Energy Savers Activity Book**! I'm so excited to share what's inside, but first, let's talk about you.

You probably already know that every time you use the TV, play a video game, or just turn on a light, you're using energy. But did you know that the choices you make have a big impact on those around you?

That's right. You have the power to use less energy and protect the environment for future generations. It's what being an Energy Saver is all about.

So, welcome to the team! Your first assignment: Put the items in this kit to use and complete the activities in this book. Then, teach your friends and family everything you know.

Did you know?

Even when a device is turned off, it could still be using energy just by being plugged in. This is called **phantom load** and it's a big cause of energy waste. Spooky!

Here's what you'll find inside the kit:

- **1 advanced power strip**: Ask an adult to help you plug items into this power strip before you plug it into the wall. It will prevent phantom load and protect your favorite devices from power surges.

- **1 LED night-light**: This night-light uses up to 75% less energy and lasts 25 times as long as a traditional bulb!*

- **This Energy Savers Activity Book, which has a collection of fun activities, including:**
  Managing Home Energy Use – page 6
  Energy Sources Poster – page 27
  Energy Math Challenge – page 28

Thanks again for doing your part.

Jennifer Raley

Jennifer Raley
Energy and Technology Programs Manager, SMECO

*How Energy-Efficient Light Bulbs Compare with Traditional Incandescents, U.S. Department of Energy. Accessed April 7, 2020, at https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/how-energy-efficient-light.

Table of Contents

INTRODUCTION

This section is designed for your child to learn about home energy use by measuring energy consumption, using audit tools, and implementing conservation.

Working with your child, as a household, you will conduct a step-by-step audit of your energy consumption and discover ways you can save money on your energy bills right away – many without any additional cost.

If you are interested in more information, the U.S. Department of Energy's Energy Saver website (https://energy.gov/energysaver/energy-saver) has tips and information about all areas of energy use in the home. Furthermore, many utility companies offer free or low-cost energy audits conducted by a professional who can demonstrate tasks and develop a plan to save money on your energy bills.

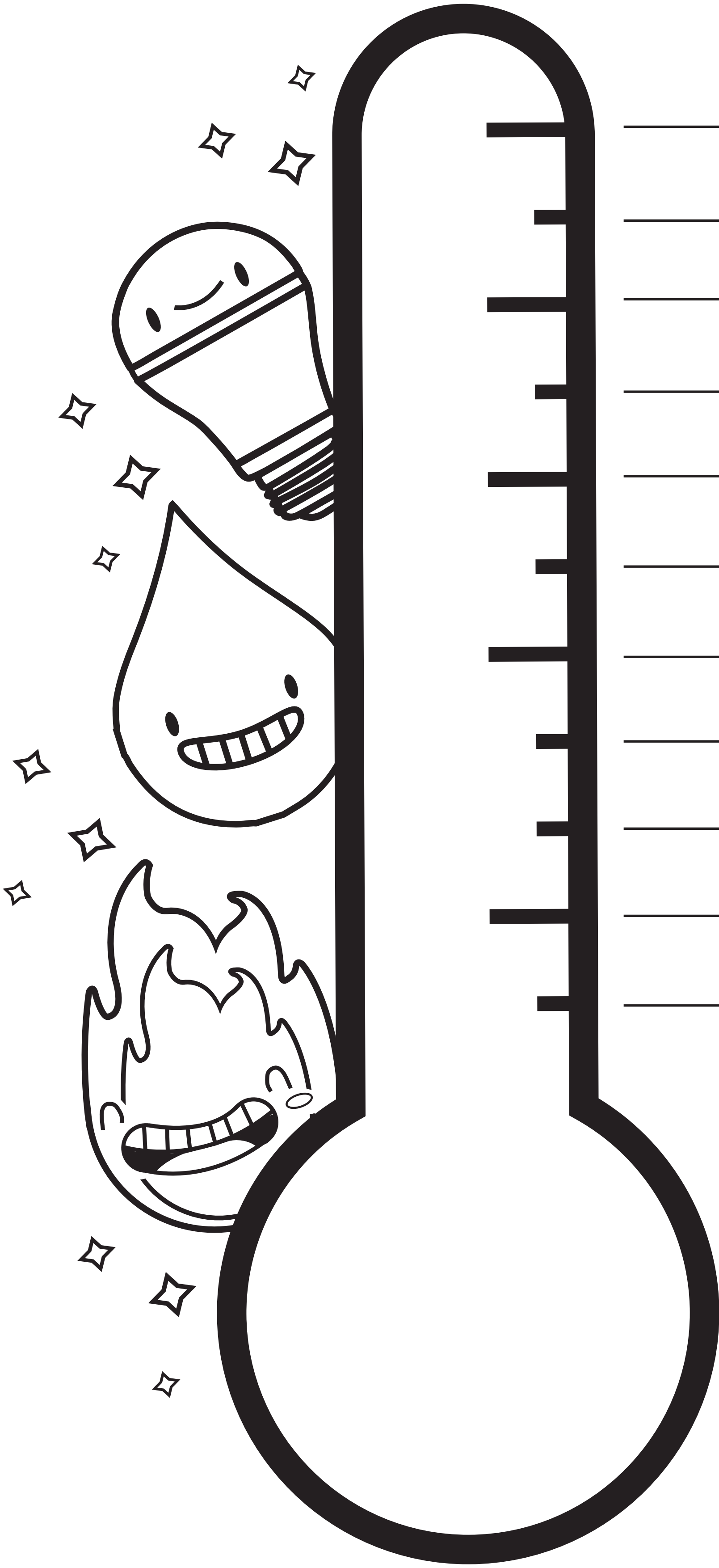
We encourage you, at the start of this unit, to set and write down a goal for your family. Decide how much money you would like to save monthly, or annually, and write it on a piece of paper. Include steps you might follow to help get you there. For example, "By January 1, we want to save a total of $500 on our electricity, gas, and water bills by taking shorter showers, using only cold water in the washing machine, and turning off lights when we leave each room." Have everyone in the family sign the goal statement so everyone can work together to achieve the goal.

A fun way to track progress toward your goal is to make a chart and fill it in as you progress toward your goal. An example tracking chart can be found on page 5. Another great way to concretely demonstrate how saving energy translates into saving money is to compare your current energy bills to those of the same month from last year. Add up the savings, and put that much money into a jar. As the jar fills with money, your household will be more excited and motivated to save more energy. At the end of your goal period, count the money in the jar, and decide as a group what you will do with it.

If you do not have certain materials listed, you can still do most of the activities with little to no modification. Simply skip the steps that utilize an item you do not have. You will still be able to learn how to use less energy and save money by going through the activities in this book.

Track Your Progress!

GOAL-TRACKING THERMOMETER



OUR GOAL

Lesson 1 | Introduction to Energy and Its Management

When electricity is factored in, the residential and commercial sectors of the economy (homes and businesses) use the most energy.

Energy efficiency is related to the equipment we select to do a certain job. For example, a 4-door sedan and pickup truck will both carry us to the store, but the sedan will probably do so using less fuel. It is more efficient. Using efficient appliances, electronics, and lighting can help reduce energy use and cost at home, while still performing the same tasks.

Energy conservation is related to the behavior of those using the equipment. For example, even the most efficient refrigerator wastes energy when the door is left open unnecessarily. Conserving behaviors do not cost any money to implement, and they can help significantly reduce the amount of money your household spends on energy.

Activity 1 | How Does Your Household Rate?

As a household, determine which answer to each statement – either column 1, 2, 3, or 4 – best matches the situation in your home. Shade in the box that corresponds to the best match, and then calculate your home's initial energy consumption score.

Energy Efficiency and Conservation at Home	4	3	2	1
Appliances That Are Energystar® Rated	All	More than half	About half	None
Lights That Are CFL or LED	All	Most	About half	Almost none or none
Electronics With Phantom Loads	None (unplugged)	About half	Most	All
Thermostat Setting During Heating Season	≤ 68	69–70	71–72	≥ 73
Thermostat Setting During Cooling Season	≥ 78	76–77	74–75	≤ 72
Laundry Loads Run Less Than Full	Never	Occasionally	About half	Usually
Dishwasher Run Less Than Full	Never	Occasionally	About half	Usually
Hot Water Setting (°F)	≤ 120	121–130	131–140	≥ 140
Doors and Windows Closed When Furnace or Air Conditioner Turned on	Always	Usually	Sometimes	Rarely
Lights Left on When Room Is Empty	Rarely	Sometimes	About half	Usually
Fans Left on Overnight	0	1–2	3–4	5+
TV's Left on Overnight	0	1	2	3+
Game Console or Computer Left Running	Never	Rarely	Occasionally	Frequently
Heating System Turned on When…	Temperature inside < 65	Temperature outside < 65	Temperature outside < 70	A/C not turned on
Cooling System Turned on When…	Temperature inside > 83 or not turned on/in use	Temperature outside > 83	Temperature outside > 80	Heat not turned on
Programmable Thermostat	Yes			No
Calculate Your Score				
Box Total (Number of Boxes Shaded per Column)				
Multiplied by...	×4	×3	×2	×1
Equals Column Total	=	=	=	=
Total Score (Add Together the Four Column Totals From Row Above)	**__________________ Initial Energy Consumption Score**			

Activity 1 | How Does Your Household Rate?

CONTINUED

Discussion

1. A perfect household score is 64. What was your score? ___________

2. Discuss the choices you can make now to improve your household's score based on your answers on the chart. Which changes would have the largest impact on your score? Which changes do you think would save the most energy?

3. Of the changes you listed in question 2 above, identify which are energy efficiency choices and which are energy conservation choices by filling in the chart below.

ENERGY EFFICIENCY CHOICES	ENERGY CONSERVATION CHOICES

Lesson 2 | Thermal Energy and Water Use

Thermal energy is the energy that gives substances their warmth. Steam has more thermal energy than liquid water, and water has more thermal energy than ice. When thermal energy is transferred, it moves from higher temperature to lower temperature. Thermal energy is transferred through conduction (direct contact), convection (flowing fluid), and radiation (waves of energy). Most home heating systems use convection to transfer thermal energy and heat rooms. Heating and cooling accounts for more than 40% of the energy used in a home, and water heating accounts for another 16%.

Heating and cooling systems are controlled by a thermostat. The temperature is set so that the heating system turns on if the air temperature falls below the setting. Programmable thermostats allow the homeowner to adjust the temperature for different times of the day, or when a cooler temperature is acceptable such as when everyone is away at work or school, or everyone is asleep under warm blankets. The program can be adjusted to begin warming the home just before the first person arrives, and to reduce the temperature after the last person is asleep or has left for the day. Programmable thermostats are available for all types of systems that will help you save money on your energy bill.

If you cannot install a programmable thermostat, you can adjust the temperature at night and when no one is home. If you do not set the temperature above 68°F in the winter or below 78°F in the summer, you will still be comfortable, yet make your energy bills more affordable.

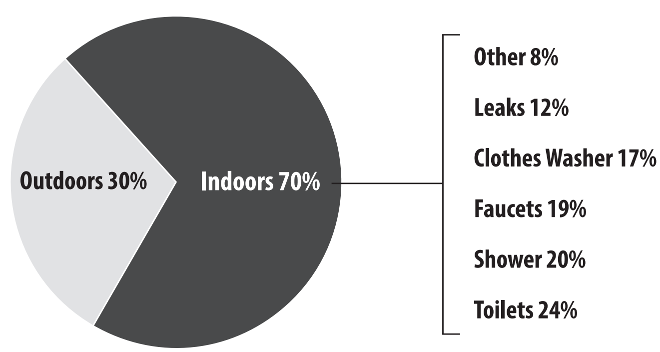
Water heating is another large energy user, so using hot water wisely will help control this expense. Setting the temperature of the water heater to 120°F will allow for hot showers, prevent accidental scalding, and save money. In addition, using a low-flow showerhead and washing clothes in cold or cool water will help use less hot water. A tankless water heater is the most efficient way to deliver hot water when you need it. It does not have a tank of water to keep hot when it's not being used, so the heater only runs when hot water is needed.

The amount of water used in your home also impacts the amount of energy used by your home. Beyond heating the water, extensive amounts of energy are put into extracting, treating, distributing, and disposing of the water you use. The average U.S. household of four uses about 400 gallons of water every day.

Here are some great ways you can reduce the amount of water you use at home:

1. Turn off the water while brushing your teeth. You don't need running water to do a good job on those pearly whites!
2. Take showers instead of baths. Most showers use significantly less water than filling the tub with water. Try to limit your showers to conserve water and energy.
3. Don't use more water than needed when cooking. A box of macaroni and cheese does not need a giant stock pot full of water, and many things that are cooked on the stove in water can instead be microwaved, saving both electricity and water.
4. Use a high-efficiency washing machine, which minimizes the amount of water used to clean clothes. Also, you can probably select the water level to match the amount of laundry you have placed in the machine, or even better, only run the washing machine with full loads.
5. Only run your dishwasher on pot scrubber when the dishes are really, really dirty. Instead, select "normal" for ordinary dish dirt.
6. Scrape your plates into the trash with a fork or knife instead of running them under a strong steam of water. Even better, scrape those food wastes into a bucket to use in composting or vermiculture (worm farming).
7. Keep a cover on your swimming pool or hot tub when it's not being used. Evaporating water must be replaced; this is especially important if you live in a dry climate.

How Water Is Used in the Home



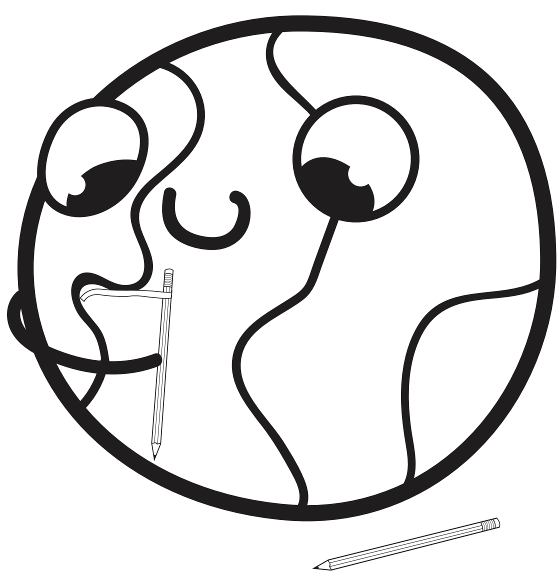
Data: EPA

Activity 1 | Seal of Approval

Adjusting the thermostat doesn't always save energy, if your home is not insulated or sealed properly. Poorly insulated attic spaces result in tremendous amounts of energy being wasted through the roof. Furthermore, air can leak or filter out through small cracks and gaps in walls and around windows and doors. This can add up to leaving a door wide open all day, every day. Sealing those gaps with caulking and weatherstripping will reduce air infiltration. Adding insulation in the attic to achieve the recommended R-value will ensure that your energy saving behaviors are not counteracted by a leaky attic. Insulation is helpful in both warm and temperate climates!

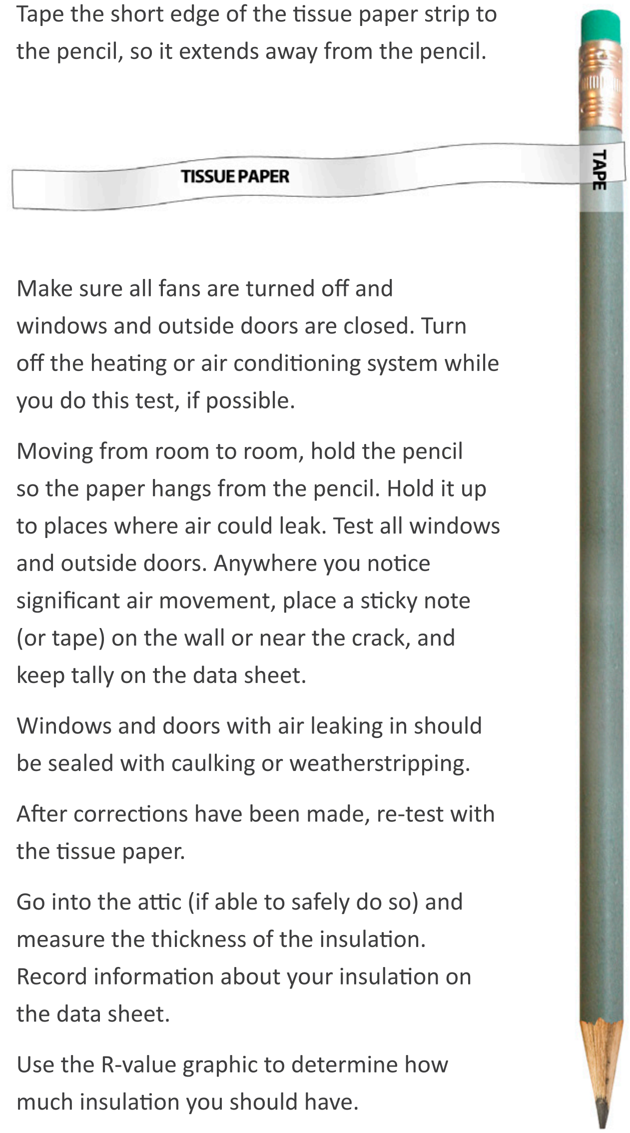
Materials

- Tissue paper strip or strip of plastic wrap
- Pencil
- Tape
- Sticky notes
- Ruler



Procedure

1. Tape the short edge of the tissue paper strip to the pencil, so it extends away from the pencil.

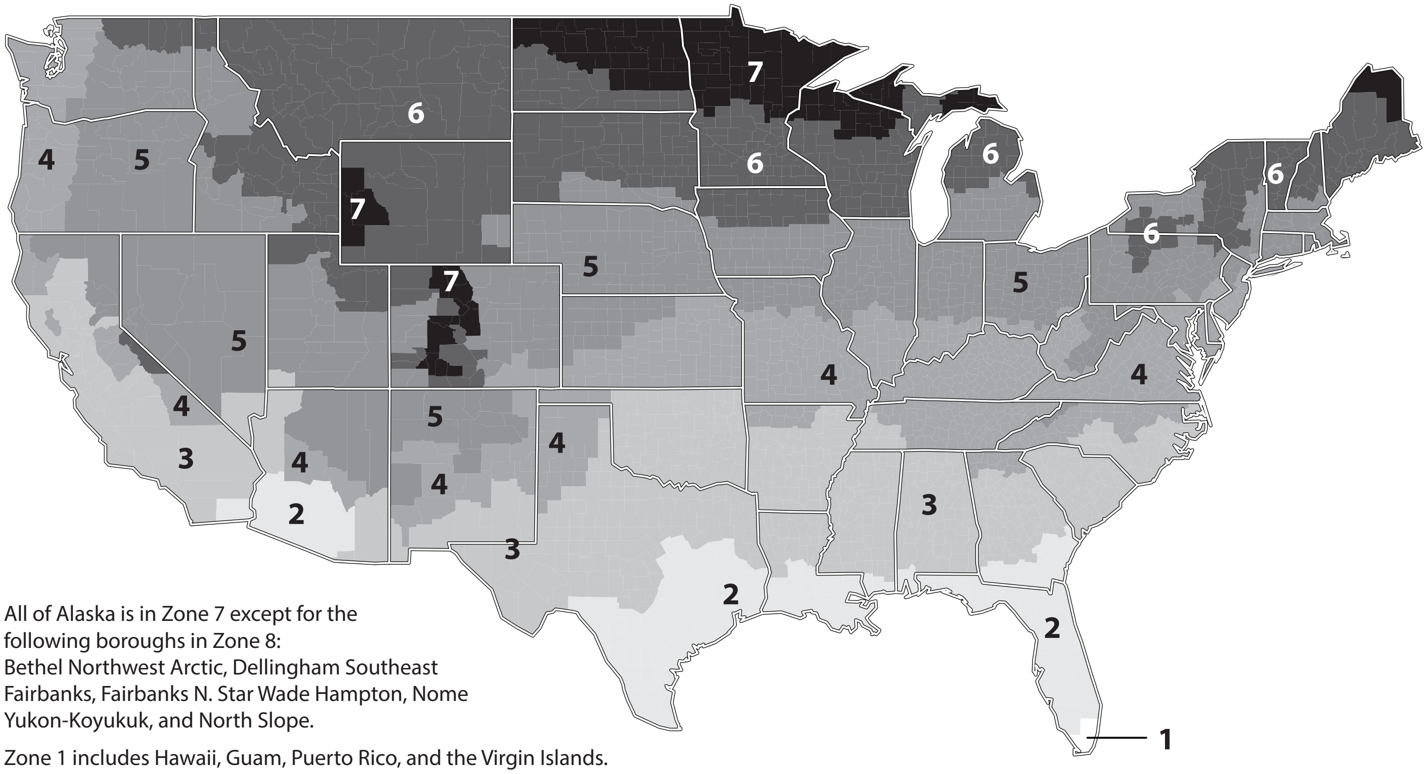


2. Make sure all fans are turned off and windows and outside doors are closed. Turn off the heating or air conditioning system while you do this test, if possible.
3. Moving from room to room, hold the pencil so the paper hangs from the pencil. Hold it up to places where air could leak. Test all windows and outside doors. Anywhere you notice significant air movement, place a sticky note (or tape) on the wall or near the crack, and keep tally on the data sheet.
4. Windows and doors with air leaking in should be sealed with caulking or weatherstripping.
5. After corrections have been made, re-test with the tissue paper.
6. Go into the attic (if able to safely do so) and measure the thickness of the insulation. Record information about your insulation on the data sheet.
7. Use the R-value graphic to determine how much insulation you should have.

Activity 1 | Seal of Approval

CONTINUED

Recommended R-Values for New Wood-framed Homes



All of Alaska is in Zone 7 except for the following boroughs in Zone 8:
Bethel Northwest Arctic, Dellingham Southeast Fairbanks, Fairbanks N. Star Wade Hampton, Nome Yukon-Koyukuk, and North Slope.

Zone 1 includes Hawaii, Guam, Puerto Rico, and the Virgin Islands.

ZONE	ATTIC	CATHEDRAL CEILING	WALL INSULATION: CAVITY	WALL INSULATION: INSULATION SHEATHING	FLOOR
1	R30 to R49	R22 to R38	R13 to R15	None	R13
2	R30 to R60	R22 to R38	R13 to R15	None	R13, R19 to R25
3	R30 to R60	R22 to R38	R13 to R15	R2.5 to R5	R25
4	R38 to R60	R30 to R38	R13 to R15	R2.5 to R6	R25 to R30
5	R38 to R60	R30 to R60	R13 to R21	R2.5 to R6	R25 to R30
6	R49 to R60	R30 to R60	R13 to R21	R5 to R6	R25 to R30
7	R49 to R60	R30 to R60	R13 to R21	R5 to R6	R25 to R30
8	R49 to R60	R30 to R60	R13 to R21	R5 to R6	R25 to R30

Data: U.S. Department of Energy

Activity 1 | Seal of Approval

CONTINUED

Data

Results of air infiltration test:

__________ windows leaked _____________ doors leaked

Notes:

__________ windows sealed _____________ doors sealed

Notes:

Results of attic insulation inspection:

Thickness of insulation: ________________

Type of insulation: _________________

R-value of this thickness and type of insulation (see chart)
__________ inches thick × __________ R-value/inch = ___________ R-value

Recommended R-value for your attic (see table on page 10): ______________

What You See		What It Probably Is	R-value/ inch
Loose fibers	Lightweight yellow, pink, or white	Fiberglass	2.5
	Dense gray or near white, may have black specks	Rock wool	2.8
	Small gray flat pieces or fibers (newsprint)	Cellulose	3.7
Granules	Lightweight	Vermiculite or perlite	2.7
Batts	Lightweight yellow, pink, or white	Fiberglass	3.2

Source: Insulation Fact Sheet, Oak Ridge National Laboratory

Discussion

1. If your home is underinsulated, you can save energy costs immediately by adding insulation. The Energy Calculator from Lawrence Berkeley National Laboratory (http://hes.lbl.gov/consumer) can help you determine what you need to add. Do you need additional insulation? How much do you need?
2. Homes should not be sealed and 100% air-tight. As a household, discuss why a small amount of fresh air is needed in your home.
3. For additional information and insulation pointers, download the Insulation Fact Sheet from Oak Ridge National Laboratory: http://web.ornl.gov/sci/buildings/docs/factSheets/Insulation-FactSheet-2008.pdf

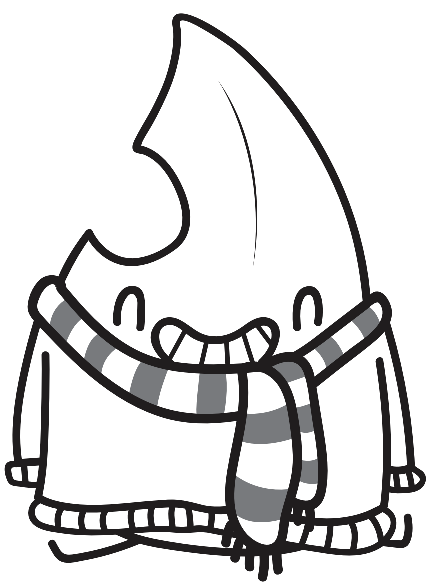
Activity 2 | We Can't Take the Heat

Staying comfortable is an important part of why we use energy. However, in our quest for comfort, we can end up using more energy than is necessary. It's always a balance between energy savings and individual comfort when setting the thermostat. The U.S. Department of Energy has determined that 68°F is a good winter setting that keeps most people comfortable while keeping energy use low. The recommended summer setting is 78°F.

Keeping food fresh and safe from spoilage is another important reason we use energy. However, sometimes the refrigerator is set cooler than is necessary. To safely store food, the refrigerator should be 35–40°F and the freezer attached to your refrigerator should be 0–5°F. A stand-alone freezer should be at or below 0°F. Also, make sure the seal around the refrigerator and freezer doors is tight to keep the cold air in and the warm air out.

Materials

- Fridge thermometer
- Dollar bill
- Empty jar or large plastic cup
- Scrap paper



Procedure

1. Open the refrigerator door, hold the dollar bill against the edge of the door, and close the door so the dollar bill is trapped between the seal and the refrigerator. Pull on the dollar bill. Take note of how easily it moves towards you, if at all. Repeat in multiple areas of both the refrigerator and freezer doors.
2. Place the fridge thermometer in a glass of water inside the refrigerator and close the door. Leave it in the refrigerator at least three hours, then record the temperature. Repeat for the freezer, carefully chipping away the ice to read the thermometer, if necessary.
3. Consult your refrigerator's setting knob or display to adjust the temperature, if needed. Make small adjustments and wait 24 hours before re-checking the temperature. Adjust as often as necessary to reach the safety zone for food (35–40°F for refrigeration, 0–5°F for freezers).
4. Hold a contest for a week. The prize can be something as simple as not having to help with dishes for the weekend. Set the thermostat to 68 °F. Every time you put on a sweater or a warm pair of socks or slippers, or wrap up with a blanket, instead of turning up the heat or turning on a space heater, write your name on a piece of scrap paper and place it in the jar or cup. The person whose name is in the jar the most at the end of the week wins! If you are in a warm climate, conduct the same competition by keeping the air conditioner set at 78 °F and recording how many times you change into cooler clothes, use a small fan, or have a cold drink to cool off.

Discussion

1. How easily did the dollar bill pull out from the refrigerator door? If it slips out easily, the seal needs replacing. Most manufacturers sell replacement seals for their appliances. A local appliance parts store, or online retailers of appliance parts, can provide a replacement if you have the brand name and model number. Your appliance retailer will tell you how to locate the model number, which is often on the inside of the door.
2. Who won your thermostat contest? How long did it take during the week before the temperature felt comfortable? What else can you do to use less energy on heating or cooling?

Lesson 3 | Electricity

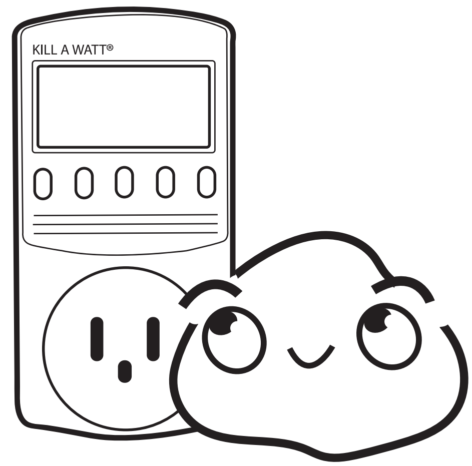
Electricity accounts for up to 70% of a home's energy use. While much of that electrical energy is used to run large appliances like refrigerators and air conditioners, the multitude of small appliances and electronics that we use every day can add up to big energy expenditures, if we are not careful about how we use them.

The electric power used by a device is measured in watts (W), which is calculated by multiplying the current by the voltage. Most household electrical devices run on 120 V circuits; the exceptions are big items like stoves and clothes dryers. The wattage of electrical devices and electronics can be determined by looking at the Underwriter Laboratories (UL) label on the device. It will list the maximum energy consumed, often in watts but sometimes as current and volts.

Electric utilities meter the energy we use by charging us for kilowatt-hours. A kilowatt is a thousand watts; therefore a kilowatt-hour is the energy needed to power 1,000 watts for one hour. The national average residential electricity rate is roughly $0.13 per kilowatt-hour, but your rate may be higher or lower. You can determine your electricity rate by looking at your utility bill. Determining how much it costs to run devices is easily accomplished when the power of the device and your electricity rate are known.

Some devices use electricity even when turned off. Electronics with a remote control, such as a DVD player or television, use power all the time. Microwave ovens with LED clocks, and any other device with an internal clock, also use power constantly. These are called phantom loads because the device appears to be turned off, but it is actually using energy. A smart power strip can eliminate phantom loads by turning off the power to everything plugged into it. Phantom loads are also eliminated by unplugging the device when it is not in use.

A Kill A Watt® meter is a great tool for measuring the amount of power being used by devices in your home. They are a relatively inexpensive purchase, and many local libraries have them available to borrow at no charge. Some local utilities make them available to their customers, too.



Activity 1 | Morning Money Crunch

How much does it cost to get ready every morning? You know how much your clothes and food cost. What about the energy you use?

Materials

- Access to UL label on electrical devices
- Calculator
- Clock or timer

Procedure

1. Use the list on the next page and check off the devices you use almost every morning when getting ready for your day. Add other devices not listed on an additional page or transfer your list to a spreadsheet.
2. Where practical, use the UL label on each device you use to find the power that it uses in watts. You may have to record the current from the UL label and then multiply by 120 V to get the power in watts.
3. If you cannot easily access the UL label, use the table on the top off the next page to determine how much energy the average device uses.
4. Use a timer or clock to determine how many minutes each device is in use.
5. Divide the time in minutes by 60. Record this number to two decimal points as the number of hours in the table.
6. Multiply the watts of the device by the number of hours, then divide by 1,000 to get the kilowatt-hour (kWh) for each device.
7. Read your electric bill to determine the rate you are charged per kWh. If you don't know this, use the national average of $0.13/kWh.
8. Multiply the kWh of each device by the cost of electricity for the cost to run that device.
9. Add the "cost to use" column for each of the devices to determine how expensive your morning is. Multiply by 5 for a work week, or by 7 if you do these same things on the weekend. How expensive is your week?
10. Multiply the weekly charge by 52 to determine the yearly cost for getting ready in the morning. If it is a device you don't use all year, estimate and multiply by the number of weeks it is used.

Activity 1 | Morning Money Crunch *CONTINUED*

Average Kilowatt-hour Consumption for Common Household Devices

Device	Estimated Energy Usage
Alarm clock	3 kWh/month
Cell phone	0.08 kWh/month
Clothes dryer	3.2 kWh/load
Clothes washer	3.5 kWh/load
Coffee maker	0.4 kWh/hr
Computer	0.05 kWh/hr
Curling iron	0.05 kWh/hr
Dishwasher	1.5 kWh/load
Electric toothbrush	0.08 kWh/month
Fan	0.03 kWh/hr
Fitbit	0.08 kWh/month
Freezer	90 kWh/month

Device	Estimated Energy Usage
Garage door opener	0.01 kWh/up-down cycle
Hair dryer	1.5 kWh/hr
Internet router or modem	0.15 kWh/day
Iron	1.08 kWh/hr
Microwave	0.12 kWh/5 min
Radio	0.02 kWh/hr
Refrigerator	150 kWh/month
Stove	1.25 kWh/hr
Straightening iron	0.05 kWh/hr
Toaster	0.04 kWh/use
TV	0.2 kWh/hr
Well pump (2 HP)	1.5 kWh/hr

Source: Silicon Valley Power, National Grid

Data Table – Your Morning

Device	Power (W)	Minutes used	Hours used	kWh total	Electricity rate	Cost to use
Alarm clock (example)	2.0	60	1.00	0.002	$0.13	$0.0003
Cell phone						
Clothes dryer						
Clothes washer						
Coffee maker						
Computer						
Curling iron						
Dishwasher						
Electric toothbrush						
Fan						
Fitness tracker						
Freezer						
Garage door opener						
Hair dryer						
Internet router or modem						
Iron						
Microwave						
Radio						
Refrigerator						
Stove						
Straightening iron						
Toaster						
TV						
Well pump (if you have a well)						

Activity 1 | Morning Money Crunch

CONTINUED

Discussion

1. How much does it cost to get ready every morning? $______________

   How much does it cost to get ready every morning for a year? $______________
2. What is the most expensive part of your morning?
3. Which parts of your morning are more expensive than you thought they would be?
4. Which parts of your morning are less expensive than you thought they would be?
5. Are there items you didn't include on the list? List these below. How do you think they compare in cost to others on the list?
6. Name three things you can do to reduce the cost of your morning. Calculate how much money you can save.

Activity 2 | (R)Amp Up the Efficiency

There are some things that use energy that nearly all of us must do. We all wash clothes, keep perishable food cold, and cook raw foods before eating them. All of these require energy, but we don't all use energy equally. The amount of energy used to do a task is related to the efficiency of the machine doing the task. Essentially, efficiency is the proportion of useful energy out of a machine compared the amount of energy going in. More efficient machines do the same work as less efficient machines, but use less energy to do the work.

Often the more efficient appliances have a higher purchase price, and this may mislead some into thinking they're more expensive overall. However, look for the EnergyGuide label, which allows you to compare the efficiency of different appliances and electronics. The EnergyGuide label often shows a more efficient appliance is less expensive to operate, and over time the difference in operating cost can more than make up for the difference in purchase price. This is called the payback period, and it is the amount of time required for the lower operating cost to make up for the higher purchase price. This is an important factor to consider when shopping for an appliance.

ENERGY STAR® rated appliances and electronics are the most efficient of their class. When you purchase an ENERGY STAR device, you know that you are buying the most efficient product available.

Materials

- Internet access to an appliance retailer or a trip to an appliance store
- Calculator

Procedure

1. Decide what appliance or electronic device you want to comparison shop. Some good suggestions are refrigerators, water heaters, washing machines, televisions, and computers.
2. Find two very similar appliances to compare. Make sure they are the same size or capacity. For example, the same number of gallons for a water heater, or the same style and size of refrigerator. Make sure one is ENERGY STAR rated, and the other is not.
3. Record the purchase price for each item.
4. Locate the EnergyGuide label for each item and record the annual energy use and operating cost for each.
5. Calculate the life cycle cost for both devices through 10 years of operation.

Activity 2 | (R)Amp Up the Efficiency

CONTINUED

Data

Appliance or electronic device: ___________________________________

Based on standard U.S. Government tests

ENERGYGUIDE

Appliance:

Brand:

Size:

Model:

Compare the energy use of this appliance with others before you buy.

This model uses

Energy use range of all similar models

Uses Least Energy

Uses Most Energy

Based on standard U.S. Government tests

ENERGYGUIDE

Appliance:

Brand:

Size:

Model:

Compare the energy use of this appliance with others before you buy.

This model uses

Energy use range of all similar models

Uses Least Energy

Uses Most Energy

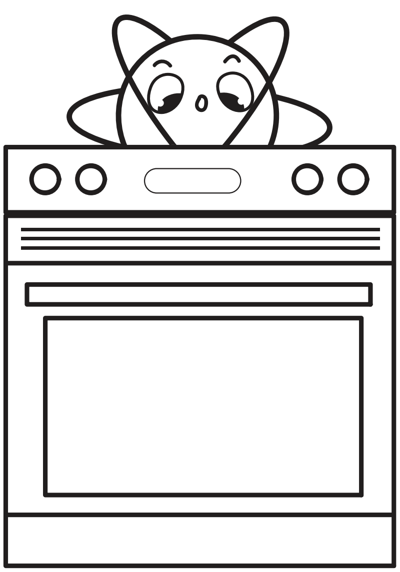
APPLIANCE 1	EXPENSES	COST TO DATE		APPLIANCE 2	EXPENSES	COST TO DATE
Purchase Price				Purchase Price		
Year 1				Year 1		
Year 2				Year 2		
Year 3				Year 3		
Year 4				Year 4		
Year 5				Year 5		
Year 6				Year 6		
Year 7				Year 7		
Year 8				Year 8		
Year 9				Year 9		
Year 10				Year 10		

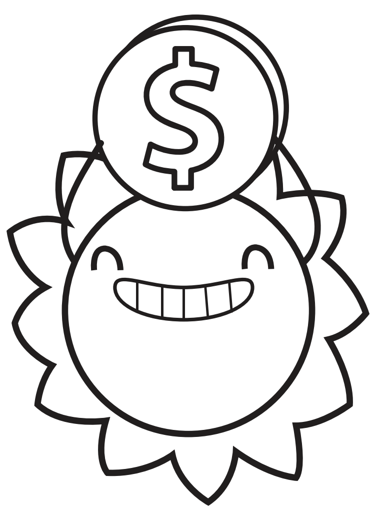
Activity 2 | (R)Amp Up the Efficiency

CONTINUED

Discussion

1. What is the payback period for the device you selected? ____________________
2. How long do most people own this device before replacing it? Does this payback period make sense for you and your household?
3. What are some other factors, besides purchase price, that you should consider when shopping for appliances or electronics?





Lesson 4 | Lighting

In 1879, Thomas Edison perfected the incandescent light. For the next 100+ years, lighting did not change much. The materials and bulb life improved, but the functionality of light bulbs in American households went largely unchanged for more than a century. However, incandescent light bulbs are exceptionally inefficient light makers, using only 10% of the electricity input to produce light! The other 90% of energy used by an incandescent is wasted as heat energy.

In 2007, the Energy Independence and Security Act was passed, and among other things it mandated improved efficiency in light bulbs sold in the United States. Today, compact fluorescent lights (CFL) and light-emitting diode (LED) lights are much more affordable and commonplace than they were even 10 years ago. As technology has improved and production increased, the cost of these bulbs reduced to the point that now they are just as affordable as traditional, inefficient incandescent light bulbs.

When shopping for a light bulb, consider two important pieces of information, both of which are found on the lighting facts label of the bulbs. The first is how many watts of power the bulb uses to produce light. This will tell you how expensive the bulb will be to operate. The second is how many lumens of light are produced. Always compare lumens produced when comparing one bulb to another. You may also find it useful to look at color temperature, which indicates the color of the light produced. Higher temperatures are brighter, bluer light while lower color temperatures are softer, more reddish or yellow light.

Activity 1 | This Is Your Light!

Sometimes it's easy to just grab the least expensive light bulb and be done with it. A light bulb is a light bulb, right? Well, not exactly. Some bulbs are a little more expensive than others, but they also last much longer. This activity will help you consider the entire life cycle cost of different light bulbs to use in your home.

Materials

- Internet access to a light bulb retailer, a trip to a light bulb retailer, or the packages of light bulbs you have already recently purchased
- Your home's electricity cost per kilowatt-hour (from your electric bill)
- Calculator

Procedure

1. Choose a halogen incandescent (halogen), a CFL, and an LED bulb that each produce about the same number of lumens of light. You can find this information in the lighting facts label on the package.
2. Record the watts, lumens, expected life, and purchase price of each bulb.
3. Circle the life span for the bulb that will last the longest. This is the number to which you will standardize all of your other calculations. In other words, if the LED bulb will last 25,000 hours, and this is the longest life span of all of the bulbs, all other light bulbs must be calculated to 25,000 hours. This ensures a fair comparison.
4. Determine how many light bulbs of the other types are needed to equal the life of the longest-lasting bulb. Record this in the table.
5. Multiply the purchase price per bulb times the number of bulbs needed to give the standardized hours of light. This is the total purchase price.
6. Convert watts to kilowatts in the data table by dividing the wattage of each bulb by 1,000.
7. Multiply kilowatts by the life span to which you are standardizing (25,000 in the example). This is the total energy used in kilowatt-hours by each bulb.
8. Multiply kilowatt-hours by the rate your utility charges, rounding to the nearest cent. This is the operation cost of each bulb for the stated number of hours of light.
9. Add the operating cost to the purchase price to get the entire life cycle cost for each type of light bulb.

Activity 1 | This Is Your Light!

CONTINUED

Data




	INCANDESCENT BULB	HALOGEN	CFL	LED
Lumens				
Watts				
Expected life span				
Cost for one bulb				
Number of bulbs needed				
Purchase price				
Watts (copied from above)				
Kilowatts				
Hours of operation (copied from circled value above)				
Total kilowatt-hours				
Electricity rate (from utility bill)				
Operating cost				
Purchase price (copied from above)				
Total life cycle cost				

Discussion

1. Which light bulb is the least expensive when accounting for the entire life cycle cost?

2. Many utilities sell efficient light bulbs at a reduced cost. How many light bulbs can you replace in your home to use a more efficient light style?

3. If you change five light bulbs, each for a more efficient bulb, how much money will you save over the life of the efficient bulbs?

Activity 2 | Shed a Little Light on Efficiency

Using efficient lighting uses less energy, which saves money. It also has a positive effect on the environment because efficient lighting reduces carbon dioxide emissions and landfill waste in burned-out light bulbs. Some people choose to go through their house and make a sweeping lighting change, but others are not financially able to replace all their lights at once. Additionally, some lighting applications need specialized light bulbs. For example, if your dining room has a dimmer switch, light bulbs compatible with a dimmer must be used. If the light is turned on and off several times in a day, a CFL bulb is not the best choice as turning one on and off repeatedly shortens the life span of a CFL. This activity will help your household decide where the most impact can be made by replacing inefficient light bulbs with more efficient bulbs.

Materials

- LED bulb
- Night-light
- Additional efficient bulbs as desired
- Calculator

Procedure

1. Room-by-room, list all of the lights in your home, noting the wattage and type of each bulb. Use additional sheets of paper, as necessary.
2. Estimate the number of minutes each bulb is on each day. Also note whether the light is subject to being turned on and off several times in a day, such as in a frequently used bathroom with no windows, or a closet. Put a star or check mark beside these bulbs.
3. Convert the minutes to hours, and calculate the kilowatt-hours for each bulb, as was done in Activity 1 of Lesson 3.
4. Discuss which lights would produce the greatest energy savings, if changed.
5. Replace additional bulbs with CFL or LED bulbs, as is practical or desired for your family.
6. Calculate the energy and monetary savings produced by replacing inefficient bulbs with efficient lights.

Data

Room	Light bulb location	Power (W)	Minutes used/day	Hours used/day	kWh total	Electricity rate	Cost/day

Activity 2 | Shed a Little Light on Efficiency

CONTINUED

Room	Light bulb location	Power (W)	Minutes used/day	Hours used/day	kWh total	Electricity rate	Cost/day

Discussion

1. What are the top three places to upgrade the light to a more efficient bulb? Why do you think that is the case?

2. Are there any places where lights could be used less often, as a conserving effort, until the light can be upgraded to a more efficient bulb?

3. Which bulbs do not need to be changed right away and can wait until the bulb burns out?

Lesson 5 | Home Systems

Up until this point, we've had you looking at individual systems within your home. However, the systems in your house all work together. The moisture level in your house can affect how warm or cool the house feels. Unless it's a particularly hot day, you probably take a shower with heated water. Washing machines and dishwashers use electricity to run, and heated water to clean. Even the lights in your home can impact the heating and cooling system if they emit a lot of heat.

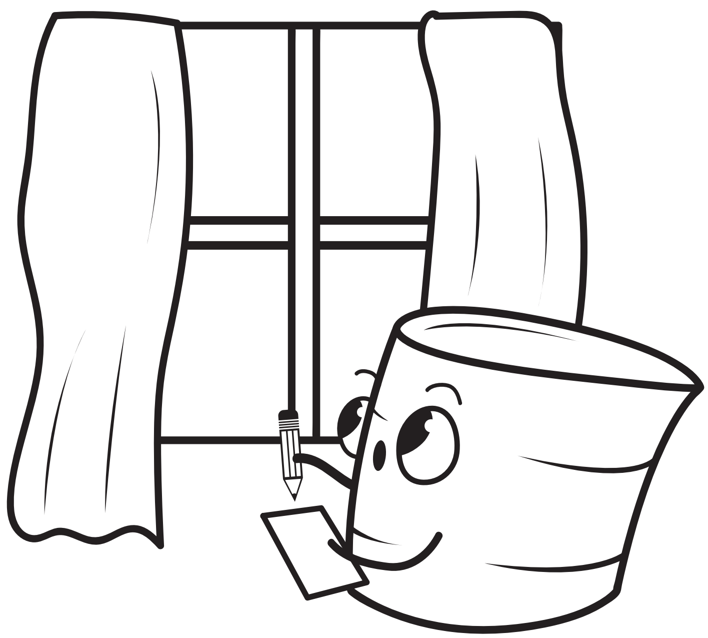
In this section, you will be evaluating each of the systems in your home, identifying their components, determining their approximate age where possible, and prioritizing which system(s) will get your attention first for an energy overhaul.

Some systems should be checked annually by a professional. Furnaces, air conditioners, and water heaters need periodic maintenance and inspection to make sure they are working properly and to ensure they continue to work when in high demand.

Other systems can be inspected and maintained by the homeowner. Water heaters need to be kept dust-free underneath so dust does not build up on vents. The coils of a refrigerator should also be vacuumed periodically to remove dust. Heating elements in an electric range should be replaced if damaged or misshapen. There are many other things you can do to extend the life of your appliances. Check appliance instruction manuals to see what you can do to make things run properly and last longer.

Activity 1 | Well, Well, Well, What Do We Have Here?

This activity has you checking all the systems in your house – heating, cooling, humidification, electrical appliances (large and small), electronics, and lighting – so that you can make decisions as a family about which require immediate attention and which can wait.



Materials

- Pen or pencil
- Vacuum cleaner with hose attachment
- Eyes, ears, and big muscles to move heavy objects

Procedure

1. Go through each section of the checklist on the next page and fill in the information about each system in your home.
2. As you encounter a buildup of dust on any system, vent, or device, use the vacuum cleaner to eliminate it. Also look for dust clinging to the side of machines that you can vacuum or sweep away.

Activity 1 | Well, Well, Well, What Do We Have Here?

CONTINUED

Checklist

Heating System

______ Central system ______ Individual room system

_____Forced air _____ Boiler/radiator system _____ Radiant floor heat

_____ Electric baseboard _____ Other system: ________________

Fuel of heating system (gas, electric, etc.): _________________________

Age of heating system: ___________________________ years

Date air filter was last replaced: ______________________

Date heating system was last serviced by HVAC professional: _____________________

Cooling System

_______ Central system ______ Individual room system (window units)

Age of cooling system: _________________ years

Date cooling system was last serviced by HVAC professional: ___________________

Humidification

_____ Central system attached to furnace _____ Room-sized system

_____ Central stand-alone system _____ None present

Date of last cleaning of humidifier: ___________________________

Water Heating System

Capacity of water heater: ____________ gallons or __________ tankless

Fuel of water heater: _____ gas _____ electric _____ solar _____ other

Water heater insulation: _____ none _____ blanket _____ other insulation

Date of last drain-and-fill of water heater (not for tankless systems): __________

Age of water heater: ___________________ years

Appliances

Age of refrigerator: ______________ years

Age of oven/cooktop/range: ____________ years Fuel: ____ gas _____ electric

Age of dishwasher: __________ years

Age of washing machine: ______ years Age of dryer: _____ years

---

Windows

Type of windows: _____ wood _____ vinyl _____ metal _______ other

Layers of glazing: _____ single _____ double _____ triple

Age of windows: __________ years

Condition of windows: _____ like new _____ some wear and tear _____ need work

---

Insulation

Type of attic insulation: _____ fiberglass _____ rock wool _____ vermiculite

_____ spray foam _____ cellulose _____ other

Type of wall insulation: _____ fiberglass _____ spray foam _____ polystyrene sheeting

_____ cellulose _____ other _____ unknown

Has the insulation been upgraded since the house was built? ____ yes _____ no

Activity 1 | Well, Well, Well, What Do We Have Here?

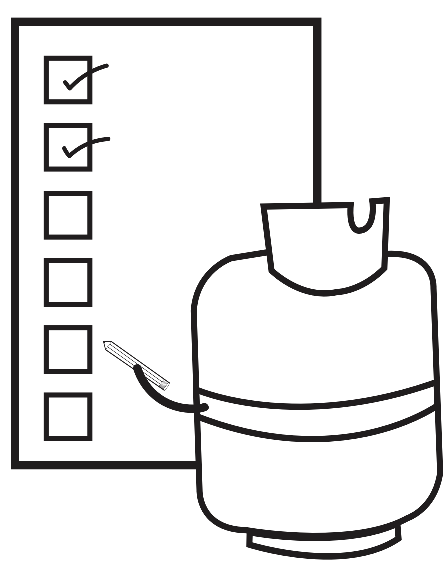
CONTINUED

Discussion

1. What items could use replacing?

2. Which items or systems may have an impact on other systems in your home. Why? How could making upgrades improve their function?

3. What items need more immediate attention?

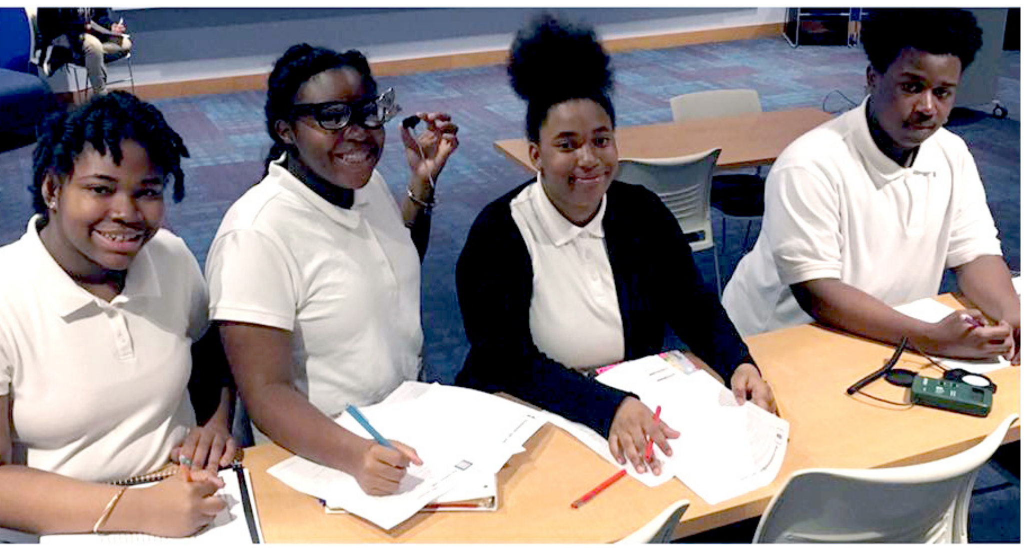


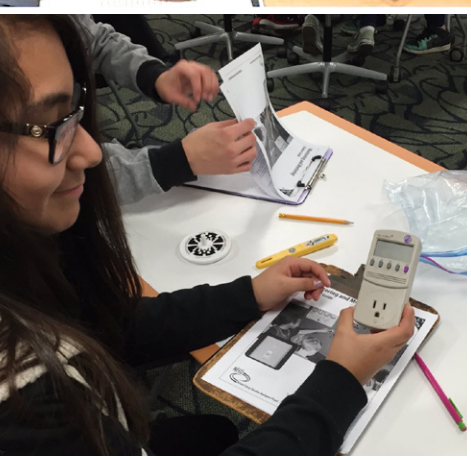
Lesson 6 | Home Energy Audits and Summary

If you look back through the activities you have already done in this unit, you will find that you have been evaluating how energy is used in your home on a system-by-system basis. Essentially, you have been auditing your home's energy use.

A trained Certified Energy Manager, or CEM, can conduct a professional audit of the energy use in your home. A professional energy audit begins with assessing how your home already uses energy. The CEM will use several tools to evaluate how much energy is being used, as well as looking at your utility bills and discussing with you the habits already in place. After making several observations and measurements, the CEM will then make a list of recommendations for reducing energy costs, starting with the least expensive to implement and working down to the most expensive. Included in the report is a calculated estimate of the energy savings, in dollars, if each recommendation is implemented.

Much of what you have done can be used as a very basic audit. However, a professional will take it a step further by looking at your home with an infrared imaging device to see where the walls may not be well insulated, as well as other tests to measure air infiltration, light levels, etc. Because you have already done some of the work of an energy audit, you can now also make some basic recommendations for your household to save money. Start with the least expensive, calculate how much money can be saved with each change, working your way to the most expensive to implement. Then decide as a group which of those recommendations you can actually put into practice.





Activity 1 | Re-rate Your Energy Use

At the beginning of this unit, you rated your energy use. Re-evaluate how you as a household use energy and see if your rating has improved. As a group, determine which answer to each statement – either column 1, 2, 3, or 4 – best matches the situation in your home now that you have learned how to be in more control of your energy use. Shade in the box that corresponds to the best match. Then calculate your home's final energy consumption score.

Energy Efficiency and Conservation at Home	4	3	2	1
Appliances That Are ENERGY STAR® Rated	All	More than half	About half	None
Lights That Are CFL or LED	All	Most	About half	Almost none or none
Electronics With Phantom Loads	None (unplugged)	About half	Most	All
Thermostat Setting During Heating Season	≤ 68	69–70	71–72	≥ 73
Thermostat Setting During Cooling Season	≥ 78	76–77	74–75	≤ 72
Laundry Loads Run Less Than Full	Never	Occasionally	About half	Usually
Dishwasher Run Less Than Full	Never	Occasionally	About half	Usually
Hot Water Setting (°F)	≤ 120	121–130	131–140	≥ 140
Doors and Windows Closed When Furnace or Air Conditioner Turned on	Always	Usually	Sometimes	Rarely
Lights Left on When Room Is Empty	Rarely	Sometimes	About half	Usually
Fans Left on Overnight	0	1–2	3–4	5+
TV's Left on Overnight	0	1	2	3+
Game Console or Computer Left Running	Never	Rarely	Occasionally	Frequently
Heating System Turned on When…	Temperature inside < 65	Temperature outside < 65	Temperature outside < 70	A/C not turned on
Cooling System Turned on When…	Temperature inside > 83 or not turned on/in use	Temperature outside > 83	Temperature outside > 80	Heat not turned on
Programmable Thermostat	Yes			No
Calculate Your Score				
Box Total (Number of Boxes Shaded per Column)				
Multiplied by...	×4	×3	×2	×1
Equals Column Total	=	=	=	=
Total Score (Add Together the Four Column Totals From Row Above)	**_______________ Initial Energy Consumption Score**			

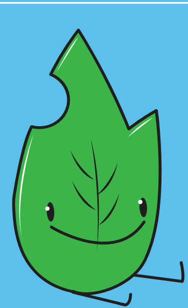
Discussion

1. A perfect household score is 64. What was your initial household score (copied from Lesson 1)? _______ What is your final household score? _______ By how many points did your score improve? _______
2. Has your score improved as much as it could? Why or why not? Where else can you improve as a group and further reduce the amount of energy you are using?
3. Develop a plan for improvements. List a timeline and perhaps place your plan in priority order by cost or importance, or both.

THE 10 ENERGY SOURCES

RENEWABLE

Fuels that can be easily made or replenished; we can never use up renewable fuels.

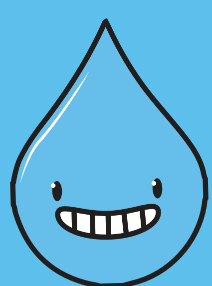


BIOMASS

Anything that is alive, or anything that was alive a short time ago is called biomass. Trees, crops, garbage, and animal waste are all biomass. Most of the biomass we use for energy today is wood.

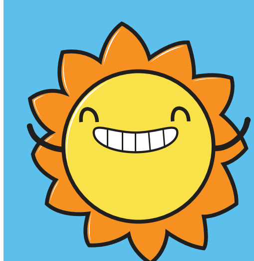
GEOTHERMAL

Geothermal energy is heat from inside the earth. The inside of the earth is very hot. Sometimes this heat comes near the surface. We can use this heat to warm our houses. We can generate electricity with it.



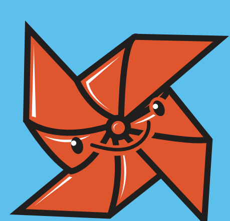
HYDROPOWER

Hydropower is energy created by moving water. Moving water has a lot of energy. We use that energy to generate electricity.



SOLAR

The sun provides lots of energy to the earth. We call it solar energy. It travels from the sun to the earth in rays. The energy from the sun makes rain fall, wind blow, and plants grow.



WIND

Wind is moving air. We can use the energy in wind to do work.

NONRENEWABLE

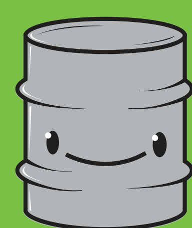
Fuels that cannot be easily made or replenished; we can use up nonrenewable fuels.

COAL

Coal was formed millions to hundreds of millions of years ago from plants. Coal is often shiny, black rock. Coal is a fossil fuel* that we burn for energy.

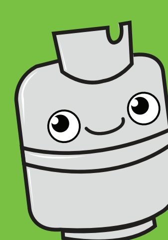
NATURAL GAS

Natural gas is a mixture of gases you can't see, smell, or taste. We often add an odor to it so we can smell it. It has a lot of energy in it. You can burn it to make heat. Natural gas is a fossil fuel.*



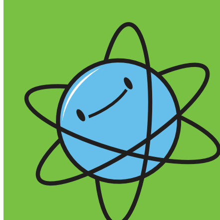
PETROLEUM

Petroleum is a liquid that is found underground. Sometimes we call it oil. Oil can be as thick and black as tar or as thin as water. Petroleum is a fossil fuel* that has a lot of energy we release when we burn it.



PROPANE

Propane is the gas we use to fuel our backyard grills and operate machines in warehouses. You cannot see it, smell it, or taste it, but you can burn it to produce heat energy. Propane is fossil fuel.*



URANIUM

Uranium is a mineral found in rocks in the ground. We split uranium atoms to release energy in nuclear power plants.

***FOSSIL FUEL:** Formed millions to hundreds of millions of years ago from the remains of living organisms. The plants and animals received their energy when they were alive from the sun. It was stored in them when they died.

Energy Math Challenge

This section has activities to enhance math skills and reinforce energy knowledge.
The answer key is provided on page 40.

Let's review some energy unit terms before we begin.

Btu — One British thermal unit is the heat energy needed to raise the temperature of one pound of water one degree Fahrenheit. A single Btu is quite small. A wooden kitchen match, if allowed to burn completely, would give off one Btu of energy. Every day, the average American uses 844,000 Btu to energy.

MBtu — An MBtu is equal to one million (1,000,000) Btu. The average American family consumes 983 MBtu of energy a year.

Quad — Quads are used to measure very large quantities of energy. A quad is equal to one quadrillion (1,000,000,000,000,000) Btu. The United States uses about one quad of energy every 3.75 days.

kWh — A kilowatt-hour is the amount of electricity used in one hour at a rate of 1,000 watts. Just as we buy gasoline in gallons and wood in cords, we buy electricity in kilowatt-hours. Utility companies charge their customers for the kilowatt-hours they use during a month. The average monthly electricity use in the United States is 908 kWh.

bkWh — A bkWh is one billion (1,000,000,000) kilowatt-hours. The U.S. consumes over 4,000 billion kilowatt-hours (bkWh) of electricity a year.

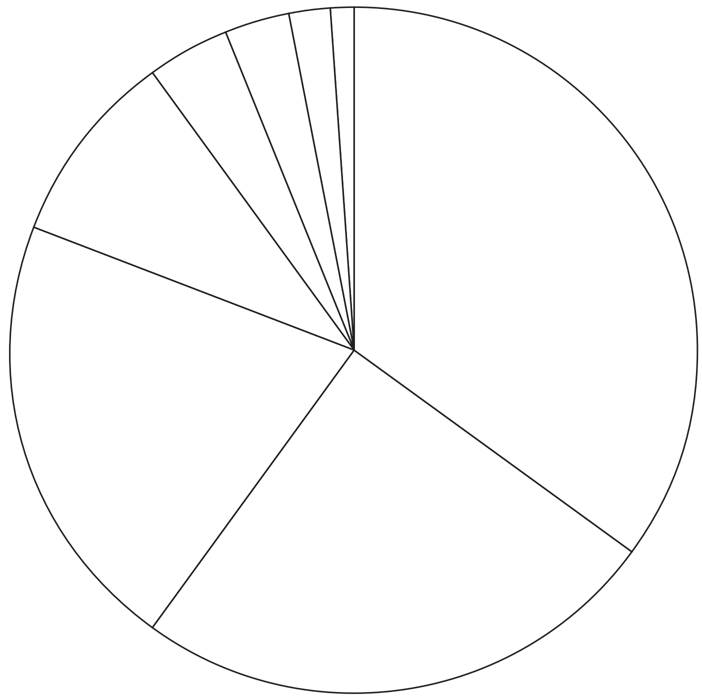
NEED
National Energy Education Development Project

Problem 1: Energy Source Use Circle Graph

Directions

Using the data below, label the sections of the circle graph.

Petroleum	35%
Natural Gas	25%
Coal	21%
Uranium	9%
Biomass	4%
Hydropower	3%
Propane	2%
Other (Solar, Wind, Geothermal)	1%



Directions

Using the graph and what you know about energy sources, answer these questions.

1. Which energy source provides the most energy?

2. What percentage are renewable energy sources?

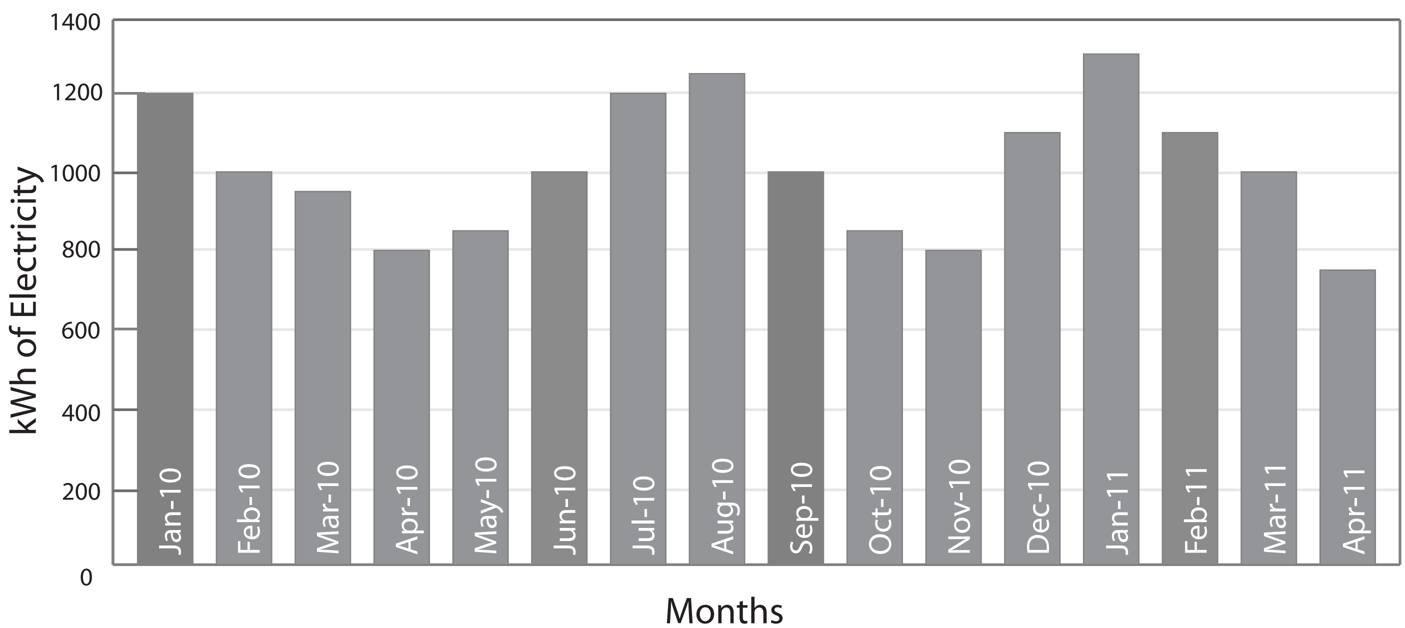
3. What percentage are nonrenewable energy sources?

4. What percentage of the energy sources are fossil fuels?

5. What percentage of the energy sources are found underground?

Problem 2: Electricity Use Chart

This is a graph of the Smith family's monthly electricity use for 2010 and part of 2011. The Smiths have an all-electric house.



Directions

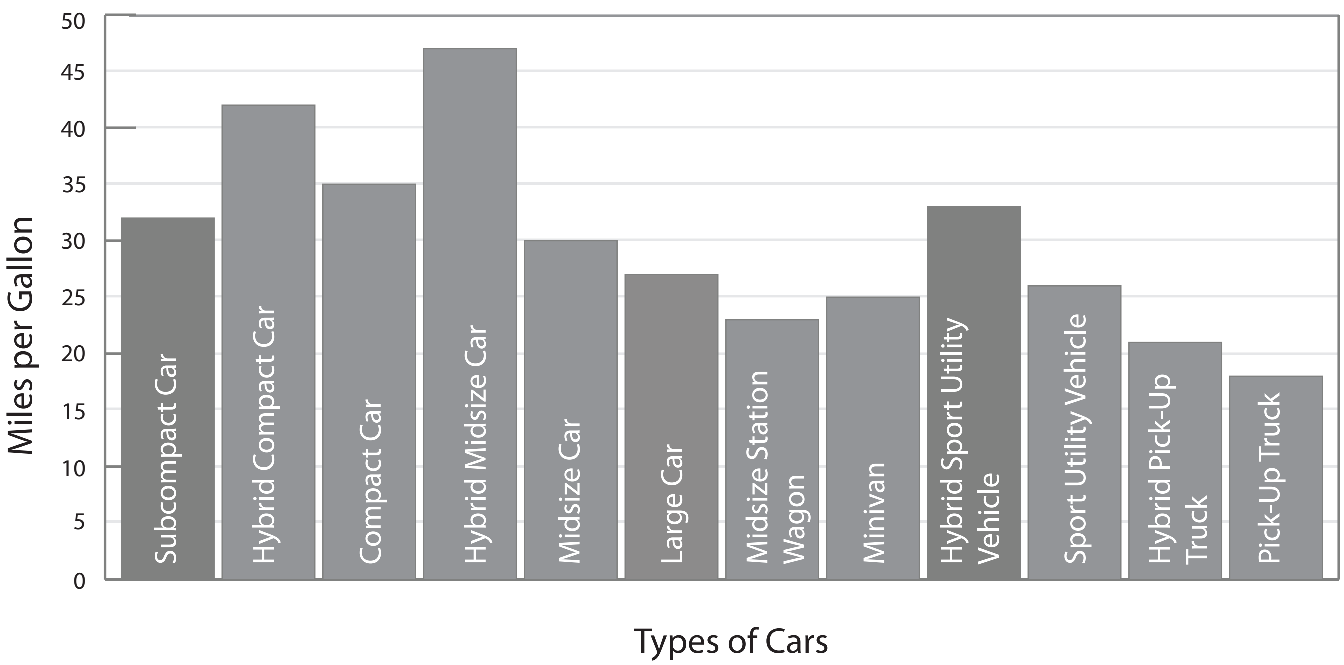
Using the graph, answer these questions.

In what month and year did the family use the most electricity?

1. In what month and year did the family use the least electricity?
2. What summer month and year do you think was the hottest?
3. How much more electricity did the family use in January 2011 than in January 2010?
4. How many kWh of electricity did the family use in 2010?

Problem 3: Fuel Economy Chart

This is a graph of the best gasoline mileage of different types of cars.



Directions

Using the graph, answer these questions.

1. What type of car gets the most miles per gallon?

2. What type of car gets the fewest miles per gallon?

3. How many miles can a compact car travel on two gallons of gasoline?

4. How many miles can a large car travel on three gallons of gasoline?

5. If a midsize car travels 60 miles, how many gallons of gas will it use?

BONUS: If the gas tank of a minivan can hold 20 gallons of gasoline, how far can it travel on a full tank of gasoline?

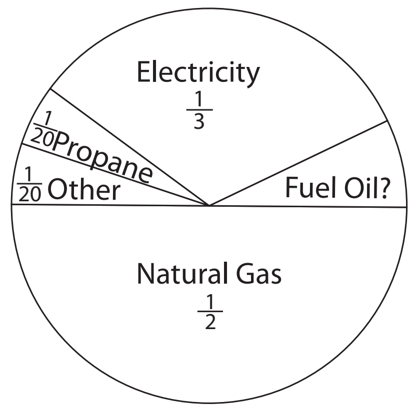
Round 1 Intermediate Math Challenge

1. The average American housing unit uses 45% of the total energy it consumes for heating and cooling rooms. Each month, 35 MBtu of energy are used for maintaining comfortable temperatures in our homes. How many MBtu of energy does the average housing unit consume each year for heating and cooling rooms?

Answer: ___________________________ MBtu

Round 1 Intermediate Math Challenge

2. Natural gas is often used for heating buildings and homes. In fact, natural gas heats half of the nation's housing units. Reduced to the lowest terms, what fraction of the housing units is heated by fuel oil?



Answer: ___________________________

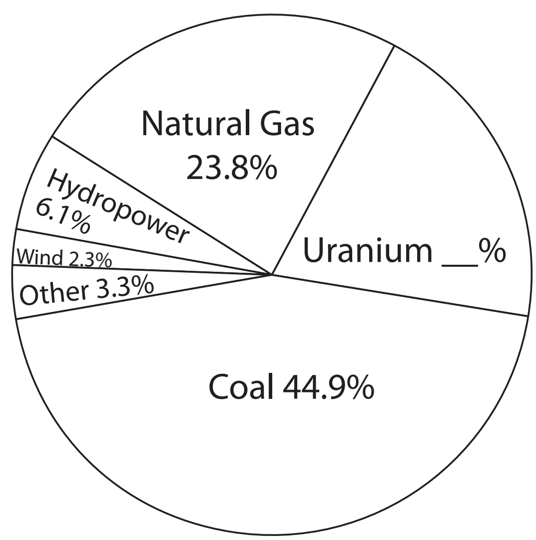
Round 1 Intermediate Math Challenge

3. The United States consumes more petroleum than it can produce. Today, the U.S. consumes 19.1 Million Barrels a Day (MBD) of petroleum – half of the petroleum is supplied by domestic production. To the nearest tenth, how many MBD are imported from other nations to supply America's demand for petroleum?

Answer: ___________________________ MBD

Round 1 Intermediate Math Challenge

4. What percentage of U.S. electricity in 2010 was generated by uranium?



2010 U.S. Electricity Production

Answer: ___________________________ %

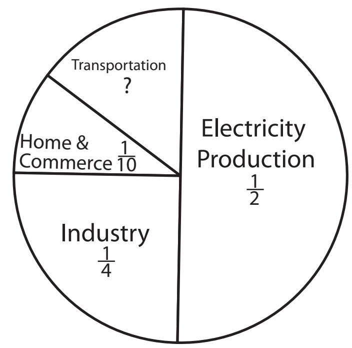
Round 2 Intermediate Math Challenge

1. Hydropower is a renewable source of energy. Hydropower provided 3.3% of the 98 quads of energy we consumed in 2010. Energy experts predict hydropower production will remain relatively constant during the next five years. How many total quads of energy will hydropower provide the nation during the next five years?

Answer: ___________________________ quads

Round 2 Intermediate Math Challenge

2. Renewables provide about 8% of the energy the U.S. consumes. The use of renewable energy sources to generate electricity accounts for half of their use. Reduced to the lowest terms, what fraction of the nation's renewables is used for transportation?



Answer: ___________________________

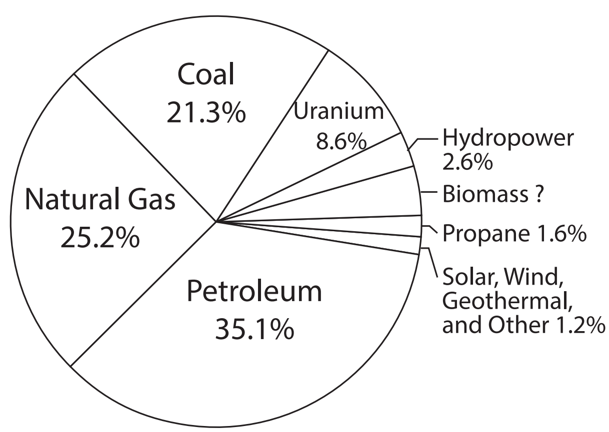
Round 2 Intermediate Math Challenge

3. Propane is 270 times more compact in its liquid state than it is as a gas. This makes propane a very portable source of heat energy. How many liters of propane gas would a three liter pressurized tank hold for your next camping trip?

Answer: ___________________________ liters

Round 2 Intermediate Math Challenge

4. From the graph, what percentage of total energy consumption is provided by biomass?



Answer: ___________________________ %

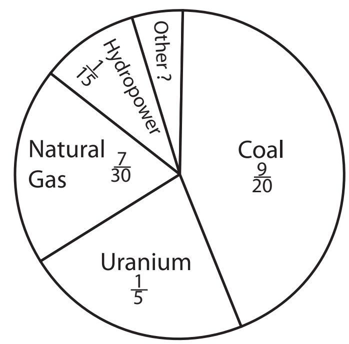
Round 3 Intermediate Math Challenge

1. The United States imports about half of its petroleum from other countries. The average daily import is 11.75 million barrels. How many barrels of petroleum would the nation import during the month of March?

Answer: ___________________________ barrels

Round 3 Intermediate Math Challenge

2. Coal generates almost half the nation's electricity. Uranium, hydropower, and natural gas produce significant amounts, too. Reduced to the lowest terms, what fraction of electricity is provided by the other energy sources?



Answer: ___________________________

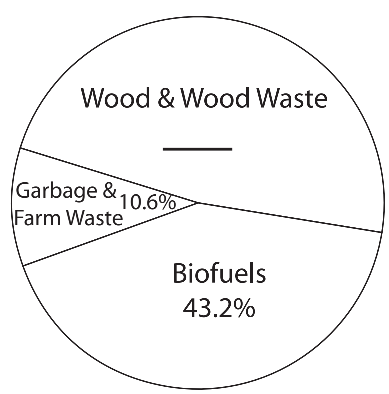
Round 3 Intermediate Math Challenge

3. About 6/7 of the energy given off by the splitting of uranium atoms is due to the motion of the splitting atoms. The other 1/7 of the heat energy is a result of the radiation released. Uranium provides the nation with 8.44 quads of energy a year. How many quads of energy are the result of the **radiation** released by the splitting uranium atoms?

Answer: ___________________________ quads

Round 3 Intermediate Math Challenge

4. From the graph, what percentage of the nation's consumption of biomass energy is provided by wood and wood waste?



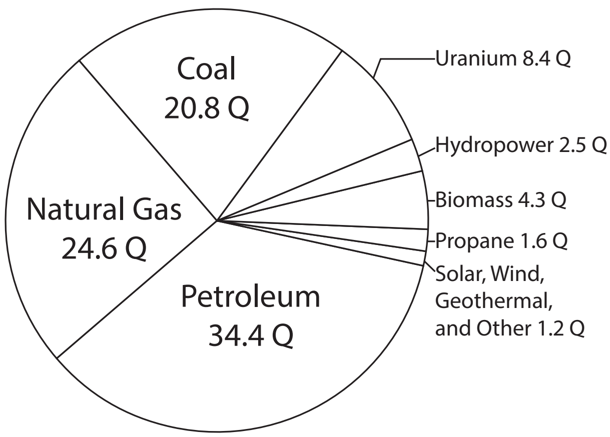
Answer: ___________________________ %

Math Challenge

Mega Question – Intermediate

Almost all the energy we use in the United States comes from nonrenewable energy sources. Using the circle graph below, determine how many total quads (Q) of energy we used in 2010, and how many quads were provided by renewable and nonrenewable sources. Write your answers in the spaces below.

2010 Consumption



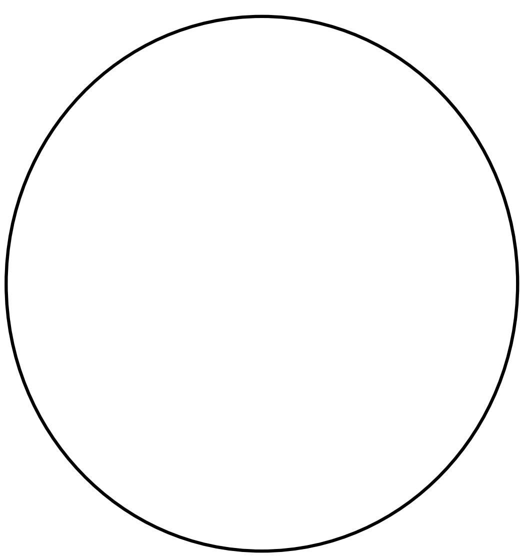
2010

Renewable:	**quads**
Nonrenewable:	**quads**
Total energy use:	**quads**

2035 Consumption

By 2035, experts predict that the United States will use 20% more energy than we did in 2010. Calculate how many total quads of energy the United States will use in 2035 and write it in the space below.

Will we use the same sources to provide that energy or will we use different sources? Fill in the blank circle graph using your predictions. The blank circle graph is 20% larger to show you what this increase looks like.



2035

Renewable:	**quads**
Nonrenewable:	**quads**
Total energy use:	**quads**

Round 1 Secondary Math Challenge

1. The United States consumes about 4,120 billion kilowatt-hours (bkWh) of electricity a year. Uranium fuels about 807 bkWh of this electrical power generation. To the nearest tenth of a percent, calculate the percentage of the nation's electricity that is generated by uranium in nuclear power plants.

Answer: ___________________________ %

Round 1 Secondary Math Challenge

2. Approximately 57% of the nation's 114 million housing units are heated by natural gas. To the nearest million, how many housing units in the nation are heated by natural gas?

Answer: ___________________________ units

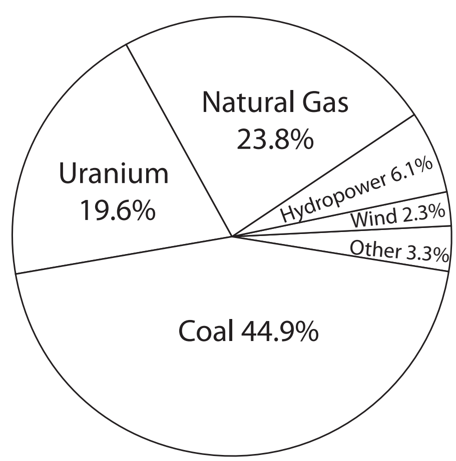
Round 1 Secondary Math Challenge

3. Today's power plants convert about one-third of the energy stored in fuels into electricity. During these conversions, most of the energy is transformed into heat rather than electricity. A certain electric power plant consumes 360 units of energy every day. How many units of electricity would the plant actually generate in a week?

Answer: ___________________________ units

Round 1 Secondary Math Challenge

4. The United States consumes about 4,120 bkWh of electricity a year. To the nearest bkWh, how many bkWh of electricity does natural gas provide?



2010 U.S. Electricity Production

Answer: ___________________________ bkWh

Round 2 Secondary Math Challenge

1. The United States consumes about 19.1 million barrels of petroleum a day. Gasoline, the number one product produced by the refining of petroleum, consumes 8 million barrels of the petroleum. To the nearest percent, calculate the percentage of petroleum that is refined into gasoline.

Answer: ___________________________ %

Round 2 Secondary Math Challenge

2. Hydropower, biomass, wind, and solar energy are all a result of the sun's rays striking the earth. Geothermal energy, which provides 2.6% of the nation's renewable energy, is the only renewable source resulting from energy found below the earth's surface. All five renewable sources of energy provide the nation with about 8 quads of energy. To the nearest tenth of a quad, how many quads of energy are a result of the sun's rays striking the earth's surface?

Answer: ___________________________quads

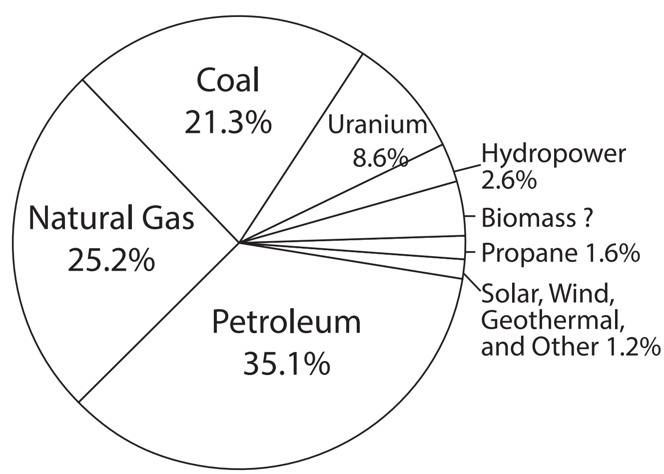
Round 2 Secondary Math Challenge

3. A 42 gallon barrel of petroleum is refined into kerosene, jet fuel, heating oil, and gasoline (the number one product). About 19.4 gallons per barrel are refined into gasoline. A tanker containing 920 million barrels of petroleum has unloaded its cargo at the refinery. To the nearest million, how many barrels of petroleum from the tanker will be refined into gasoline?

Answer: ___________________________ barrels

Round 2 Secondary Math Challenge

4. The United States consumes about 98 quads of energy a year. How many quads of energy does biomass provide?



Answer: ___________________________ quads

Round 3 Secondary Math Challenge

1. To generate electricity, a fossil fuel power plant consumes 72 units of chemical energy stored in the fossil fuel. Only 26 units of electrical energy are actually produced and sent out over the transmission lines. This loss occurs because a large amount of the energy stored in a fossil fuel is changed into thermal (heat) energy during the generation of electrical power. To the nearest whole percent, calculate the efficiency of this power plant at converting chemical energy into electrical energy.

Answer: ___________________________ %

Round 3 Secondary Math Challenge

2. The average American family consumes approximately 983 million Btu (MBtu) of energy a year. Heating and cooling rooms accounts for 54% of total household energy use, operating appliances and lights accounts for 37%, and heating water accounts for 18%. To the nearest MBtu, how many MBtu of energy are consumed by the average household for heating and cooling rooms in one year?

Answer: ___________________________MBtu

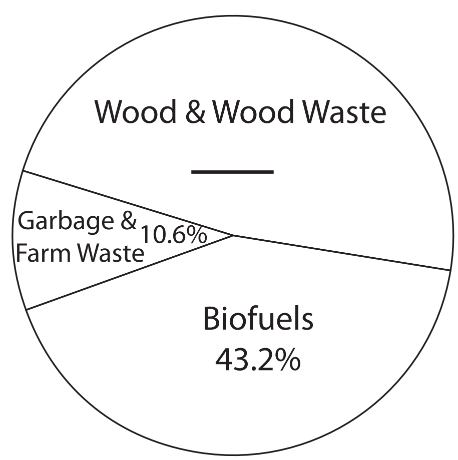
Round 3 Secondary Math Challenge

3. When uranium atoms are split, they give off heat. This heat produces high pressure steam that turns a turbine in a nuclear power plant. Each year, the nation's 104 nuclear reactors generate about 807 bkWh of electricity – 20% of total U.S. electricity production. To the nearest hundredth of a bkWh, how many bkWh of electricity does the average U.S. nuclear reactor generate a month?

Answer: ___________________________ bkWh

Round 3 Secondary Math Challenge

4. Biomass provides the nation with 4.3 quads of energy. How many quads of biomass energy are provided by wood and wood waste?



Answer: ___________________________quads

Electric Connections

U.S. ELECTRIC POWER GENERATION SOURCES

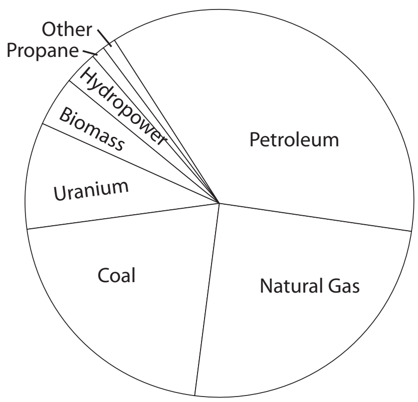
The United States is becoming more dependent on electricity to meet its energy needs. Almost 40% of the nation's energy is used to make electricity and experts predict that this figure will continue to increase. To meet the growing demand, many energy sources are used to generate electricity.

In the "Your Rank" column, place a number for each source from 1 (provides the most amount of electricity) to 10 (provides the least amount of electricity). After you have finished, use the numbers found in the answer key to fill in the "EIA's Rank" column and see how you did!

SOURCE	STATISTICS	YOUR RANK	EIA'S RANK
BIOMASS	In 2017, biomass produced 62.8 billion kilowatt-hours of electricity, 1.6% of the nation's total. Biomass electricity is usually the result of burning wood waste, landfill gas, and solid waste.		
COAL	Over 91% of the nation's coal is consumed by electric utility companies to produce electricity. In 2017, coal produced 1,205.8 billion kilowatt-hours of electricity, which was 30% of the nation's electricity.		
GEOTHERMAL	In 2017, geothermal power plants produced 15.9 billion kilowatt-hours of electricity, mostly from facilities in the western U.S. Geothermal energy produced 0.4% of the nation's electricity.		
HYDROPOWER	Nationwide, there are 2,200 hydro plants that generate 7.3% of U.S. electricity. Hydro plants produced 293.8 billion kilowatt-hours of electricity in 2017. It is the leading renewable energy source used to provide electricity.		
NATURAL GAS	Natural gas produced 1,296.4 billion kilowatt-hours of electricity in 2017, generating 32.2% of the nation's electricity. Natural gas is used by turbines to provide electricity during peak hours of demand.		
PETROLEUM	Petroleum provided 0.5% of U.S. electricity, generating 21.4 billion kilowatt-hours of electric power in 2017.		
PROPANE	There are no statistics available for propane's contribution to electricity generation. Very little propane is used to produce electricity.		
SOLAR	Solar energy provided about 1.3% of U.S. electricity in 2017, amounting to 53.3 billion kilowatt-hours of electricity. Electricity was generated by solar thermal systems or photovoltaic arrays.		
URANIUM	In 2017, 99 nuclear reactors provided the nation with 20% of its electrical energy needs. Nuclear energy produced 805 billion kilowatthours of electricity.		
WIND	Wind energy produced 254.3 billion kilowatt-hours of electricity in 2017, providing 6.3% of the nation's electricity. Most of the windgenerated electricity is produced in Texas, Iowa, and Oklahoma.		

Answer Key

Problem 1, 2, and 3 Answers



	1	2	3	4	5	Bonus
Problem 1	Petroleum	8%	92%	83%	92%	—
Problem 2	Jan 11	Apr 11	Aug 10	100 kWh	12,000 kWh	—
Problem 3	Hybrid Midsize	Pick-Up	70 mi	81 mi	2 gal	500 miles

Intermediate Math Challenge Answers

Round 1:	1. 420 MBtu	2. 1/15
	3. 9.6 MBD	4. 19.6%
Round 2:	1. 16.2 quads	2. 3/20
	3. 810 liters	4. 4.4%
Round 3:	1. 364.25 million barrels	2. 1/20
	3. 1.20 Q	4. 46.2%

Mega Question: The totals for the 2010 list: Renewable – 8 quads, Nonrenewable – 89.8 quads, and Total – 97.8 quads. The total for the 2035 list is 117.5 quads. There are no right or wrong answers for the 2035 pie chart as long as the numbers add up to 117.5 quads.

Secondary Math Challenge Answers

Round 1:	1.19.6%	2. 65 million units
	3. 840 units	4. 981 bkWh
Round 2:	1. 42%	2. 7.8 quads
	3. 425 million barrels	4. 4.4 quads
Round 3:	1. 36%	2. 442 MBtu
	3. 0.65 bkWh	4. 1.99 or 2 quads

Electric Connections – Energy Information Administration's (EIA) Rank

Biomass – 6
Coal – 2
Geothermal – 9
Hydropower – 4
Natural Gas – 1
Petroleum – 8
Propane – 10
Solar – 7
Uranium – 3
Wind – 5

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Louisville Gas and Electric Company
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Minneapolis Public Schools
Mississippi Development Authority–Energy Division
Mississippi Gulf Coast Community Foundation
National Fuel
National Grid
National Hydropower Association
National Ocean Industries Association
National Renewable Energy Laboratory
NC Green Power
Nebraskans for Solar
New Mexico Oil Corporation
New Mexico Landman's Association
NextEra Energy Resources
NEXTracker
Nicor Gas
Nisource Charitable Foundation
Noble Energy
North Carolina Department of Environmental Quality
North Shore Gas
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