

SAVING ENERGY AT HOME

STUDENT AND FAMILY GUIDE

2016-2017



An Energy Efficiency Curriculum brought to you by





Message to Families

Welcome to Ohio Energy Project's (OEP) award-winning energy efficiency education program, sponsored entirely by your local electric and/or natural gas provider. Your student's teacher was selected to participate in this innovative program and has received training and classroom materials designed to meet Ohio's Learning Standards. Additionally, students develop leadership skills by helping their families learn about energy efficiency while conserving resources and money in their homes.

With your support, students will have the opportunity to put energy conservation lessons into action by installing energy saving measures from the Home Energy Efficiency kit provided by your sponsoring utility. Once installed, these energy saving measures give families the opportunity to see how low-cost and no-cost measures can make a substantial difference in lowering energy use. If you rent, we recommend that you check with your landlord before making any modifications.

This Student and Family Guide will allow your child to do additional research on your home's energy use that will demonstrate how your efforts to save energy can make a difference. At the end of the lessons there is a Family Installation Survey to be completed. This survey, found at www.ohioenergy.org, will allow the students to report on the measures installed in your home.

We are pleased that your family will be participating in this educational opportunity with thousands of other families across Ohio. We encourage you to contact your child's teacher or email OEP at e3smart@ohioenergy.org with any questions you might have. If you are not interested in receiving a Home Energy Efficiency Kit please contact your child's teacher.

What teachers have to say about OEP's Energy Efficiency Program:

"This unit really helps the students to educate not only themselves but also their parents in order to become more energy conscious and efficient in their homes."

"When parents and students reviewed their energy bills and saw that they actually LOWERED their individual bills with this program... that is when it 'hit home.' Now those parents and students are spreading the word to others!"

SAVING ENERGY AT HOME

STUDENT AND FAMILY GUIDE

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LESSON 1

Background Information: What is Energy?

The United States uses a lot of **energy**—over two million dollars worth of energy per minute, 24 hours a day, 365 days a year. With just less than 4.5 percent of the world’s population, we consume about 18.6 percent of the world’s energy resources.

All of us use energy every day—for getting from one place to another, cooking, heating and cooling rooms, making products, lighting, heating water, and entertainment.

We use a lot of energy to make our lives comfortable, productive, and enjoyable. Most of that energy is from nonrenewable energy sources. It is important that we use our energy resources wisely.

Energy Efficiency and Conservation

The choices we make about how we use energy have environmental and economic impacts. There are many things we can do to use less energy and use it more wisely. These actions include both energy conservation and energy efficiency.

Energy conservation is any action or behavior that results in using less energy. Drying clothes outside on sunny days is an example of energy conservation.

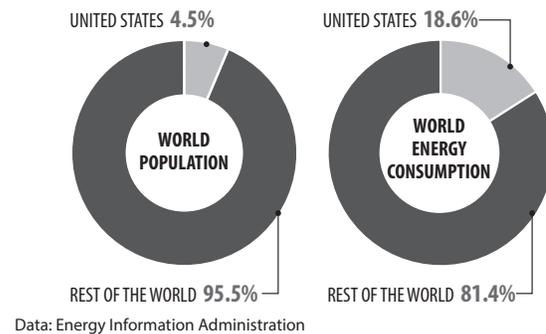
Energy efficiency focuses on technologies that use less energy to perform the same tasks or the same amount of work. Buying a dryer that uses less energy is an example of energy efficiency.

Who Uses Energy?

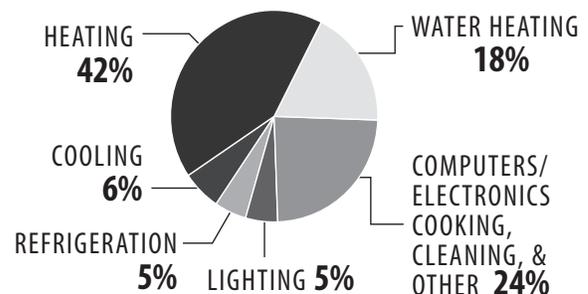
The U.S. Department of Energy uses categories to classify energy users—residential, commercial, industrial, electric power and transportation. These categories are called the sectors of the economy.

The residential sector includes houses, apartments, and other places where people live. The commercial sector includes schools, businesses, and hospitals. The residential and commercial sectors are put together because they use energy for similar tasks—for heating, air conditioning, water heating, lighting, and operating appliances.

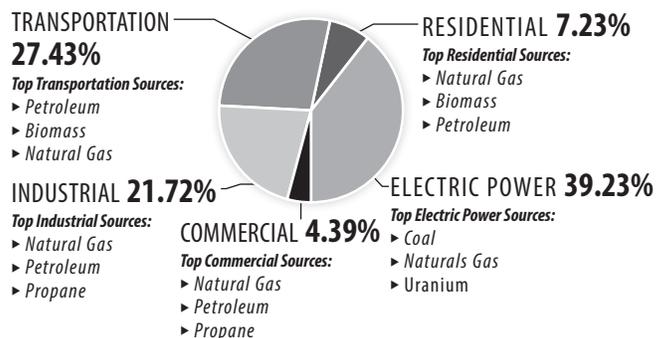
Population Versus Energy Consumption, 2014



Home Energy Usage, 2014



U.S. Energy Consumption by Sector, 2014



LESSON 1: BACKGROUND INFORMATION

What Is Energy?

Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work.

Forms of Energy

All forms of energy fall under two categories:



POTENTIAL

Stored energy and the energy of position (gravitational).

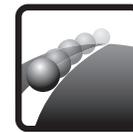


CHEMICAL ENERGY is the energy stored in the bonds between atoms in molecules. Gasoline and a piece of pizza are examples.

NUCLEAR ENERGY is the energy stored in the nucleus or center of an atom – the energy that holds the nucleus together. The energy in the nucleus of a plutonium atom is an example.

ELASTIC ENERGY is energy stored in objects by the application of force. Compressed springs and stretched rubber bands are examples.

GRAVITATIONAL POTENTIAL ENERGY is the energy of place or position. A child at the top of a slide is an example.



KINETIC

The motion of waves, electrons, atoms, molecules, and substances.



RADIANT ENERGY is electromagnetic energy that travels in transverse waves. Light and x-rays are examples.

THERMAL ENERGY or heat is the internal energy in substances – the vibration or movement of atoms and molecules in substances. The heat from a fire is an example.

MECHANICAL ENERGY is the movement of a substance from one place to another. Wind and moving water are examples.

SOUND ENERGY is the movement of energy through substances in longitudinal waves. Echoes and music are examples.

ELECTRICAL ENERGY is the movement of electrons. Lightning and electricity are examples.

LESSON 1: BACKGROUND INFORMATION

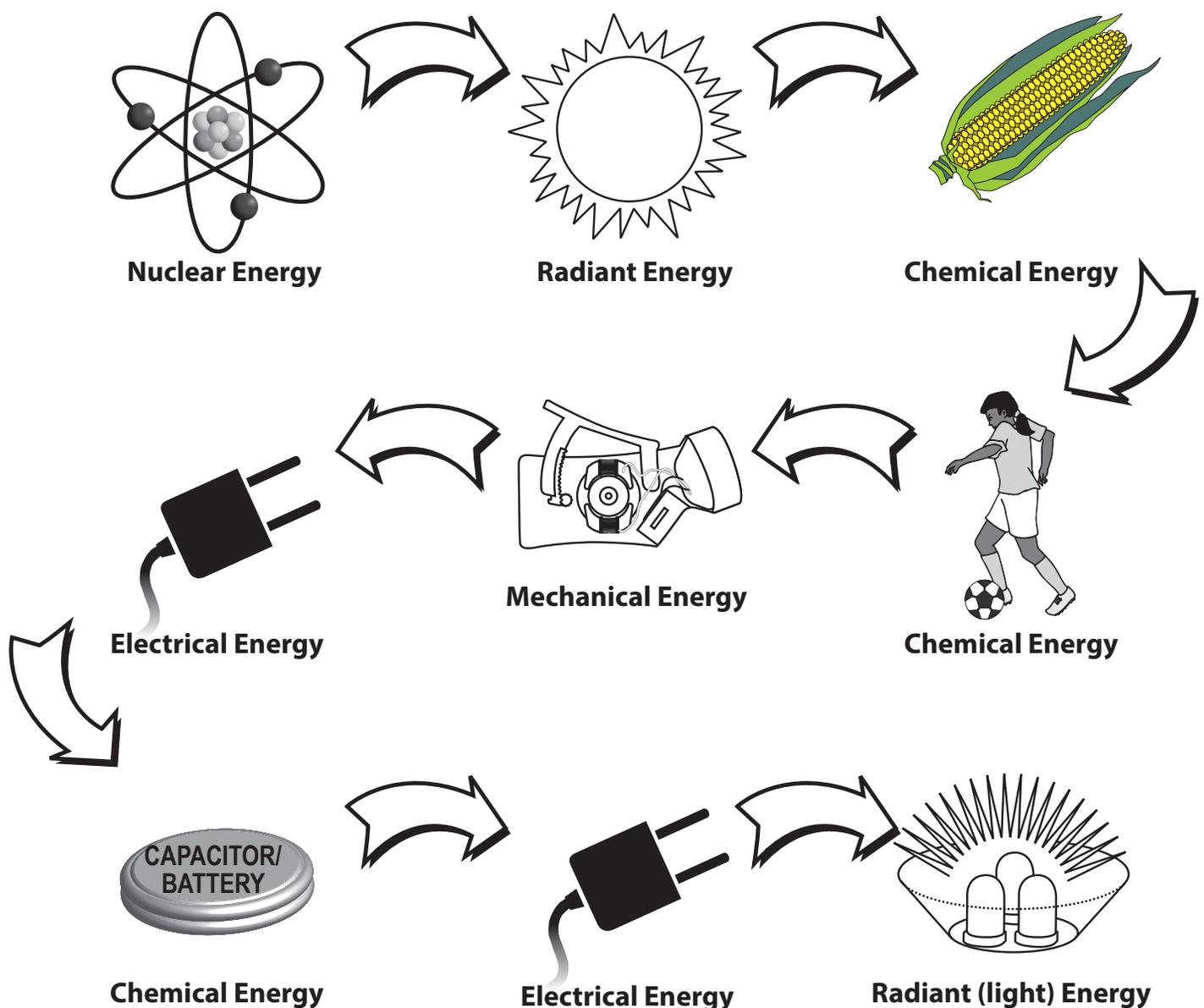
Energy Transformations

Conservation of Energy

Your parents may tell you to conserve energy. "Turn off the lights," they say. To scientists, **energy conservation** is not just about turning off the lights. The **Law of Conservation of Energy** says that energy is neither created nor destroyed. When we use energy, it doesn't disappear. We change one form of energy into another form.

A car engine burns gasoline, converting the chemical energy in gasoline into motion energy. Solar cells change radiant energy into electrical energy. Energy changes form, but the total amount of energy in the universe stays the same.

Energy Transformations for a Hand Generated Flashlight



LESSON 1: BACKGROUND INFORMATION

Sources of Energy

We use many different energy sources to do work for us. They are classified into two groups—renewable and nonrenewable.

In the United States, most of our energy comes from nonrenewable energy sources. Coal, natural gas, petroleum, propane, and uranium are nonrenewable energy sources. They are used to make electricity, heat our homes, move our cars, and manufacture all kinds of products. These energy sources are called nonrenewable because their supplies are limited. Petroleum, a fossil fuel, for example, was formed hundreds of millions of years ago from the remains of ancient sea plants and animals. We can't make more crude oil deposits in a short time.

Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

RENEWABLE energy sources are replenished in a short period of time.



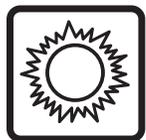
WIND is energy from moving air.



GEOTHERMAL energy is heat from within the earth.



HYDROPOWER is energy that comes from the force of moving water.



SOLAR energy is energy from the sun.



BIOMASS is any organic matter (anything that was once alive) that can be used as an energy source such as wood, crops, and yard waste.

NONRENEWABLE energy sources are limited since it takes a very long time to replenish their supply.



COAL is a solid, black fossil fuel formed from the remains of plants that lived and died millions of years ago.



NATURAL GAS is a colorless, odorless fossil fuel made mostly of methane.



PETROLEUM is a fossil fuel that looks like a black liquid. It is also known as crude oil.



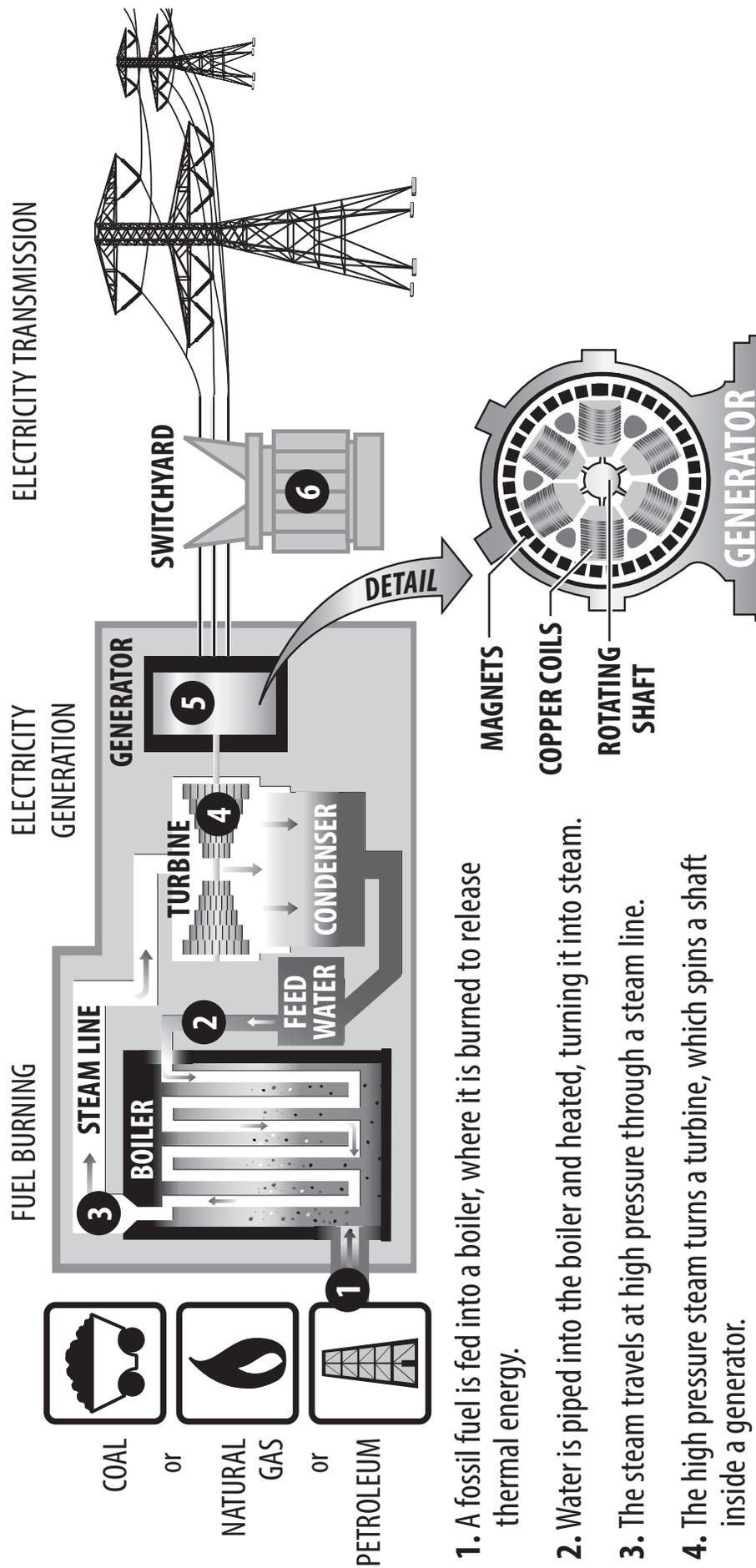
PROPANE is a fossil fuel refined from natural gas and petroleum.



URANIUM is the fuel used by most nuclear power plants. During nuclear fission, atoms are split apart to form smaller atoms, which releases energy.

LESSON 1: BACKGROUND INFORMATION

Burning Fossil Fuels to Generate Electricity



1. A fossil fuel is fed into a boiler, where it is burned to release thermal energy.
2. Water is piped into the boiler and heated, turning it into steam.
3. The steam travels at high pressure through a steam line.
4. The high pressure steam turns a turbine, which spins a shaft inside a generator.
5. Inside the generator, the shaft spins coils of copper wire inside a ring of magnets. This creates an electric field, producing electricity.
6. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.

LESSON 1: BACKGROUND INFORMATION

Industrial Sector

Manufacturing the goods we use every day consumes an enormous amount of energy. The industrial sector of the economy consumes almost one-third of the nation's energy. In industry, energy efficiency and conservation are driven by economics—money. Manufacturers know that they must keep their product costs low so people will buy them.

Since energy is one of the biggest costs in many industries, manufacturers must use as little energy as possible. Their demand for energy efficient equipment has resulted in many new technologies in the last decades. Consumers can have an effect on industrial energy use through the product choices we make and what we do with the packaging and the products we no longer use.

A Consumer Society

Not only is America a consumer society, it is also a 'throw away' society. Americans produce more trash than any other developed country. The average person throws away approximately 1,600 pounds of trash a year!

The best way for consumers to reduce the amount of energy used by industry is to avoid buying unnecessary products and to repair and reuse items wherever possible. Buying only those items you need, as well as reusing and recycling products, can reduce energy use in the industrial sector. The 4 R's of an energy-wise consumer are easy to put into practice. Managing waste saves money, energy, and natural resources, and helps protect the environment.

Reduce

Buy only what you need. Buying fewer goods means less to throw away. It also means fewer goods are produced and less energy is used to manufacture them. Buying goods with less packaging also reduces the amount of waste and the amount of energy used.



Reuse

Buy products that can be used more than once. If you buy things that can be reused rather than disposable items that are used once and thrown away, you save natural resources. You will also save the energy used to make them, and reduce the amount of landfill space needed to contain the waste. Savings also result when you buy things that are durable. They may cost more, but they last a long time and do not need to be replaced often, saving money and energy.



Repair

Many people throw away products when they break and buy new ones. Many of these products could be easily and cheaply repaired. Always consider repairing a product before throwing it away. It saves energy, money, and natural resources.

Recycle

Make it a priority to recycle all materials that you can. Using recycled material to make new products almost always consumes less energy than using new materials. Recycling reduces energy needs for mining, refining, and many other manufacturing processes.

Recycling steel saves 75 percent of the energy needed to make products from raw iron ore. Recycling aluminum cans saves 92 percent of the energy required to produce aluminum from bauxite. Many other products can also be recycled and contribute to savings in energy and resources.



Recycling is only part of the process to save energy. Consumers also need to make an effort to buy recycled goods. Many products now have labels that tell consumers how much recycled material they contain.

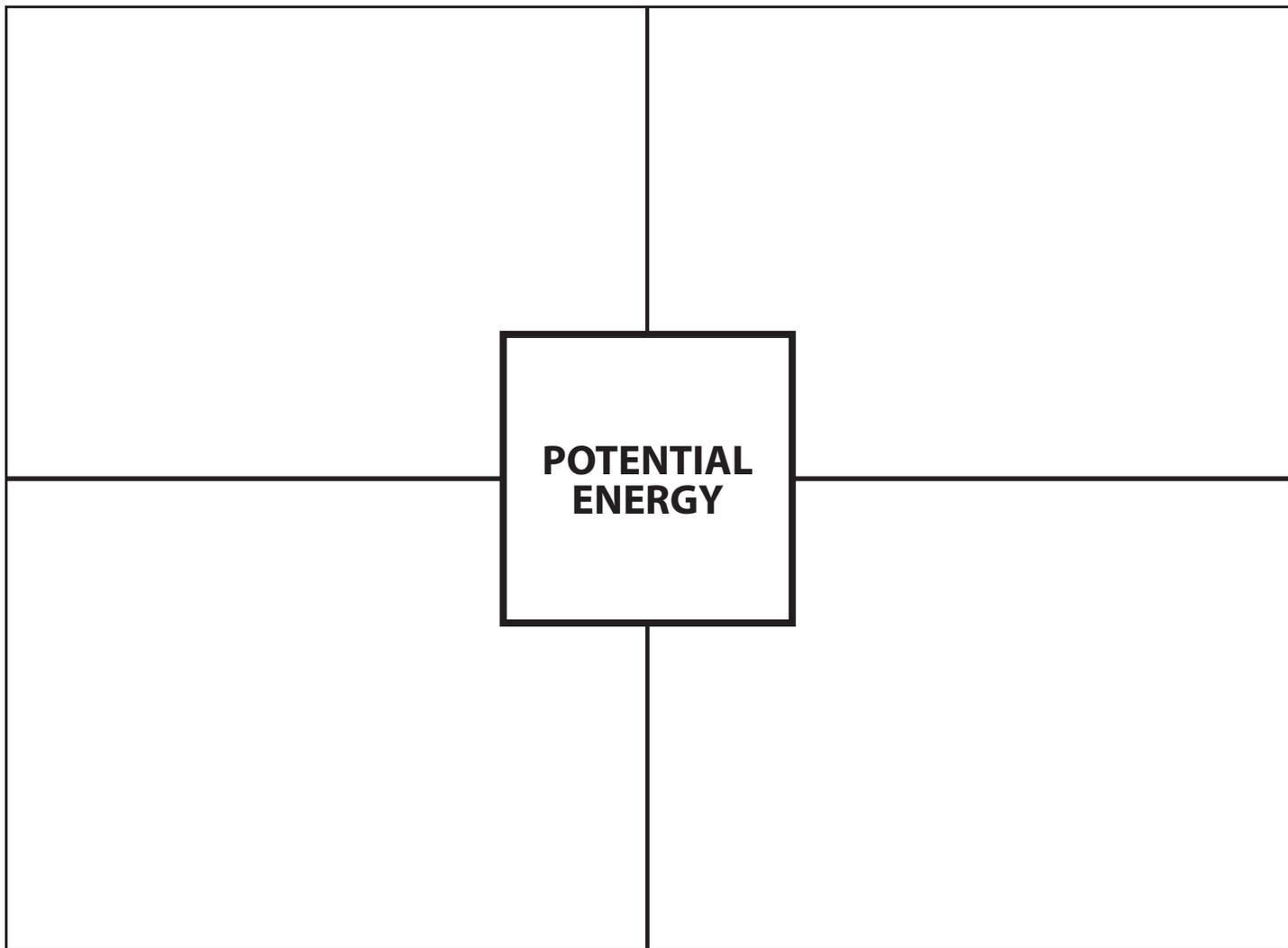
Energy Sustainability

Efficiency and conservation are key components of **energy sustainability**—the concept that every generation should meet its energy needs without compromising the needs of future generations. Sustainability focuses on long-term actions that make sure there is enough energy to meet today's needs as well as tomorrow's.

Sustainability also includes the development of new clean technologies for using fossil fuels, promoting the use of renewable energy sources, and encouraging policies that protect the environment.

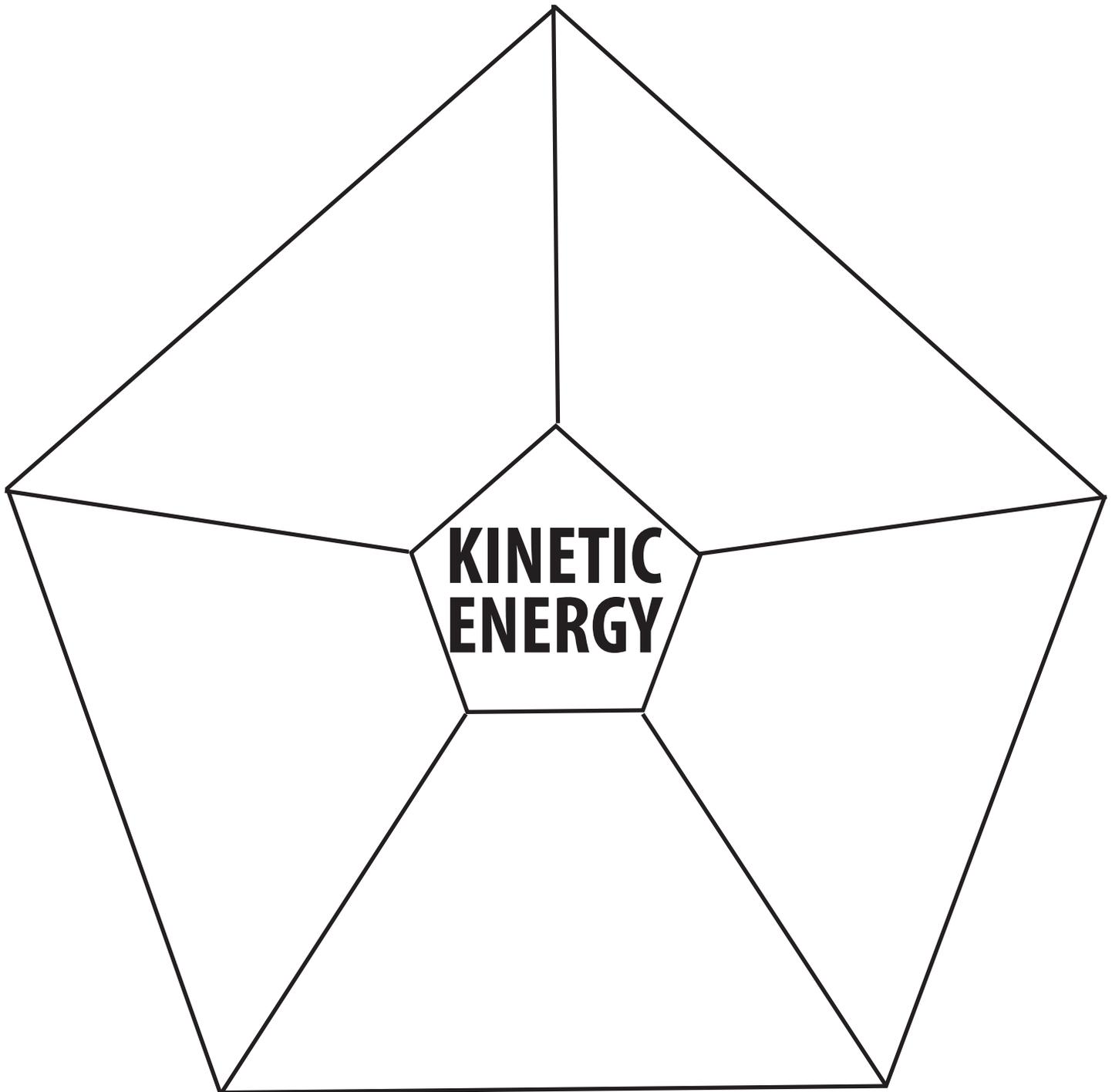
Forms of Energy

Energy can be stored. Stored energy is called potential energy.



Forms of Energy

Energy can be in motion. Motion energy is called kinetic energy.



LESSON 1

Energy Transformation - Toys

Energy cannot be created or destroyed. It can only change from one form to another.

Using the Transformation Cards, show how energy has been transformed by each of the toys. Look at the Toaster example below.

M Mechanical	R Radiant	C Chemical	N Nuclear	E Electrical	T Thermal	+ Plus	 Transforms to
------------------------	---------------------	----------------------	---------------------	------------------------	---------------------	------------------	--

Toaster

M	+	E		T	+	R
----------	----------	----------	---	----------	----------	----------

Dynamo Flashlight

--	--	--	--	--	--	--	--	--

Glow Stick

--	--	--	--	--	--	--	--	--

Solar Toy

--	--	--	--	--	--	--	--	--

Toy Vehicle

--	--	--	--	--	--	--	--	--

LESSON 1

Energy Source Matching

Write the number of the energy source on the line next to its definition.

1. Petroleum _____ **Black rock burned to make electricity.**

2. Wind _____ **Energy from heat inside the Earth.**

3. Biomass _____ **Energy from flowing water.**

4. Uranium _____ **Energy from wood, waste, and garbage.**

5. Propane _____ **Energy from moving air.**

6. Solar _____ **Energy from splitting atoms.**

7. Geothermal _____ **Portable fossil fuel used in grills.**

8. Hydropower _____ **Fossil fuel for cars, trucks, and jets.**

9. Coal _____ **Fossil fuel gas moved by pipeline.**

10. Natural Gas _____ **Energy in waves from the sun.**

Forms and Sources of Energy

In the United States we use a variety of resources to meet our energy needs. Use the information below to analyze how each energy source is stored and delivered.

1 Using the information from the *Forms of Energy* charts and the graphic below, determine how energy is stored or delivered in each of the sources of energy. Remember, if the source of energy must be burned, the energy is stored as chemical energy.

NONRENEWABLE

Petroleum _____
 Natural Gas _____
 Coal _____
 Uranium _____
 Propane _____

RENEWABLE

Biomass _____
 Hydropower _____
 Wind _____
 Solar _____
 Geothermal _____

2 Look at the U.S. Energy Consumption by Source graphic below and calculate the percentage of the nation's energy use that each form of energy provides.

What percentage of the nation's energy is provided by each form of energy?

Mechanical _____
 Chemical _____
 Radiant _____
 Thermal _____
 Nuclear _____

What percentage of the nation's energy is provided by nonrenewables? _____

by renewables? _____

U.S. Energy Consumption by Source, 2014

NONRENEWABLE

	PETROLEUM 34.9% <i>Uses: transportation, manufacturing</i>
	NATURAL GAS 27.5% <i>Uses: heating, manufacturing, electricity</i>
	COAL 18.0% <i>Uses: electricity, manufacturing</i>
	URANIUM 8.3% <i>Uses: electricity</i>
	PROPANE 1.6% <i>Uses: heating, manufacturing</i>

RENEWABLE

	BIOMASS 4.8% <i>Uses: heating, electricity, transportation</i>
	HYDROPOWER 2.5% <i>Uses: electricity</i>
	WIND 1.7% <i>Uses: electricity</i>
	SOLAR 0.4% <i>Uses: heating, electricity</i>
	GEOTHERMAL 0.2% <i>Uses: heating, electricity</i>

*Total does not add to 100% due to independent rounding.
 Data: Energy Information Administration

The Energy I Used Today

Circle the things you used or did today in the left column. For each item circled, write the number of Energy Bucks (in parenthesis) in the Energy Bucks column. Add them together to find your Total Energy Bucks Used. List the transformation of energy in the right column. The first example has been completed for you.

What device woke me up this morning?	ENERGY BUCKS	TRANSFORMATION
Alarm Clock/Radio/Cell phone (2 bucks)	2	E → S
What devices were used to make my breakfast?		
Microwave (2 bucks)	_____	_____
Stove/Oven (5 bucks)	_____	_____
Toaster Oven/Toaster (3 bucks)	_____	_____
Refrigerator (3 bucks)	_____	_____
What devices did I use as I got ready for school this morning?		
Air Conditioning/Heating (10 bucks)	_____	_____
Radio/CD Player/MP3 Player/iPod (2 bucks)	_____	_____
Gaming System (3 bucks)	_____	_____
TV/DVD Player (3 bucks)	_____	_____
Shower/Bath (3 bucks)	_____	_____
Hair Dryer (3 bucks)	_____	_____
Curling Iron/Curlers/Flat Iron (3 bucks)	_____	_____
Telephone/Cell Phone (2 bucks)	_____	_____
Computer (3 bucks)	_____	_____
iPad/Tablet (2 bucks)	_____	_____
What rooms had lights turned on this morning?		
Bedroom (2 bucks)	_____	_____
Bathroom (2 bucks)	_____	_____
Kitchen (2 bucks)	_____	_____
Family Room (2 bucks)	_____	_____
Other (2 bucks)	_____	_____

How did I get to school today?**ENERGY BUCKS****TRANSFORMATION**

Walk (0 bucks)

Bicycle (0 bucks)

School Bus (1 buck)

Carpool (2 bucks)

Family Vehicle (5 bucks)

What devices did I use after school yesterday?

Air Conditioning/Heating (10 bucks)

Travel in Vehicle (5 bucks)

Lights (2 bucks)

Computer (3 bucks)

iPad/Tablet (2 bucks)

Gaming System (3 bucks)

Radio/CD Player/MP3 Player/iPod (2 bucks)

TV/DVD Player (3 bucks)

Telephone/Cell phone (2 bucks)

What devices were used at home last night?

Air Conditioning/Heating (10 bucks)

Microwave (2 bucks)

Stove/Oven (5 bucks)

Toaster Oven/Toaster (3 bucks)

Refrigerator (3 bucks)

Grill (2 bucks)

Lights (2 bucks)

TV/DVD Player (3 bucks)

Gaming System (3 bucks)

Shower/Bath (3 bucks)

Hair Dryer (3 bucks)

Telephone/Cell Phone (2 bucks)

Computer (3 bucks)

iPad/Tablet (2 bucks)

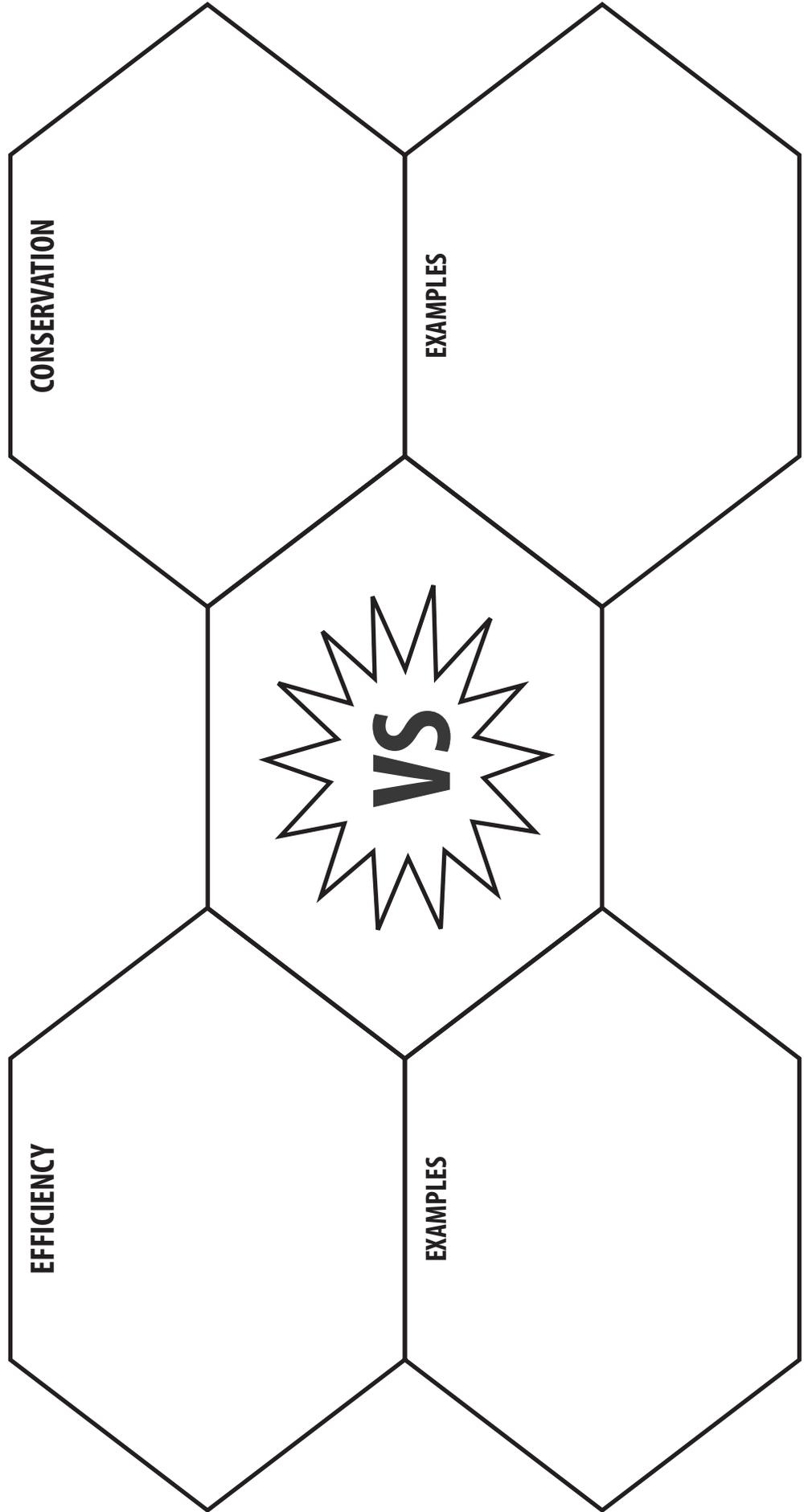
Radio/CD Player/MP3 Player/iPod (2 bucks)

Total Energy Bucks Used

LESSON 1

Efficiency vs. Conservation

Energy efficiency and conservation are both important ways to save energy. Write the definitions for each in the top boxes and examples in the bottom boxes.





LESSON 1

Home Activity

Household Rating Guide: How to Rate Your Family's Energy Use

How much energy does your family use every month? Are your family members aware of the energy they use? Do they know about ways to save energy at home by changing their actions and taking simple steps to make the house more energy efficient?

This guide can help your family save energy in five energy areas:

- Living Efficiently
- Home Heating and Cooling
- Water Heating
- Household Appliances and Electronics
- Lighting

Start by finding your family's Household Energy Conservation Rating. First, read the statements in each energy section carefully. Decide how much or how little your family's energy use fits the statements and then rate your family's energy use by choosing a number from 0 to 5 for each statement in the first five categories.

For example, if your family never makes an effort to save energy in a category, choose 0. But if your family always makes an effort, choose 5. (If some members of your household are more energy conscious than others, choose the number you feel represents the average for your family.)

Please be honest with your responses. Do not be embarrassed if you give your family low ratings; most American households would receive ratings of 0, 1, or 2. The important thing is to honestly evaluate your current energy consumption and work to reduce it.

Living Efficiently

1. We have had an energy audit of our house.

Your local utility will send someone to your house to perform an audit and show you where your house is wasting energy and what you can do to correct it.

Yes No

2. We have eliminated drafts around windows and doors with caulking and weatherstripping.

Proper caulking and weatherstripping can cut fuel costs by up to 10 percent.

Yes No

3. We have the proper amount of insulation in the attic and walls.

If you need to add insulation, the cost will be made up by lower utility bills.

Yes No

4. We have insulated our hot water tank and piping.

A well-insulated tank can save \$10-20 in energy costs over a 12-month period.

Yes No

5. We have low-flow shower heads.

These easy-to-install devices save energy and provide adequate shower pressure.

Yes No

6. When buying new appliances, we compare EnergyGuide labels and buy energy efficient models.

The most energy efficient new appliances cost a little more, but save money and energy over their operating life.

Yes No

7. When purchasing vehicles, fuel mileage is one of our most important considerations.

A fuel efficient vehicle can save thousands of dollars in fuel costs over the life of the vehicle.

Yes No

Household Rating Guide

Home Heating and Cooling

1. We inspect windows and doors, and make repairs as necessary, to make sure they are airtight.

Caulking and weatherstripping can deteriorate over time. 25% of home heat loss is around windows and doors.

Never 0 1 2 3 4 5 Always

2. We inspect the ductwork to make sure there are no cracks or openings. *Openings or cracks in the ducts can allow conditioned (heated or cooled) air to escape into the attic and crawl spaces.*

Never 0 1 2 3 4 5 Always

3. We clean or replace system filters as recommended.

Keeping filters clean provides more efficient heating and cooling.

Never 0 1 2 3 4 5 Always

4. In winter, we dress warmly and set the thermostat at 68 degrees or lower during the day and 60 degrees or lower at night. *Setting the thermostat back 8 degrees for 8 hours a day can save 10%.*

Never 0 1 2 3 4 5 Always

5. In the summer, we dress lightly and set the thermostat at 78 degrees or higher.

This temperature is considered the most comfortable for humans if fans are used to circulate the air.

Never 0 1 2 3 4 5 Always

6. We keep windows and doors closed when the heating or air conditioning system is operating.

Having windows and doors open makes your heating or air conditioning system work harder.

Never 0 1 2 3 4 5 Always



Water Heating

1. The water heater thermostat is always set at 120 degrees.

Most hot water heaters are set much higher than necessary. You can save up to 10 percent on your energy bill by setting the temperature at 120 degrees.

Never 0 1 2 3 4 5 Always

2. We inspect the insulation on our hot water tank and piping, and make repairs as necessary.

Insulation can come loose or deteriorate over time.

Never 0 1 2 3 4 5 Always

3. We use cold water whenever hot water is not necessary (e.g., washing clothes, rinsing dishes, running disposal). *Using cold water saves energy and most tasks do not require hot water.*

Never 0 1 2 3 4 5 Always

4. We take short showers and fill the tub with only the water we need.

Short showers use less energy than baths.

Never 0 1 2 3 4 5 Always

5. We fill the sink to wash dishes rather than running the water, and use the short cycle on the dishwasher.

Running water to wash dishes and long dishwasher cycles use a lot of water and energy.

Never 0 1 2 3 4 5 Always



Household Rating Guide

Household Appliances and Electronics

1. We turn off appliances and electronics, such as televisions, when not in use.

Many appliances continue to draw energy when they are in the off position.

Never 0 1 2 3 4 5 Always

2. We preheat the oven for only five minutes or not at all.

It also saves energy to cook several dishes at once to make maximum use of this concentrated heat.

Never 0 1 2 3 4 5 Always

3. When baking, we keep the oven door closed rather than opening it often to look inside and use a timer. *An open oven door lets valuable heat escape.*

Never 0 1 2 3 4 5 Always

4. Whenever possible, we use a toaster oven or microwave instead of a regular oven.

These smaller appliances save energy for most cooking jobs.

Never 0 1 2 3 4 5 Always

5. We inspect refrigerator and freezer door seals often to make sure they are airtight.

Insert a piece of paper halfway in the door. If you can pull the paper out easily, the seal is not airtight.

Never 0 1 2 3 4 5 Always

6. We use the energy-saver feature on the dishwasher, allowing the dishes to air dry.

Producing heat to dry dishes uses a lot of energy.

Never 0 1 2 3 4 5 Always

Lighting

1. We turn off indoor and outdoor lights when they are not needed.

Many people leave lights on without thinking—wasting energy.

Never 0 1 2 3 4 5 Always

2. We use natural lighting whenever we can by opening blinds/shades/curtains.

Natural lighting is free to use.

Never 0 1 2 3 4 5 Always

3. We use energy-efficient lights in garages and work areas that need lots of light.

A 40-watt fluorescent lamp provides 50-80 lumens per watt, while a 60-watt incandescent provides only 13-15 lumens per watt. You save energy and get more light from fluorescents.

Never 0 1 2 3 4 5 Always

4. We replace burned-out incandescent light bulbs with compact fluorescent (CFL) bulbs or light emitting diodes (LED).

New CFLs and LEDs fit conventional light fixtures. They are more expensive to buy, but last ten times longer and use one-fourth or less of the energy of incandescent bulbs, saving you money and energy in the long run.

Never 0 1 2 3 4 5 Always

5. We keep lamps and light fixtures clean because dirt absorbs light.

Get the best use of lighting by dusting regularly.

Never 0 1 2 3 4 5 Always



Lesson 1 – What is Energy?

ASSESSMENT

1. The energy in petroleum, natural gas, coal and biomass is stored as _____?
a. thermal energy b. chemical energy c. kinetic energy d. sound energy
2. The energy source that provides most of our transportation needs is _____?
a. wind b. petroleum c. propane d. coal
3. Which energy source is a type of mechanical energy?
a. uranium b. geothermal c. solar d. hydropower
4. Which conservation behavior would save the most energy in your home?
a. turn off an LED light b. open the window instead of turning on the air conditioning c. driving to school d. turn off the TV for one hour

5. What is the most energy efficient way to dry your hair? Explain.

6. You ate a banana for breakfast. List the transformation steps involved in giving you energy for your morning at school.

7. Appliances are one of the “Top Five” energy users in your home. Describe two ways you can conserve energy with the appliances you use most at home.

LESSON 2

Background Information: Insulation, Heating, and Cooling

Heat Seeks Balance

Everything in nature seeks balance. Heat seeks balance, too. Heat flows from hotter places to colder places and from hotter substances to colder substances. What happens if you pour hot water into a cold tub? The molecules of hot water have more energy. They are fast moving. They crash into the colder molecules and give them some of their energy.

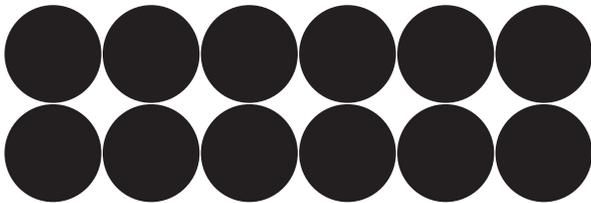
Conductors and Insulators

In some materials, heat flows easily from molecule to molecule. These materials are called **conductors**. They conduct—or move—heat energy well. Materials that don't conduct heat well are called **insulators**.

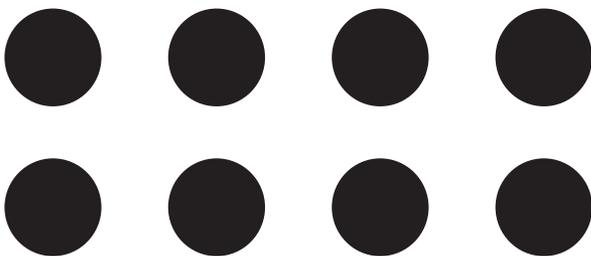
The molecules in good conductors are close together. There is very little space between them. When they vibrate, they push against the molecules near them. The energy flows between them easily.

The molecules in insulators are not so close together. It is harder for energy to flow from one molecule to another in insulators.

Good Conductor



Good Insulator



Look at the objects to the right. The pot, the spoon, and the fork are made of metal. The pot and the fork have plastic handles. The dish is made of glass. The oven mitt is made of cotton fabric.

Which materials are the insulators? The insulators are the materials that don't move heat. They protect us from heat. Our experience tells us that wood, plastic, and cotton are all good insulators. Metals are good conductors. The metal part of the pan moves heat to the food inside to cook the food. The plastic handle protects our hands. The cotton glove protects our hands, too.

What about glass? It is not as good of a conductor or insulator as the other materials. It is used to conduct heat in pots and pans, and can also be used to insulate. Glass was once used on power and telephone lines as an insulator.

Heat and Temperature

Heat and **temperature** are different things. Two cups of boiling water have twice as much heat as one cup of boiling water, but the water would be at the same temperature.

Temperature is a measure of the average kinetic energy of molecules. The faster the molecules move, the greater the temperature. Heat (thermal energy) is a form of energy that incorporates both the temperature (the speed of the molecules) and the amount of material, or mass of the substance. A bathtub filled with hot water will have more heat (thermal energy) than a cup of hot water at the same temperature because every drop of water has some heat and the bath tub has many more drops.

Cold things have thermal energy, or heat, even though the molecules are moving slowly and the temperature is low. A giant iceberg would have more heat (thermal energy) than a cup of boiling water, even though its temperature is lower. Each frozen particle in the iceberg has a very tiny amount of heat, but when you add them all together it becomes a significant amount of heat (thermal energy).

We Can Measure Temperature

We use thermometers to measure temperature. Thermometers can measure temperature using different scales. In the United States, we typically use the Fahrenheit (F) scale in our daily lives. Scientists typically use the Celsius (C) scale, as do people in most other countries.

Conductors and Insulators



LESSON 2: BACKGROUND INFORMATION

Heating and Cooling Systems

Heating and cooling systems use more energy than any other systems in our homes. Natural gas and electricity are used to heat most homes and electricity is used to cool almost all homes. About half of the costs for the average family's utility bills are for keeping homes at comfortable temperatures. The energy sources that power these heating and cooling systems can contribute carbon dioxide emissions to the atmosphere. Using these systems wisely can reduce environmental emissions.

With all heating and air conditioning systems, you can save energy and money too by having proper insulation, sealing air leaks, maintaining the equipment, and practicing energy-saving behaviors.

Programmable Thermostats

Programmable thermostats automatically control the temperature of buildings for time of day and can save energy and money. During heating seasons, for example, they can lower the temperature during the day when no one is home and at night when people are sleeping. In the morning and evening, when people are awake at home, they can automatically raise the temperature. Most consumers set the temperature higher than recommended during heating seasons and lower than recommended during cooling seasons. A temperature setting of 68°F (20°C) during the day and 60-62°F (13-14°C) at night during heating seasons is comfortable if people dress warmly and use warm blankets. During cooling seasons, a temperature setting of 78°F (25°C) is comfortable if people dress appropriately and use fans to circulate air. Many programmable thermostats come with pre-loaded settings. Proper use of the pre-programmed settings on a programmable thermostat can save your family about \$180 every year in energy costs.

Insulation and Weatherization

Warm air leaking into your home in cooling seasons and out of your home in heating seasons wastes energy. You can reduce heating and cooling costs by investing a few hundred dollars in proper insulation and weatherization products. Insulation is rated using an R-value that indicates the resistance of the material to heat flow. The R-value needed varies, depending on the climate, ceilings, walls, attics, and floors. In very cold climates, a higher R-value is recommended.

Insulation wraps your house in a blanket, but air can still leak in or out through small cracks. Often the effect of many small leaks equals a wide open door. One of the easiest energy-saving measures is to caulk, seal, and weather-strip cracks and openings to the outside. Home performance professionals can seal air leaks in attics and basements. Homeowners typically save up to \$200 a year in heating and cooling costs by air sealing their homes and adding insulation.

Doors and Windows

Some of a home's air leaks occur around and through the doors and windows. Doors should seal tightly and have door sweeps at the bottom to prevent air leaks. Insulated storm doors provide added barriers to leaking air.

Major Sources of Air Leaks

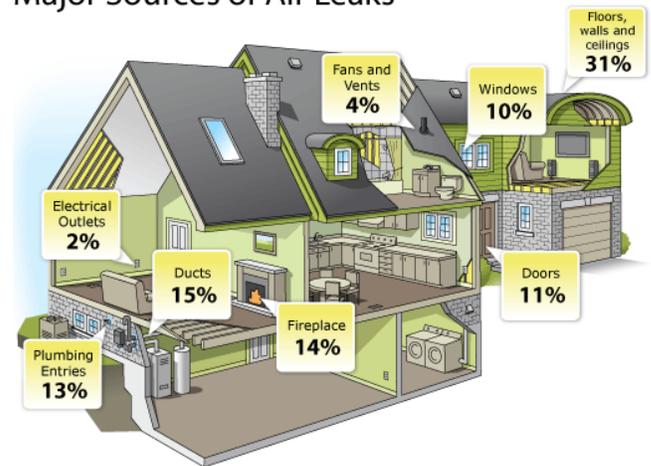
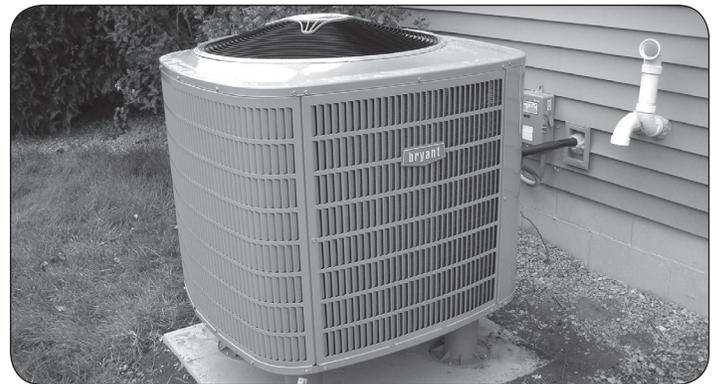


Image courtesy of InsulationSmart

Data: U.S. Department of Energy, Energy Savers

AIR CONDITIONING SYSTEM



PROGRAMMABLE THERMOSTAT



INSULATION



Image courtesy of Owens Corning

LESSON 2

Insulation Investigation

Question

Are certain materials better for insulating than others?

Materials

- 2 Insulation containers
- 2 Thermometers
- Insulating material
- Masking tape
- 2 Rubber bands
- Hot water (provided by teacher)

Hypothesis

Procedure

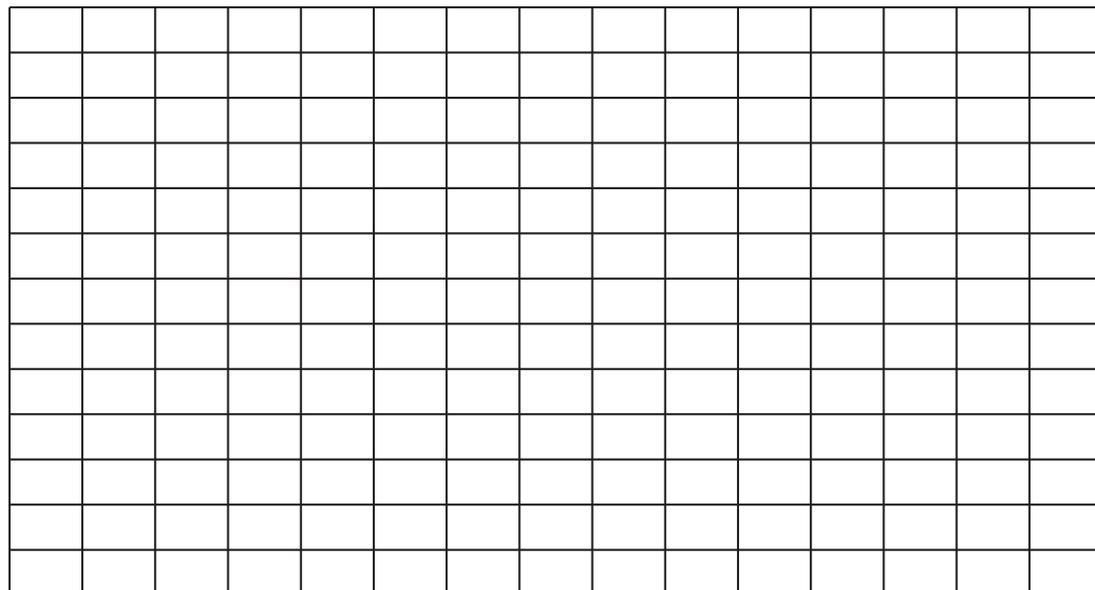
1. Remove the tops from the cans.
2. Use the insulating material to insulate one can on the sides only. Use the rubber bands or masking tape to hold the insulation in place.
3. Ask your teacher to fill both of your cans with hot water. Replace the tops.
4. Suspend a thermometer through the hole in each top, making sure it does not touch the bottom or the sides of the can.
5. In the chart below, record the temperature (°F) of the water in the cans at one-minute intervals for 10 minutes. Your teacher will keep track of the time with a timer. Calculate the overall change in temperature (ΔT) for both cans.
6. Graph the results on the graph below.

Data Table

TYPE OF INSULATION: _____

TIME (MIN)	0	1	2	3	4	5	6	7	8	9	10	ΔT
Insulated temperature												
Uninsulated temperature												

TEMPERATURE (degrees Fahrenheit)



TIME (minutes)

LESSON 2

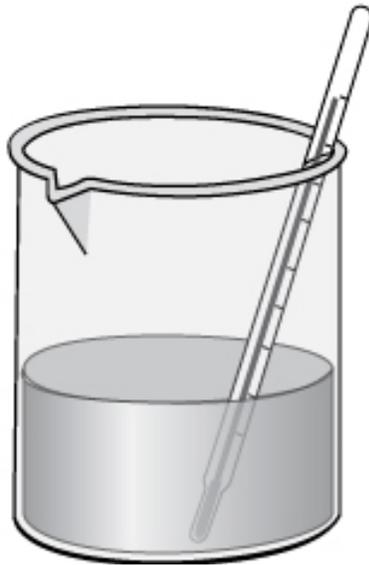
Insulation Investigation Questions

1. In 10 minutes, how much did the temperature of the water in the uninsulated container change? _____

2. In 10 minutes, how much did the temperature of the water in the insulated container change? _____

3. After 10 minutes, what was the difference in temperature between the insulated and uninsulated container? _____

4. Comparing the class data, which material was the best insulator? _____
5. Which material was the worst insulator? _____
6. Draw arrows to show the direction of heat transfer in the experiment.



7. Heat transfers from areas of _____ temperature to areas of _____ temperature.
8. What variables in the experiment might make the results unreliable? _____

9. How might you change the experiment to get more reliable results? _____

Lesson 2 - Insulation, Heating, and Cooling

ASSESSMENT

1. Draw an arrow to show how heat will transfer for the following items:

Mug of Coffee



House on a Summer Day



2. Weather stripping reduces the transfer of heat and works as a thermal _____.

- a. conductor b. insulator c. contact d. covering

3. A material that increases heat transfer (such as a metal pan) is a thermal _____.

- a. conductor b. wave c. insulator d. coat

4. Which item would have a higher temperature?

- a. small flame from a match c. a jug of water
b. glacier d. car

5. Which item would have more thermal or heat energy?

- a. small flame from a match c. a jug of water
b. glacier d. car

6. Explain why insulation is important in your home.

7. Explain where the heat energy travels when you leave the refrigerator door open.

LESSON 3

Background Information: Water Heating

Water heating is the second largest energy expense in homes. It typically accounts for about 18 percent of the average utility bill. Heated water is used for showers, baths, laundry, dish washing, and cleaning. The greatest cost of washing dishes, bathing, and washing clothes comes from the energy required to heat the water. There are four main ways you can lower your water heating bills:

- use less hot water;
- turn down the thermostat on your water heater;
- insulate your water heater and water pipes; and
- buy an ENERGY STAR® or energy efficient water heater, dishwasher, and washing machine.

The easiest way to cut the cost of heating water is to reduce the amount of hot water you use. This can be done with little cost and minor changes in lifestyle. For example, a five minute shower uses 10-25 gallons of water. You can cut that amount in half by using a low-flow shower head.

Other ways to conserve hot water include taking showers instead of baths, taking shorter showers, fixing leaks in faucets and pipes, and using the lowest temperature wash and rinse settings on clothes washers.

Most water heater thermostats are set much higher than necessary. Lowering the temperature setting on your water heater to 120°F (49°C) saves energy. Lowering the temperature 10 degrees Fahrenheit (6°C) can result in energy savings of \$12-\$30 annually. Buying a high efficiency water heater can save \$40-\$140 a year.

EnergyGuide Labels

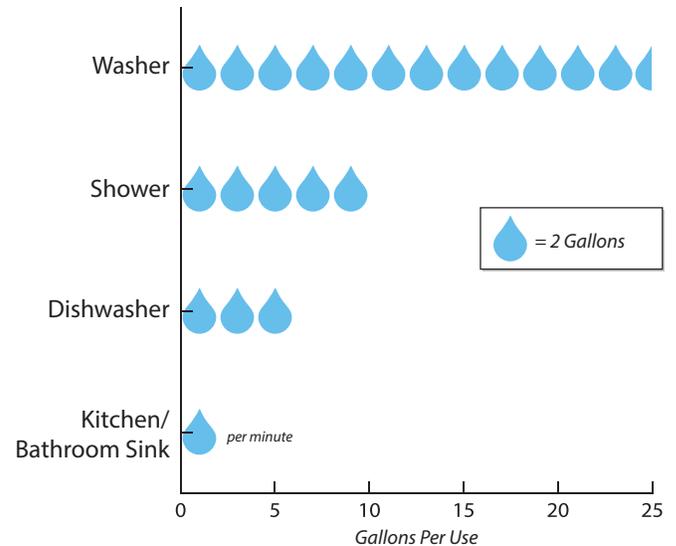
Another way to determine which appliance is more energy efficient is to compare energy usage using **EnergyGuide labels**. The government requires most appliances to display bright yellow and black EnergyGuide labels. Although these labels do not tell you which appliance is the most efficient, they will tell you the annual energy consumption and operating cost of each appliance so you can compare them.

Natural Gas Safety

Because natural gas is colorless, odorless and tasteless, a chemical called mercaptan is added to the gas before distribution. Mercaptan gives it a "rotten eggs" smell so that people can detect natural gas leaks.

Before your family begins any digging project be sure to call 811. Local utility companies will mark the utility lines in your yard within 2-3 days of your call so that you can dig safely.

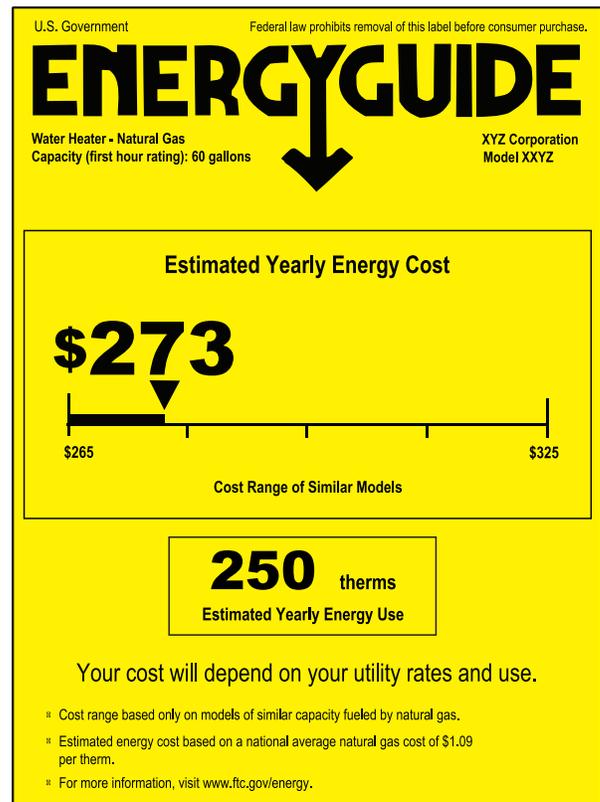
Water Consumption of Common Devices



Data: DOE, Energy Savers Guide

When appliances and faucets use hot water, you pay for the water and the utility costs to heat the water. Save hot water whenever possible.

ENERGYGUIDE LABEL



LESSON 3

Water Heating Investigation

Question

Is water temperature constant throughout the school and is it set correctly?

Materials

- 1 Flow meter bag
- 1 Hot water gauge
- Digital thermometer

Hypothesis

Procedure

1. What energy source fuels the water heating system? _____
2. Record the temperature setting of the hot water thermostat. _____

With the help of an adult:

3. Identify water sources in your school and list them below.
 - With the flow meter bag, measure the water flow of all sources and record on the chart below. **FOR YOUR SAFETY: Measure ONLY COLD water with the flow meter bag.**
 - With the hot water gauge or digital thermometer, measure the temperature of the hot water at all sources and record on the chart. **FOR YOUR SAFETY: BE CAREFUL not to touch the water.**
4. Compare the actual temperature to the recommended temperature of 120°F.
5. Gather data from the other teams and add below.

LOCATION	WATER FLOW	ACTUAL TEMPERATURE	>, <, OR = TO RECOMMENDED TEMPERATURE OF 120°F

LESSON 3

Comparing EnergyGuide Labels

Your family needs to buy a new water heater. Water heaters usually last a long time—10 years or more—so you can save a lot of money using an energy efficient one. Use the chart below to figure out which water heater to buy, comparing the information on the EnergyGuide labels.

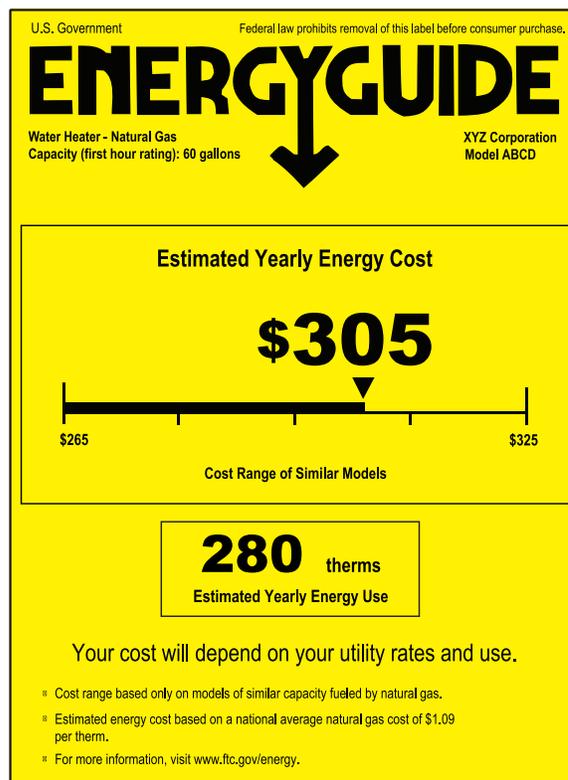
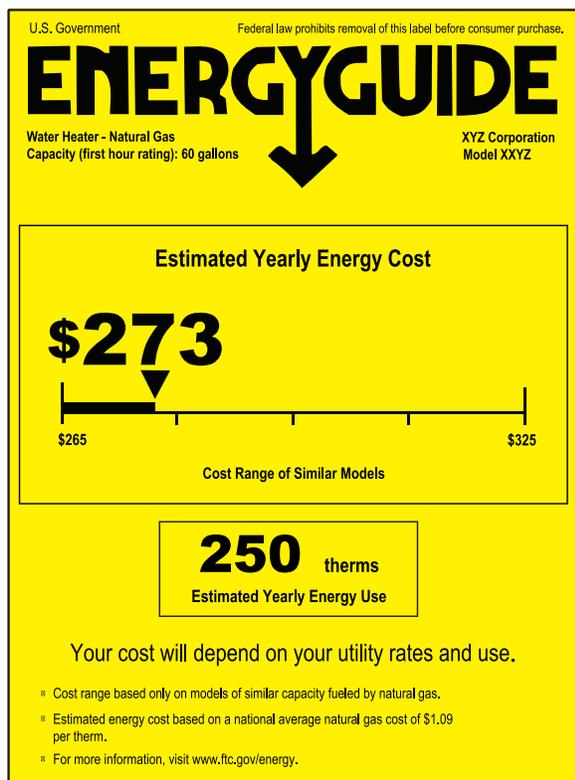
▪How many years will it take before you begin to save money?

▪How much money will you have saved after seven years?

Water Heater 1: Purchase Price: \$375.00

Water Heater 2: Purchase Price: \$250.00

WATER HEATER 1	EXPENSES	COST TO DATE	WATER HEATER 2	EXPENSES	COST TO DATE
Purchase Price			Purchase Price		
Year One			Year One		
Year Two			Year Two		
Year Three			Year Three		
Year Four			Year Four		
Year Five			Year Five		
Year Six			Year Six		
Year Seven			Year Seven		





LESSON 3

Home Activity

Investigating Home Water Heating and Usage

Materials

- Hot water gauge
- Flow meter bag
- Kitchen sink aerator (if available)
- Bathroom sink aerator (if available)
- Low flow showerhead (if available)
- Teflon tape (if available)
- Natural gas scratch n' sniff card (if available)

Procedure

With the help of an adult:

1. Locate the water heater. Read and record the temperature setting of the water heater. _____
2. Locate the EnergyGuide label and record the estimated yearly energy cost. _____
3. Use the hot water gauge to measure the temperature of the hot water in your bathroom sink. Is the temp greater than 120°F? _____
4. Use the flow meter bag to measure how much COLD water your main shower uses. If the showerhead is NOT efficient based on the chart on the bag, install the low flow showerhead, if available. Measure again.
5. Use the flow meter bag to measure how much COLD water your main bathroom sink and kitchen sink use. If they are NOT efficient based on the chart on the bag, install the energy efficient aerators, if available. Measure again.

WATER FLOW	BEFORE INSTALLATION	AFTER INSTALLATION
Main Shower		
Main Bathroom Sink		
Kitchen Sink		

6. Share the natural gas scratch n' sniff card (if available) with family members to ensure everyone can recognize the smell of a gas leak.
7. Visit your local utility's website to find out about other residential energy saving programs.

The Tools

Hot Water Gauge: Measures the temperature of your hot water. See instructions on plastic card.

Flow Meter Bag: Measures the amount of water flow. Instructions are on the bag.

Aerators and Showerheads: Reduce the water flow without reducing pressure. The smaller aerator is for the main bathroom sink; the larger aerator is for the kitchen sink. Install using instructions for the showerhead.

Teflon Tape: Ensures a tight seal for showerhead and aerators.

Lesson 3 – Water Heating

ASSESSMENT

1. The second largest energy expense in your home is _____.
a. lighting b. heating water c. heating/cooling d. refrigeration
2. For maximum energy efficiency, the ideal temperature for a water heater is _____.
a. 100° F b. 200° F c. 120° F d. 180° F
3. A device used on a faucet that maintains pressure while conserving water is _____.
a. an aerator b. a water heater c. a flow meter bag d. a filter
4. Which of the following is not a possible energy source for a water heater? _____.
a. natural gas b. electricity c. propane d. wind

5. Identify two ways you can save energy while taking a shower.

6. Describe a flow meter bag and how it is used. When measuring water flow rate, what units are used to describe it? Identify an efficient flow rate for a showerhead.

LESSON 4

Background Information: Lighting

In 2012, legislation under the Energy Independence and Security Act put restrictions on how much energy light bulbs use. Traditional bulbs, called **incandescent** bulbs, have been replaced by more efficient bulbs like **halogens**, **compact fluorescents**, and **light emitting diodes (LEDs)** on store shelves.

Lighting accounts for five percent of a home's energy use, which translates to about 14% of the home's electricity bill. Much of this is the result of using inefficient lighting. Many homes still use incandescent lighting. Only 10 percent of the energy consumed by an incandescent bulb actually produces light; the rest is given off as heat. There are other more efficient lighting choices on the market, including halogens, fluorescents, and LEDs. Halogens are sometimes called energy-saving incandescent bulbs because they last slightly longer, and use less energy than traditional incandescent bulbs, however they can burn hotter than incandescent lights do. Fluorescent lights produce very little heat and are even more efficient. Most schools use fluorescent tube lighting throughout the building, but may use incandescent bulbs in other spaces around the school.

A fluorescent lamp is a glass tube lined inside with a phosphor coating. The tube is filled with argon gas and a small amount of mercury. At the ends of the tube are electrodes that generate an electric field when electricity flows through them. The energized electrons cause the mercury gas to emit UV (ultra violet) light. The invisible UV light strikes the phosphor coating, which emits visible light.

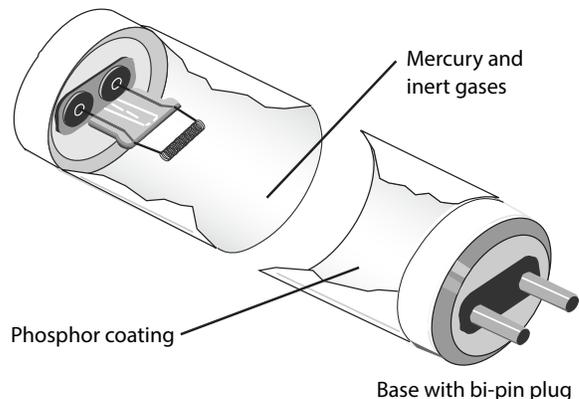
Incandescent bulbs have a tungsten filament inside the bulb. An electric current passes through the filament, heating it until it glows. Almost 90% of the energy in the bulb is given off as heat.

Recycle Used CFLs

CFL bulbs contain mercury inside their glass tubing. While it is only a small amount, CFL bulbs should be recycled to make sure mercury is disposed of properly. Check local retailers or municipalities for recycling programs.



Fluorescent Tube Lamp



In fluorescent tubes, a very small amount of mercury mixes with inert gases to conduct the electric current. This allows the phosphor coating on the glass tube to emit light.

Compact Fluorescent Light Bulbs



CFLs come in a variety of styles for different purposes. CFLs use about one-third the energy of a halogen incandescent.

LESSON 4: BACKGROUND INFORMATION

LEDs have been commonly found in electronic devices and exit signs. Now they are offered as affordable options for lighting in homes and businesses. Light emitting diodes contain **semiconductors** like solar panels; the difference is in the way the electrical energy is used by the LED. Three layers within the LED – p-type, n-type, and a depletion zone – combine to produce light. A minimum voltage is needed to energize electrons and they move from one layer to the next. When the electrons move back again, they emit light that we see.

One of the quickest and easiest ways to immediately decrease your electricity bill is to install CFL or LED bulbs in the place of incandescent or halogen bulbs. For every 100-watt incandescent bulb replaced, a savings of \$30-\$80 can be realized over the lifetime of the bulb. A CFL uses 75 percent less energy than an incandescent, and an LED bulb uses even less energy. CFL and LED bulbs last longer than incandescent bulbs, too. Each type of bulb has benefits as well as drawbacks. For example, a CFL is less expensive than an LED, but it is more fragile, contains mercury, and is not always dimmable. An LED is more durable than a CFL, but it is heavier and is sometimes more expensive. Both types are available in a wide variety of shapes and light colors. When shopping for a replacement bulb, look for ENERGY STAR® rated bulbs for the best quality and energy efficiency ratings, and make sure the bulb you buy produces the same brightness of light, as measured in lumens.

There are a few ways you can save energy on lighting in the home:

- switch incandescent bulbs to CFLs or LEDs;
- shut off lighting when exiting the room; and
- use natural light by opening blinds or curtains when possible.

Facts of Light

Lights bulbs can be compared in a variety of ways. When looking at different light bulbs you must consider:

- Lumens: the amount of light the bulb produces
- Watts: the amount of electricity the bulb uses
- Life: how many hours the bulb should last

Did You Know?

Only 10 percent of the energy used by a traditional incandescent bulb produces light. The rest is given off as heat.



INCANDESCENT BULB



HALOGEN BULB



CFL BULB



LED BULB



LEDs offer better light quality than incandescent bulbs and halogens, last 25 times as long, and use even less energy than CFLs. LEDs now have a wide array of uses because technology has improved and costs have decreased. It is possible to see CFL use decrease as LED costs continue to improve.

LESSON 4

Lighting Investigation

Question

How much heat (thermal energy) does an incandescent light bulb (IL) produce compared to a CFL and LED bulb?

Materials

- 3 lamp bases
- 1 Incandescent bulb (IL)
- 1 Fluorescent bulb (CFL)
- 1 Light emitting diode bulb (LED)
- 3 Digital thermometers

Hypothesis

Procedure

1. Record student roles for each member in the group:
 - a. CFL Thermometer reader _____
 - b. IL Thermometer reader _____
 - c. LED Thermometer reader _____
 - d. Timer _____
 - e. Data Recorder _____
2. Set up all three light bulbs in their lamp bases and plug each into an outlet.
3. Place the digital thermometers 5-10 cm from each bulb. Be sure to keep everything the same for all three bulbs. Taping the thermometers down works well.
4. Take the initial temperature of all three thermometers before turning on the bulbs and record on the data sheet. **Safety note: Do NOT touch the IL bulb as it gets very HOT quickly.** Turn all 3 bulbs on at the same time and begin recording the temperature every minute for 10 minutes.
5. After 10 minutes, calculate the change in temperature for each bulb and record.
6. Graph the results of your temperature investigation. Use a different color for each of the bulbs. Make a key showing which bulb each color represents. Label the graph and give it a title.
7. With your group, answer the questions regarding the results of your temperature investigation.

LESSON 4

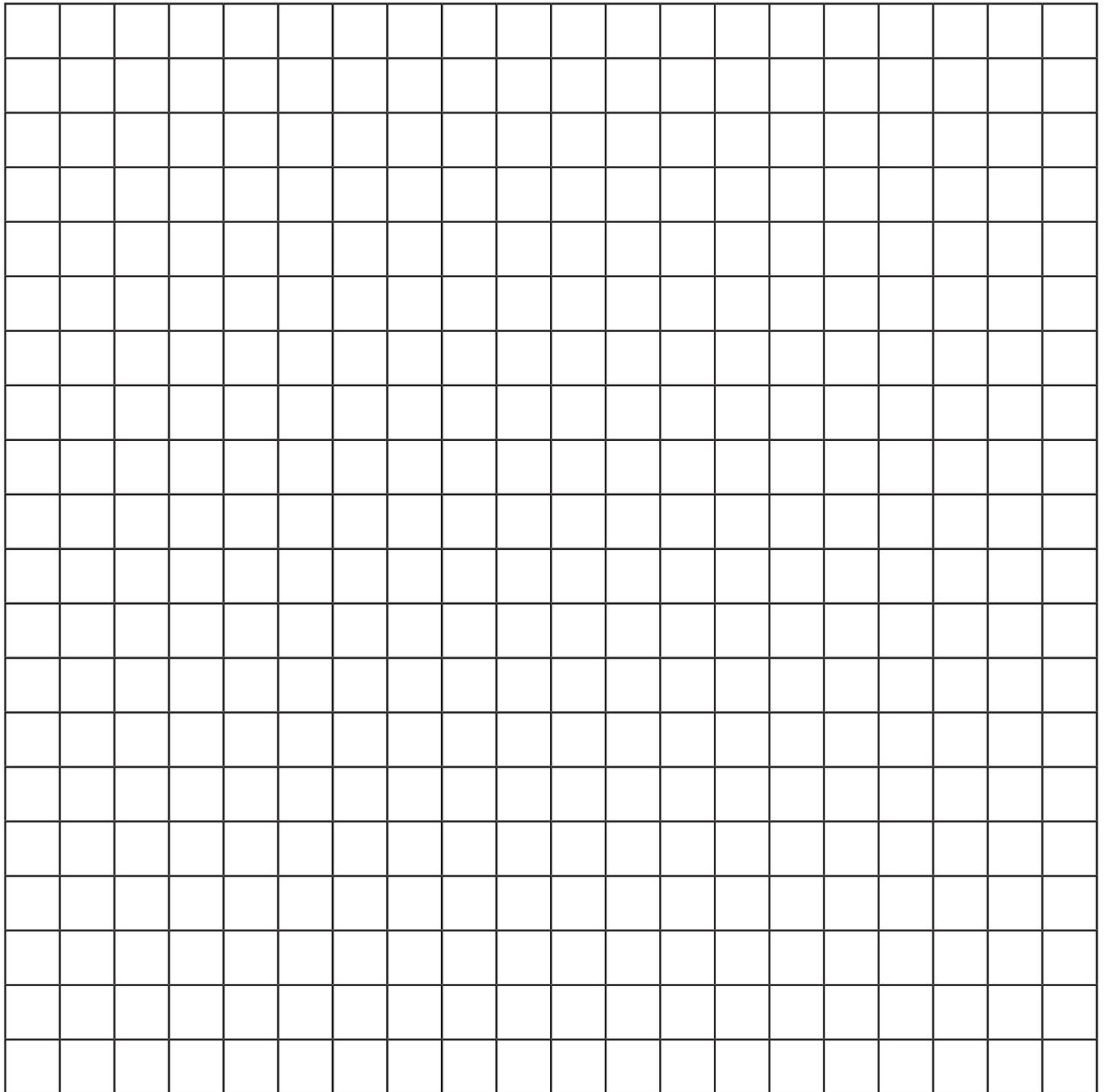
Lighting Investigation

DATA SHEET

Time (min)	Temperature of CFL Bulb (°C)	Temperature of IL Bulb (°C)	Temperature of LED Bulb (°C)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Change in Temperature ΔT			

Lighting Investigation

GRAPH TITLE _____



0 1 2 3 4 5 6 7 8 9 10

COLOR KEY:



CFL



LED



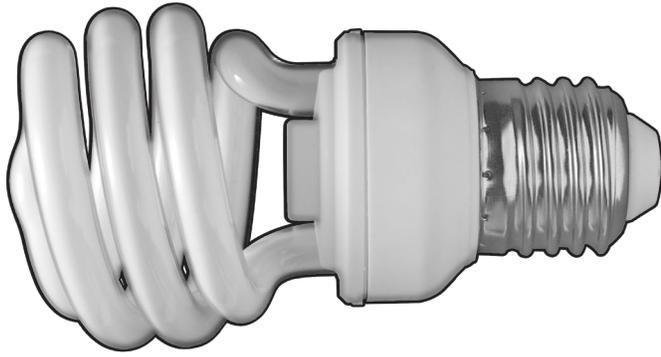
IL

LESSON 4

Lighting Investigation Results

1. Do your results support your hypothesis? Explain.
2. What characteristics do the light bulbs have in common?
3. How do the light bulbs differ?
4. Which light bulb is coolest in temperature when in use?
5. Which bulb is truly a “heat bulb” not a “light bulb”? Explain your answer.
6. What variables remain controlled?
7. What was your independent variable?
8. What is the dependent variable?

Light Bulb Comparison



	INCANDESCENT BULB (IL)	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Brightness	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	12,500 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	\$0.50	\$3.00	\$5.00

LESSON 4

Facts of Light

Why should I change my light bulbs? That is a great question! To get the answer, we need to look at the life cycle cost for light bulbs. Life cycle cost is the initial cost of the appliance (in our case a light bulb) AND the cost of energy needed to use the appliance over its life. Use the *Light Bulb Comparison* to determine which light bulb has the lowest life cycle cost.

Initial cost of light bulb + Energy costs (electricity) = Life cycle cost of light bulb

 Compact Fluorescent Bulb	 Incandescent Light Bulb	 Light Emitting Diode
Amount of light = _____ lumens	Amount of light = _____ lumens	Amount of light = _____ lumens
Power in watts = _____ watts	Power in watts = _____ watts	Power in watts = _____ watts
Lifespan = _____ hours	Lifespan = _____ hours	Lifespan = _____ hours
Bulbs needed for 25,000 hours? _____	Bulbs needed for 25,000 hours? _____	Bulbs needed for 25,000 hours? _____
Cost per bulb = _____	Cost per bulb = _____	Cost per bulb = _____
Total bulb cost for 25,000 hrs? \$ _____	Total bulb cost for 25,000 hrs? \$ _____	Total bulb cost for 25,000 hrs? \$ _____
_____ watts X 25,000 hrs = _____ watt-hours	_____ watts X 25,000 hrs = _____ watt-hours	_____ watts X 25,000 hrs = _____ watt-hours
Kilowatt-hours (kWh)? _____	Kilowatt-hours (kWh)? _____	Kilowatt-hours (kWh)? _____
Cost per kWh = \$0.13	Cost per kWh = \$0.13	Cost per kWh = \$0.13
Cost of electricity for 25,000 hours _____ kwh x \$ _____ /kwh = \$ _____	Cost of electricity for 25,000 hours _____ kwh x \$ _____ /kwh = \$ _____	Cost of electricity for 25,000 hours _____ kwh x \$ _____ /kwh = \$ _____
Life Cycle Cost \$ _____ + \$ _____ = \$ _____	Life Cycle Cost \$ _____ + \$ _____ = \$ _____	Life Cycle Cost \$ _____ + \$ _____ = \$ _____

Calculate Life Cycle Savings:

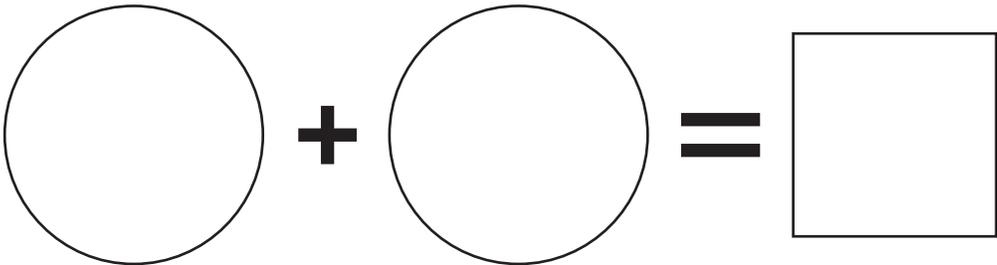
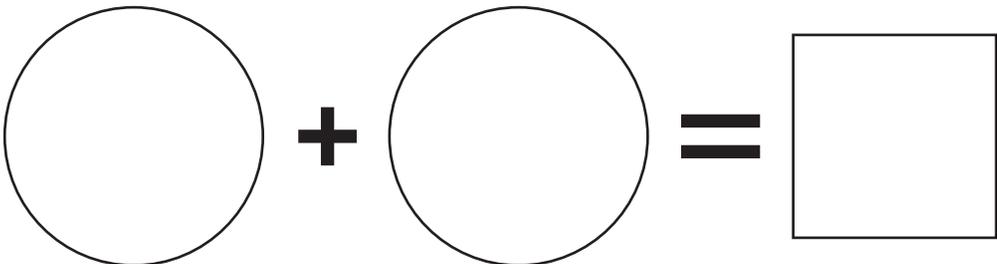
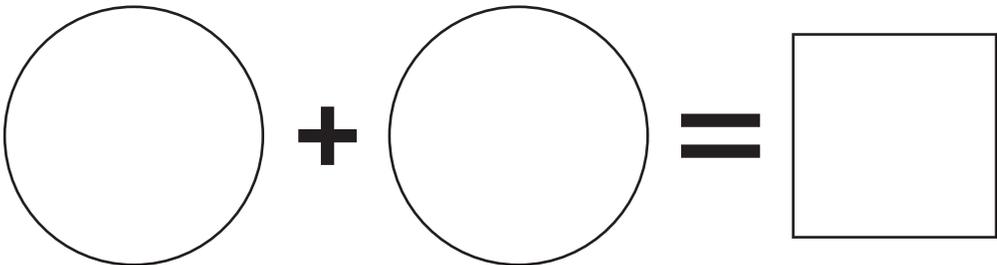
IL Life Cycle Cost _____ – CFL Life Cycle Cost _____ = Life Cycle savings _____

IL Life Cycle Cost _____ – LED Life Cycle Cost _____ = Life Cycle savings _____

LESSON 4

Facts of Light Summary

Use the *Facts of Light* data to show the life cycle cost of each bulb when used for 25,000 hours.

<p>INCANDESCENT</p> 	 <p>COST OF INCANDESCENT BULBS COST OF ELECTRICITY INCANDESCENT LIFE CYCLE COST</p>
<p>FLUORESCENT</p> 	 <p>COST OF FLUORESCENT BULBS COST OF ELECTRICITY CFL LIFE CYCLE COST</p>
<p>LED</p> 	 <p>COST OF LED BULBS COST OF ELECTRICITY LED LIFE CYCLE COST</p>



LESSON 4

Home Activity

Installing Light Bulbs

Safety note: Be sure to have an ADULT help with the installation of all light bulbs.

Materials

- Light Bulbs
- LED Nightlight (if available)

Procedure

1. Share your *Facts of Light Summary* with your family. Explain how you collected your data and calculated the life cycle cost of each bulb.
2. How many total light bulbs are in your home? _____
3. How much money could you save by replacing one incandescent bulb with a CFL?
4. How many CFLs or LEDs are in your home?
_____ No CFLs or LEDs

_____ 1-2 CFLs or LEDs

_____ 3-4 CFLs or LEDs

_____ > 4 CFLs or LEDs
5. Look at the nightlight (if available). The cost per year in electricity for an LED nightlight (plugged in constantly) is about \$0.02. If you use the nightlight for 80 years, what would the electricity cost you?
6. Install your lightbulb(s) with an adult.

LESSON 4 – Lighting Investigation

ASSESSMENT

1. A CFL uses about _____ of the energy used by an incandescent light bulb.
a. one fourth b. one tenth c. one half d. the same amount
2. An incandescent light bulb converts most of its energy into _____.
a. light energy b. nuclear energy c. thermal energy d. mechanical energy
3. The average cost of one kilowatt-hour of electricity for homes in Ohio is _____.
a. 25 cents b. \$1.00 c. 13 cents d. 2 cents
4. One of the easiest and cheapest ways to reduce electricity use at home is to _____.
a. replace windows b. add insulation to the attic
c. replace an old refrigerator d. change an IL to a CFL
5. What do the letters CFL stand for? Why are CFLs more efficient?

6. Why should you replace incandescent light bulbs with CFLs or LEDs and not wait until they burn out?

7. How do you calculate the life cycle cost of a light bulb?

LESSON 5

Background Information: Appliances and Machines

Electricity - What's a Watt?

We use electricity to perform many tasks. We use units called watts, kilowatts, and kilowatt-hours to measure the electricity that we use.

A **watt** is a measure of the electric power an appliance uses. Every appliance requires a certain number of watts to work correctly. Traditional light bulbs were rated by watts (60, 75, 100), as well as home appliances, such as a 1500-watt hairdryer. A **kilowatt** is 1,000 watts. It is used to measure larger amounts of electricity.

A **kilowatt-hour** (kWh) measures the amount of electricity used in one hour. Sometimes it's easier to understand these terms if you compare them to a car. A kilowatt is the *rate* of electric flow, or how much energy you are consuming at a specific instant. In a car, it would be similar to how fast you are driving at one instant. A kilowatt-hour is a quantity or amount of energy, or how much you consumed over a period of time. A kWh is like the distance traveled in a car.

We pay for the electricity we use in kilowatt-hours. Our power company sends us a bill for the number of kilowatt-hours we use every month. Most residential consumers in the United States pay about 13 cents per kilowatt-hour of electricity. In 2014, Washington state residents paid the least for electricity: 8.67 cents per kilowatt-hour. Hawaii residents paid the most: over 37 cents per kilowatt-hour.

Cost of Electricity

How much does it cost to make electricity? It depends on several factors, such as:

- **Fuel Cost:** The major cost of generating electricity is the cost of the fuel. Many energy sources can be used. Hydropower is the cheapest way while solar cells are usually the most expensive way to generate electricity.
- **Building Cost:** Another key is the cost of building the power plant itself. A plant may be very expensive to build, but the low cost of the fuel can make the electricity economical to produce. Nuclear power plants, for example, are very expensive to build, but their fuel—uranium—is inexpensive. Coal-fired plants, on the other hand, are cheaper to build, but their fuel—coal—is more expensive.
- **Efficiency:** When figuring cost, you must also consider a plant's efficiency. Efficiency is the amount of useful energy you get out of a system. A totally efficient machine would change all the energy put in it into useful work. Changing one form of energy into another always involves a loss of usable energy.

In general, today's power plants use three units of fuel to produce one unit of electricity. Most of the lost energy is waste heat. You can see this waste heat in the great clouds of steam pouring out of giant cooling towers on some power plants. A typical coal plant burns about 4,500 tons of coal each day. About two-thirds of the chemical energy in the coal (3,000 tons) is lost as it is converted first to thermal energy, and then to motion energy, and finally into electrical energy.

How Much Is a Watt?



1 WATT
Small, LED flashlight



1.5 KILOWATTS = 1500 WATTS
Blow dryer

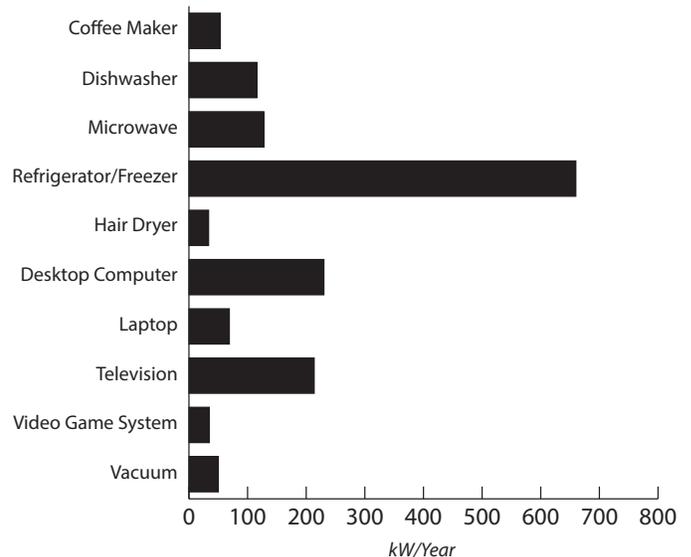


3 TO 5 MEGAWATTS =
3,000,000 to 5,000,000 WATTS
Diesel-electric locomotive engines



2 GIGAWATTS =
2,000,000,000 WATTS
Peak output of the Hoover Dam

How Much Electricity Do Appliances Use?



Data: DOE, Buildings Data Book

LESSON 5: BACKGROUND INFORMATION

Appliances and Machines

Appliances, machines, and electronic devices use about 24 percent of a typical household's energy, with refrigerators, freezers, clothes washers and dryers at the top of the list. Any appliance that is designed to change temperature uses a lot of energy. You can save energy by:

- turning off appliances and machines when you aren't using them;
- using the energy-saver setting on dishwashers and refrigerators;
- keeping the doors closed as much as possible on refrigerators and freezers—know what you want before you open the doors;
- being aware that many machines use energy even when turned off—save energy by unplugging them; and
- using machines and appliances during the morning and evening, not during peak demand time.

When you shop for a new appliance, you should think of two price tags. The first one covers the purchase price—the down payment. The second price tag is the cost of operating the appliance. You'll pay the second price tag on your utility bill every month for the next 10 to 20 years. An energy efficient appliance will usually cost more, but it will save a lot of money in energy costs. An energy efficient model is almost always a better deal.

ENERGY STAR®

When you shop for a new appliance, look for the **ENERGY STAR®** label—your guarantee that the product saves energy. ENERGY STAR® qualified appliances incorporate advanced technologies that use less energy and water than standard models. A list of energy efficient appliances can be found on the ENERGY STAR® website at www.energystar.gov.

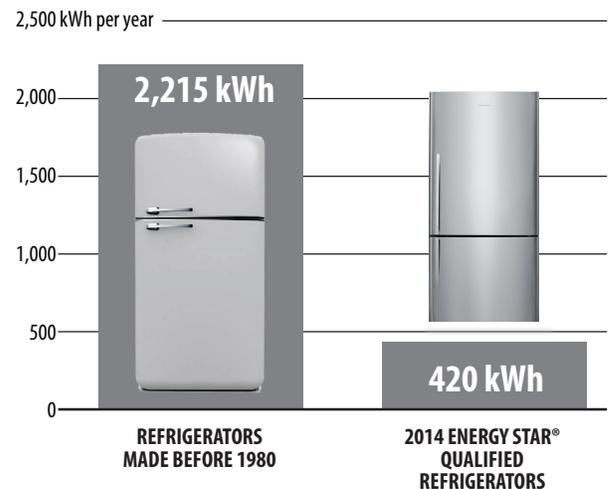


Vampire Power

Household appliances and electronics contribute to a significant portion of the expenses seen on monthly electric bills. What consumers may not know is a large part of that expense could be a result of items that are not even used. According to energy experts, about 5 to 10 percent of a home's electricity is used by appliances that are in standby mode. In Ohio, that means approximately \$55 to \$110 per year could be saved on your electric bill if you knew which electronics and other household items have standby modes and took action to lower this power use. This electricity "loss" also is referred to as vampire power.

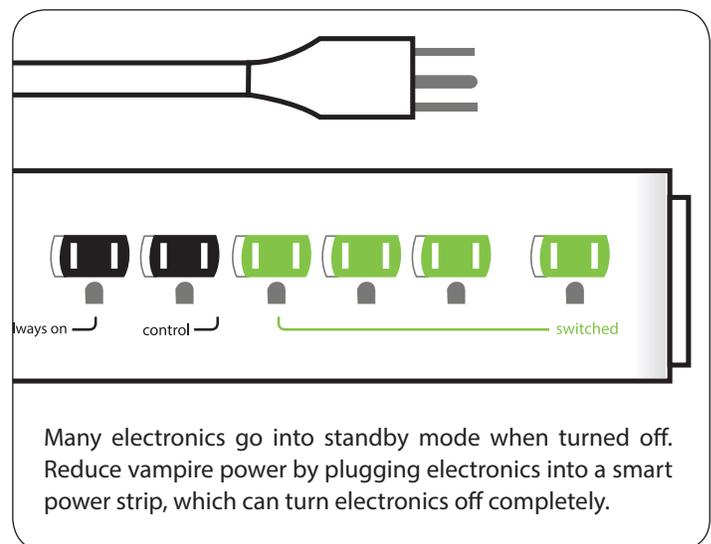
Many everyday appliances and electronics use significant power while in standby mode. The use and amount depends on the individual product; however, some of these appliances that use vampire power include: clock radios, satellite/cable boxes and digital video recorder (DVR) equipment, televisions, DVD and VCR players, video game consoles, computers and monitors, printers, and microwaves.

Refrigerator Efficiency



Data: ENERGY STAR®

SMART POWER STRIPS



Many electronics go into standby mode when turned off. Reduce vampire power by plugging electronics into a smart power strip, which can turn electronics off completely.

Appliances and Machines Investigation

Question

Which items are the largest energy consumers in your school or home?

Materials

- Kill A Watt™ monitor
- Pluggable appliances

Hypothesis

Procedure

Calculate how much it costs to operate the machines in your classroom or home. You need to know the wattage, the cost of electricity, and the number of hours a week each machine is used. You can find the wattage by plugging the machine into the watt meter.

You can estimate the number of hours the machine is used each week, then multiply by 40 to get the yearly use. We are using 40 weeks for schools, because school buildings aren't used every week of the year. Using the copier as an example, if it is used for ten hours each week, we can find the yearly use like this:

$$\text{Yearly use} = 10 \text{ hours/week} \times 40 \text{ weeks/year} = 400 \text{ hours/year}$$

Remember that electricity is measured in kilowatt-hours. You will need to change the reading from the watt meter (in watts) to kilowatts. One kilowatt is equal to 1,000 watts. To get kilowatts, you must divide the watts by 1,000. For example, if the copier used 1,265 watts on the watt meter you would divide like this:

$$\begin{aligned} \text{kW} &= \text{W}/1,000 \\ \text{kW} &= 1,265/1,000 = 1.265 \end{aligned}$$

The average **cost of electricity in Ohio is about thirteen cents (\$0.13)** a kilowatt-hour. You can use this rate or find out the actual rate from your school's electric bill. Using the average cost of electricity, we can figure out how much it costs to run the copier for a year by using this formula:

$$\begin{aligned} \text{Yearly cost} &= \text{Hours used} \times \text{Kilowatts} \times \text{Cost of electricity (kWh)} \\ \text{Yearly cost} &= 400 \text{ hours/year} \times 1.265 \text{ kW} \times \$0.13/\text{kWh} \\ \text{Yearly cost} &= 400 \times 1.265 \times \$0.13/\text{kWh} = \$65.78 \end{aligned}$$

MACHINE OR APPLIANCE	HOURS PER WEEK	HOURS PER YEAR	WATTS (W)	KILOWATTS (kW)	RATE (\$/kWh)	ANNUAL COST
Copier	10	400 hours	1,265 W	1.265 kW	\$0.13	\$65.78

LESSON 5

The Environment and You

When we breathe, we produce carbon dioxide. When we burn fuels, we produce carbon dioxide, too. Carbon dioxide (CO₂) is a greenhouse gas. Greenhouse gases hold heat in the atmosphere. They keep our planet warm enough for us to live, but since the Industrial Revolution, we have been producing more carbon dioxide than ever before. Since 1850, the level of CO₂ in the atmosphere has increased 44.3 percent.

Research shows that greenhouse gases are trapping more heat in the atmosphere. Scientists believe this is causing the average temperature of the Earth's atmosphere to rise. They call this global climate change or global warming. Global warming refers to an average increase in the temperature of the atmosphere, which in turn causes changes in climate. A warmer atmosphere may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.

Driving cars and trucks produces carbon dioxide because fuel is burned. Heating homes by burning natural gas, wood, heating oil, or propane produces carbon dioxide, too.

Making electricity can also produce carbon dioxide. Some energy sources—such as hydropower, solar, wind, geothermal, and nuclear—do not produce carbon dioxide, because no fuel is burned. About 38.6 percent of our electricity, however, comes from burning coal. Another 30.4 percent comes from burning natural gas, petroleum, and biomass.

The general rule is that, on average, every kilowatt-hour of electricity produces 1.23 pounds of carbon dioxide. Let's use this rule to figure out how much carbon dioxide is produced by the machines in your classroom. You can put the figures from the earlier worksheets in the boxes below. Here are the figures for the copier:

$$\text{CO}_2 \text{ a year} = \text{wattage} \quad \times \quad \text{hours of use} \quad \times \quad \text{rate of CO}_2/\text{kWh}$$

$$\text{CO}_2 \text{ a year} = 1.265 \text{ kW} \quad \times \quad 400 \text{ hr/yr} \quad \times \quad 1.23 \text{ lb/kWh} \quad = \quad 622.38 \text{ lbs}$$

MACHINE OR APPLIANCE	KILOWATTS (kW)	RATE OF CO ₂ /kWh (LBS)	HOURS PER YEAR	CO ₂ /YEAR (LBS)
<i>Copier</i>	<i>1.265 kW</i>	<i>1.23</i>	<i>400 hours</i>	<i>622.38</i>



LESSON 5

Home Activity

APPLIANCES AND ENERGY STAR® LOGOS

Materials

- Refrigerator thermometer
- Dollar bill

Procedure

1. With the help of an adult, test the seal on the door of your refrigerator. To do this, you will need a dollar bill. Close the door over the dollar bill so that it is half in and half out of the refrigerator. Grasp the end of the bill with both hands by the corners and pull slowly and steadily. Do not try to jerk it; it might tear. A refrigerator with a tighter seal (dollar bill does not move) is more efficient and uses less energy. You can save energy and money by keeping the refrigerator door closed tightly.

- _____ comes out easily
- _____ comes out fairly easily
- _____ comes out with difficulty
- _____ does not move

2. Use the refrigerator thermometer to measure the temperature of your refrigerator and freezer and record in the chart below.

APPLIANCE	TEMPERATURE	SAFE ZONE (°F)
Refrigerator		37°-40°
Freezer Section		0°-5°
Separate Freezer (if applicable)		0° or Colder

3. Look around your house for large or small appliances that have ENERGY STAR® logos on them. Explain to your family that the ENERGY STAR® means the appliances meet strict energy efficiency standards. What ENERGY STAR® appliances did you find?



LESSON 5 – APPLIANCES AND MACHINES

ASSESSMENT

1. Most appliances are powered by _____.

a. natural gas

b. electricity

c. propane

d. petroleum

2. One of the appliances that uses the most energy in your home is the _____.

a. refrigerator

b. computer

c. radio

d. television

3. One kilowatt is equal to _____ watts.

a. 10

b. 100

c. 1000

d. 10,000

4. A fan and a hair dryer both move air. How do the watts used by each compare? Explain why there is such a difference.

5. Explain how an appliance could have a lower wattage than another but still cost more per year for electricity. Give examples.

Family Installation Survey

This program is funded through your local electric and/or natural gas provider. We ask all families to complete this survey to measure the energy savings from the program. Thank you for making a difference and saving money with your energy efficiency actions.

Please visit www.ohioenergy.org to complete the survey.

The screenshot shows the Ohio Energy Project website interface. At the top left is the logo for the Ohio Energy Project, featuring a stylized sun with orange and yellow dots above the text "OHIO energy PROJECT". To the right of the logo are contact options: "Call us! 614•785•1717", "Email us!", and social media icons for Facebook, Google+, and YouTube. Below these is a search bar with the text "search our site!". A horizontal navigation bar contains five yellow circular icons with labels: "about oep" (lightbulb), "educators" (apple), "students and families" (speech bubbles), "be a partner" (handshake), and "energy bike" (bicycle). Below the navigation bar is a sidebar with several menu items: "family installation survey", "online energy games", "image gallery", "residential resources", and "oep calendar of events". The "oep calendar of events" section shows a calendar with three events: "Energy Portfolios Due" on APR 15, "Youth Energy Celebration" on MAY 10, and "Board of Directors Meeting" on JUN 2. A "View All" link is at the bottom of the calendar. The main content area is titled "family installation survey" and contains the heading "We Need Your Input – Complete with Your Family". Below the heading is a paragraph of text: "When finished, print the last page to return to your teacher. Your answers will be part of the statewide data collection. No individual student's results will be tied back to the student or family. Questions with an asterisk must be completed. Your teacher should provide your class with a password. You cannot begin the survey without first providing the correct password." This is followed by "Thank you!" and the instruction "Select Your School District, School and then Teacher:". There are three dropdown menus: "Canton City School District", "McKinley Senior High School", and "Drake Yost". At the bottom is a "Password" field with a masked input box.

LESSON 6 – What Have We Learned?

CONNECTIONS

1. What are the most important things you have learned about energy and how to save it?

2. What energy concepts would you like to learn more about?

3. What things do you think you and your family will do to save energy at home?

4. How will saving energy now impact your life later as an adult?

Saving Energy Glossary

appliance	any piece of equipment, usually powered by electricity, that is used to perform a particular function; examples of common appliances are refrigerators, clothes washers, microwaves, and dishwashers
compact fluorescent	a light bulb consisting of a gas-filled tube and a magnetic or electronic ballast; electricity flows from the ballast through the gas, causing it to give off ultraviolet light; the ultraviolet light excites a white phosphor coating on the inside of the tube, which emits visible light; compact fluorescent light bulbs use less energy and produce less heat than a comparable incandescent bulb
conductor	a material that transfers energy through it well, often metal
energy	the ability to do work or make a change
energy conservation	saving energy through behavior changes and installing energy efficient devices
energy efficiency	the ratio of the energy delivered by a machine to the energy supplied for its operation; often refers to reducing energy consumption by using technologically advanced equipment without affecting the service provided
ENERGY STAR®	a Federal Government program that recognizes the most energy efficient machines with a logo
energy sustainability	meeting energy demands without affecting the needs of others for the future
EnergyGuide label	the label on an appliance that shows how much energy the appliance uses in comparison to similar appliances
fossil fuel	fuels (coal, oil, etc.) that result from the compression of ancient plant and animal life formed over hundreds of millions of years
gauge	an instrument for or a means of measuring or testing
halogen	a type of incandescent light bulb that uses a small amount of a halogen gas and a filament; slightly more efficient than traditional incandescent bulbs
incandescent	a type of electric light in which light is produced by a filament heated by electric current; the most common example is the type you find in table and floor lamps
insulation	a material used to separate surfaces to prevent the transfer of electricity, heat, or sound
insulator	a material that does not transfer energy well
Kill A Watt™ monitor	a device that measures the amount of electrical energy used by a machine
kilowatt	a unit of power, used to measure electric power or consumption; a kilowatt equals 1,000 watts
kilowatt-hour (kWh)	a measure of electricity, measured as one kilowatt (1,000 watts) of power expended over one hour
kinetic	the energy of motion
light emitting diodes	energy saving bulb that generates light through the use of a semiconductor
lumen	a measure of the amount of light produced by a bulb
nonrenewable	fuels that cannot be renewed or made again in a short period of time, such as petroleum, natural gas, coal, propane, and uranium
payback period	the length of time you must use a more expensive, energy efficient appliance before it begins to save you money in excess of the additional upfront cost
renewable	fuels that can be made or used again in a short period of time, such as solar, wind, biomass, geothermal, and hydrometer
semiconductor	a material that has a conductivity level between an insulator and a conductor
temperature	a measure of thermal energy
thermostat	a device that controls the amount of heating and cooling produced and/or distributed
watt	a unit of measure of power
weatherization	to make a house better protected against the effects of weather

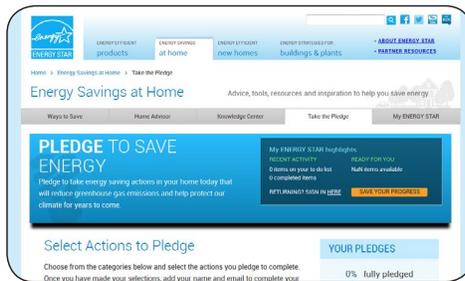
Internet Resources



The National Energy Education Development Project

Energy information and activities for students and teachers.

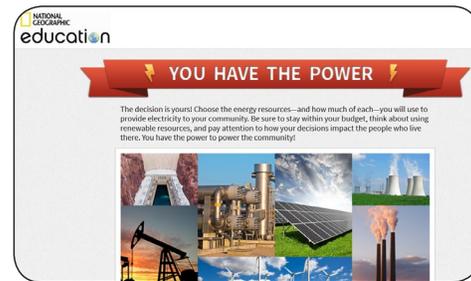
www.need.org



Energy Savings at Home

Take the ENERGY STAR® Pledge and do your part to save energy and reduce emissions.

www.energystar.gov/campaign/takeThePledge



National Geographic

The decision is yours! Choose the energy resources—and how much of each—you will use to provide electricity to your community.

<http://media.education.nationalgeographic.com/assets/richmedia/0/213/project/index.html?page=intro>



Ohio Consumers Council

Learn ways to save 5-10% of your electric bill by turning off appliances instead of using standby mode.

http://www.occ.ohio.gov/publications/electric/Vampire_Power.pdf



Energy Hog

This interactive video game is full of sound effects, cartoon characters, and activities that teach students about energy efficiency.

www.energihog.org



Energy Kid's Page

Energy Ant hosts this site containing energy facts, fun and games, classroom activities, and more.

www.eia.gov/kids



Find Your Efficiency Zone

Based on the zip code entered, it will provide a comparison of the energy costs of an average home and an energy-efficient home in your area.

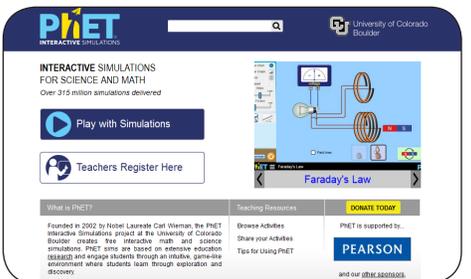
<http://homeenergysaver.lbl.gov/consumer>



Ask A Scientist

This online question-and-answer service for K-12 teachers and students was launched in 1991. Today Ask A Scientist is in several formats including YouTube™, AMA, and on Twitter.

www.anl.gov/education/learning-center/classroom-resources



Energy Systems

Interactive simulations show how energy works.

<http://phet.colorado.edu>

Tips to Save Energy

- Install a programmable thermostat to lower utility bills and manage your heating and cooling systems efficiently.
 - Air-dry dishes instead of using your dishwasher's drying cycle.
 - Turn off appliances and devices when you are not in the room or when they are not in use.
 - Put devices like TVs, DVD players, stereo equipment, and lights into smart power strips. Electronics in standby mode can still use several watts of power.
 - Call 811 before you dig.
 - Lower the thermostat on your water heater to 120°F.
- Take short showers instead of baths and use low-flow showerheads for additional energy savings.
 - Wash only full loads of dishes and clothes.
- Check to see that windows and doors are closed when heating or cooling your home.

