SAVING ENERGY AT HOME

2018-2019

STUDENT AND FAMILY GUIDE

e³ smart℠

An Energy Efficiency Curriculum brought to you by

OHIO energy PROJECT

funded by

AEP OHIO℠

An AEP Company

aepohio.com/save

Columbia Gas®

columbiagasohio.com/ways-to-save

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. Participating 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 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

Table of Contents

Background Information: What is Energy?

What Is Energy?

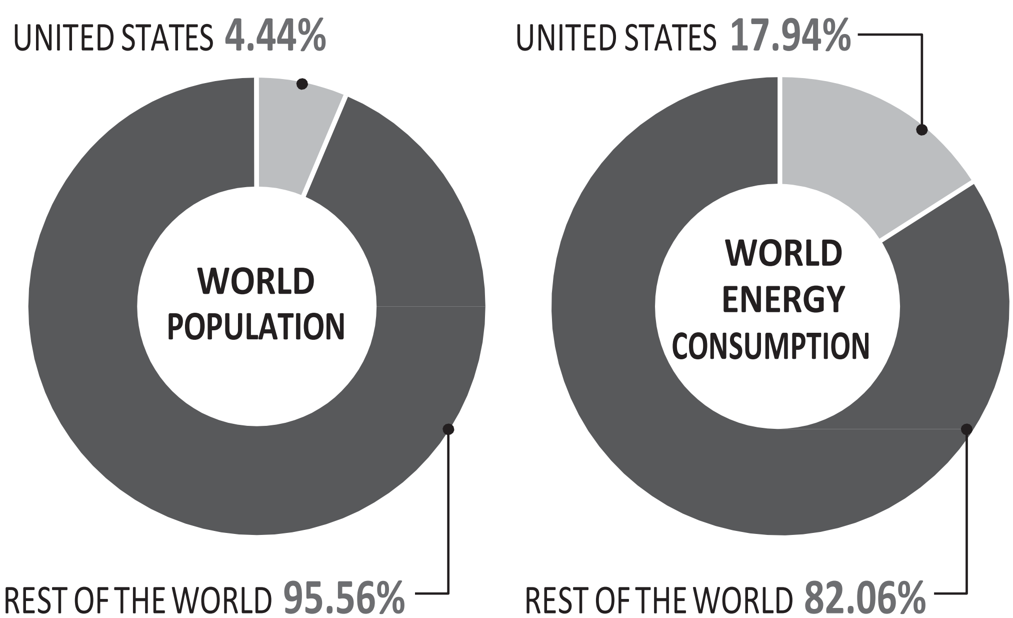
Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as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

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.

Population Versus Energy Consumption, 2015



Data: Energy Information Administration

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.

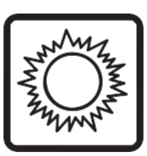
Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

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

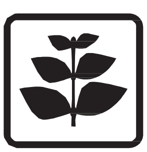
WIND is energy from moving air.

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.

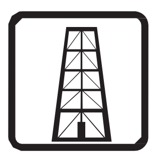


BIOMASS is any organic matter (anything that was once alive) that can be used as an energy source such as wood, crops, and yard waste.

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.



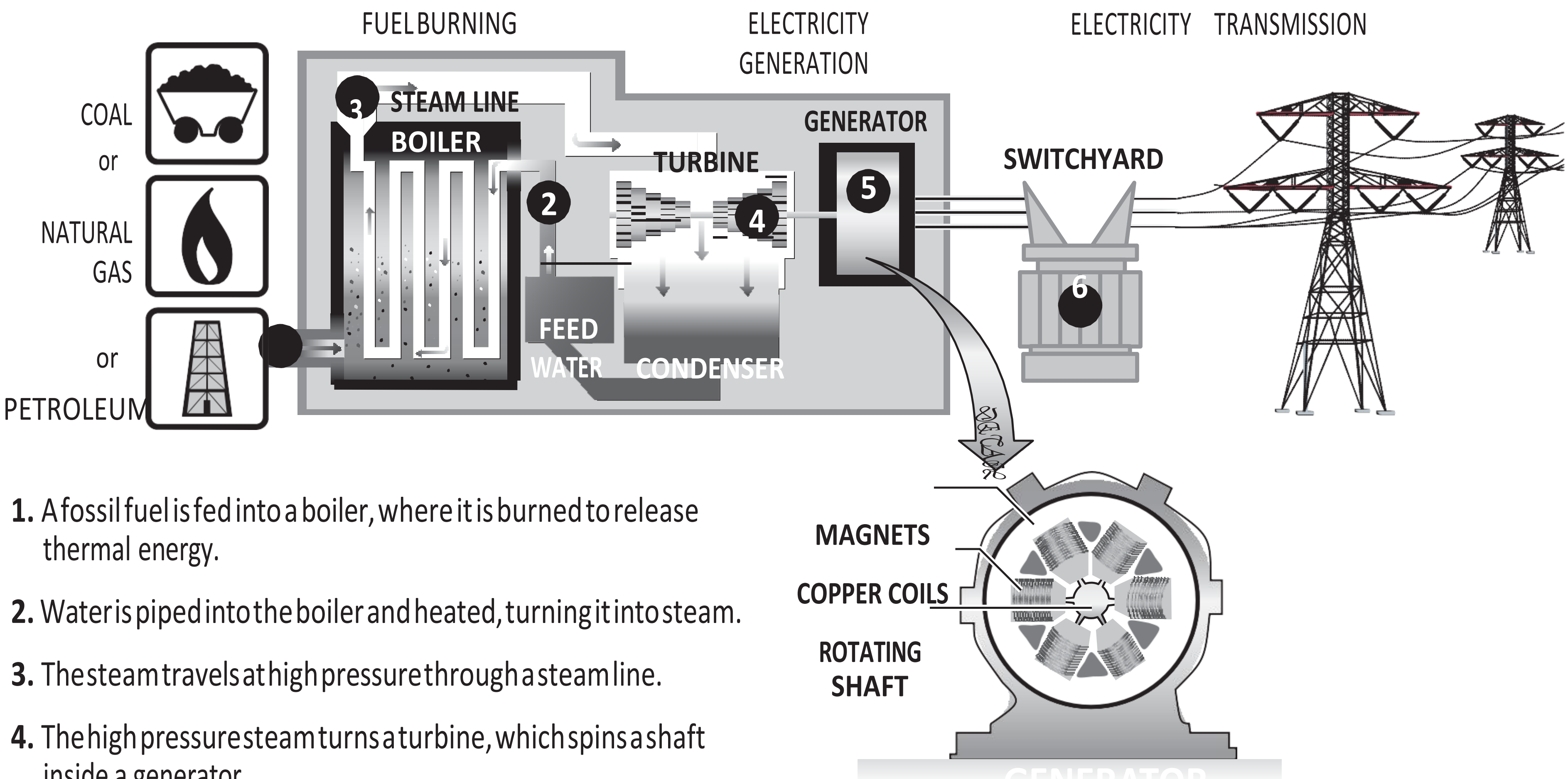
PETROLEUM is a fossil fuel that looks like a black liquid. It is also known as crude oil.

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.

Burning Fossil Fuels to Generate Electricity

HOW WE USE OUR ENERGY SOURCES



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.

Energy Source Matching

✔ **Procedure**

1. Match the source of energy with the definition and complete the chart.

Wind
Uranium
Biomass
Petroleum
Natural Gas
Coal
Propane
Solar
Geothermal
Hydropower

Energy Source	Definition	Example
	A solid black fossil fuel that formed from the remains of plants that lived and died millions of years ago	
	Energy from the sun	
	Any organic matter that can be used as an energy source such as wood or crops	
	A fossil fuel that looks like a thick, black liquid	
	a colorless, flammable gas, refined from petroleum and natural gas	
	The fuel used by nuclear power plants to produce steam	
	Energy in moving air	
	A colorless, odorless fossil fuel made mostly of methane	
	Energy that comes from the force of falling water	
	Energy from the heat within the Earth	

2. Match each example with the energy source and complete the chart.

- Turbines can be located on land or offshore
- Fuel mainly used for heating or transportation
- Volcanoes and geysers are evidence
- Can be refined to gasoline and diesel fuel
- Dams built to create a reservoir
- Atoms split (fission) forming smaller atoms and releasing energy
- Energy transformed by photosynthesis in plants
- Travels to the Earth as radiant energy
- Can be mined on surface or deep from within the Earth
- Can be compressed into tanks for grilling food

Background Information

All forms of energy fall under two categories:

POTENTIAL

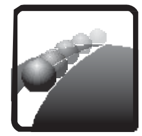
Stored energy and the energy of position (gravitational).

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.

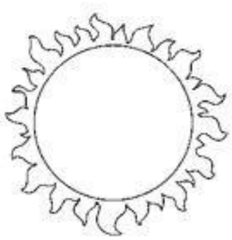
Energy Transformations

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.

Chemical Energy

Radiant (light) Energy



Radiant (light) Energy

Chemical Energy

Mechanical Energy

Chemical Energy

Electrical Energy

Radiant (Light) Energy + Sound Energy

Energy Flows

The Sun's Energy Affects Our Lives

from Borrego Solar Photovoltaic Lesson Plans Intermediate Module pages 56 – 57

Even though the energy that arrives at the surface of the earth is just a very tiny part of all the energy that the sun gives off, it is still a huge amount of energy. The energy we get from the sun in one day is greater than all the energy that all the people of earth would use in 25 years!

What happens to all that energy?

A lot of the energy goes into heating up the surface of the earth – the land and ocean. As the surface gets warm, it warms the air above it. When the sun heats up the ocean (and other bodies of water, like rivers and lakes), some of the water is evaporated and goes into the air.

When air is heated, it moves, and carries with it the water vapor that it contains. The moving air is the wind and the water vapor eventually comes back to earth as rain and snow. Thus, the energy of the sun is what gives us weather.

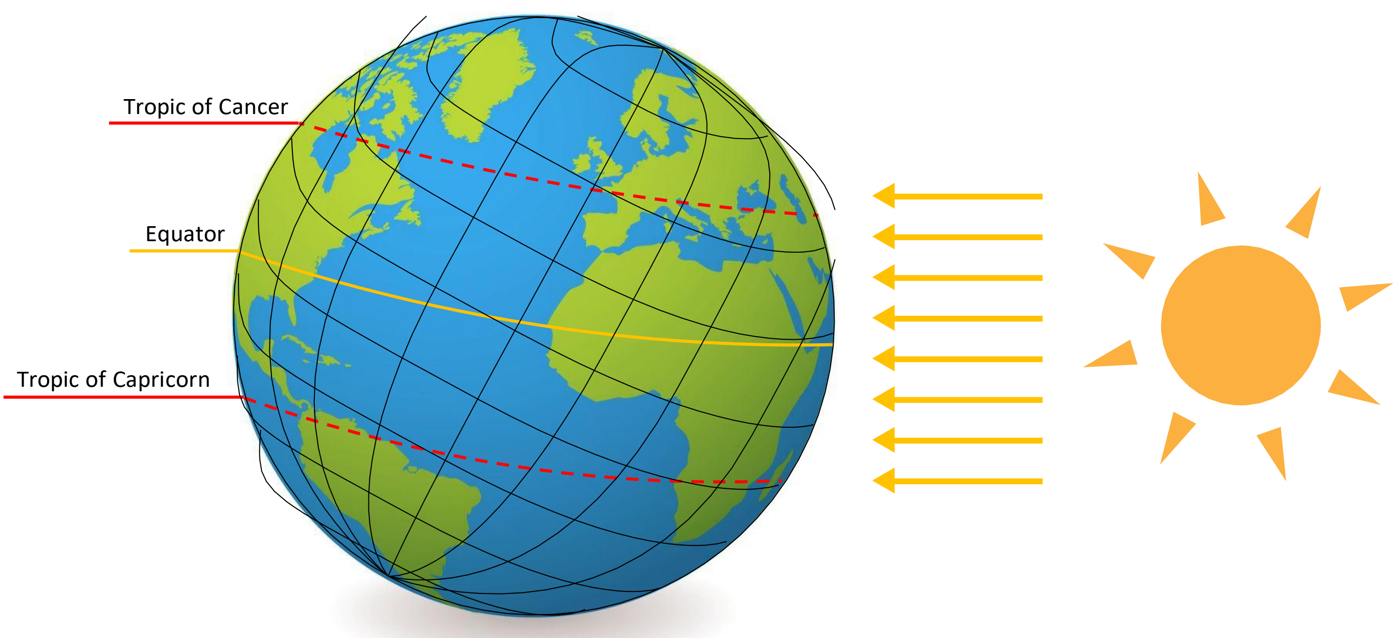
Some of the energy of the sun is absorbed by plants, and that energy is captured in materials which make up bodies of the plants and the seeds that they produce. People and animals eat the plants, and some of the energy is released to keep their bodies warm and provide power to their muscles so they can move.

Parts of the plants can also be used as fuel, like when we burn wood for campfires or to cook. In fact, all the energy in all of the fuel we burn – whether it is wood, gasoline, natural gas, coal or oil – originally came from the sun providing energy for plants to perform photosynthesis.

Some of that fuel is burned in power plants, which produces electricity to power our homes and other buildings.

Some places also get electricity from "hydroelectric" plants, which use the energy of falling water instead of burning fuel. That energy comes from the sun, too. It's the warmth of the sun that lifts that water – in the form of water vapor- from the oceans up to the mountains. There it falls as rain and snow and fills the rivers that power the hydroelectric plants. The sun is the energy source of the water cycle.

Not very long ago, we invented some ways to capture and use the energy of sunlight, with solar or photovoltaic panels to make electricity. Only a very, very tiny part of the sunlight that arrives to earth is used in this way.



Energy Forms Matching

✔ **Procedure**

1. Match the form of energy with the definition and complete the chart.

Chemical
Elastic
Mechanical
Nuclear
Radiant
Sound
Gravitational Potential Energy
Thermal
Electrical

Energy Form	Definition	Example
	The energy stored in the bond between molecules	
	Energy in the form of electromagnetic waves	
	The energy of place or position	
	The movement of energy through a substance in a longitudinal wave	
	The energy stored in the nucleus of an atom	
	The movement of an object from one place to another	
	The movement of electrons	
	Energy stored by applying force such as squeezing	
	The internal energy in a substance due to the movement of particles	

2. Match each example with the energy form and complete the chart.

Gasoline, food, battery

Music, shouting

Stretched rubber band

Sunlight and X-rays

Walking, riding a bicycle

Uranium and plutonium atomic nucleus

Lightning, electricity

Rubbing your hands together, heat from fire

A boulder on top of a hill

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		RENEWABLE	
Petroleum	______________	Biomass	______________
Natural Gas	______________	Hydropower	______________
Coal	______________	Wind	______________
Uranium	______________	Solar	______________
Propane	______________	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, 2015

NONRENEWABLE

PETROLEUM **36.6%** *
Uses: transportation, manufacturing - includes propane

NATURAL GAS **29.0%** *
Uses: heating, manufacturing, electricity - includes propane

COAL **16.0%**
Uses: electricity, manufacturing

URANIUM **8.6%**
Uses: electricity

PROPANE
Uses: heating, manufacturing

*Propane consumption is included in petroleum and natural gas totals.

RENEWABLE

BIOMASS **4.9%**
Uses: heating, electricity, transportation

HYDROPOWER **2.4%**
Uses: electricity

WIND **1.8%**
Uses: electricity

SOLAR **0.4%**
Uses: heating, electricity

GEOTHERMAL **0.2%**
Uses: heating, electricity

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

Energy Flows

How is energy transformed? Compare and contrast energy transformations below.

Directions:

After your teacher hands out a set of energy source transformation cards to your group, sequence the cards in the order that they happen. The initial card should begin on the left with the subsequent cards following to the right. Write out the energy transformation.

What do the sources have in common?

Can each of these sources produce the same end product?

Is electricity a primary or secondary source of energy?

Background Information

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.

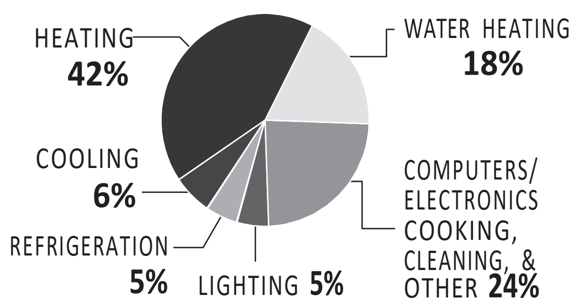
Energy conservation is any action or behavior that results in using less energy. Drying clothes outside on sunny days is an example of energy conservation. **Energy efficiency** focuses on technologies that use less energy to perform the same tasks or the same amount of work. Buying a dryer that uses 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.

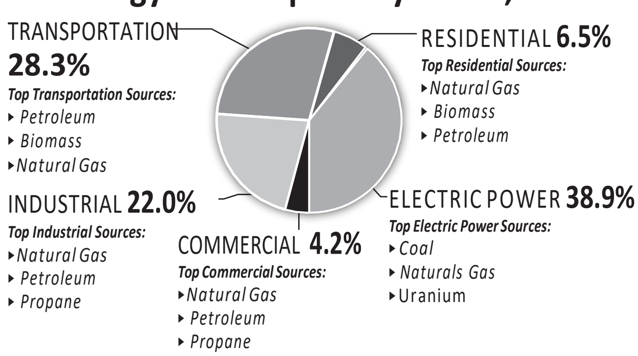
The residential sector includes houses, apartments, and other places where people live. The commercial sector includes schools, businesses, and hospitals. The residential and commercial sectors are put together because they use energy for similar tasks—for heating, air conditioning, water heating, lighting,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

Home Energy Usage, 2015



Data: U.S. Department of Energy

U.S. Energy Consumption by Sector, 2015



The residential, commercial, and industrial sectors use electricity. This graph depicts their energy source consumption outside of electricity.

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

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 it 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.

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)	_______________	_______________

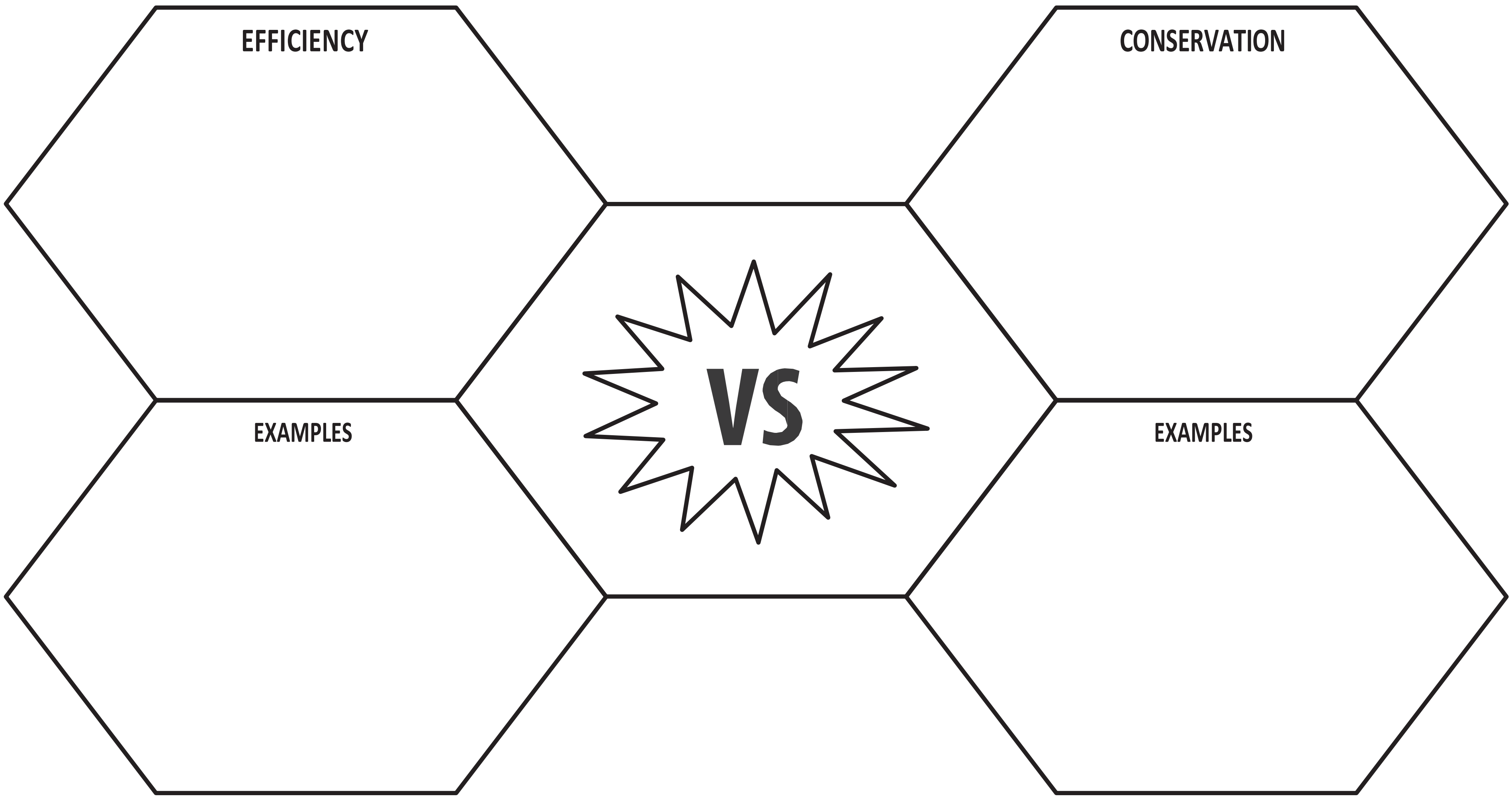
What devices were used at home last night?

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 _______________

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 – 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 1 – What is Energy?

CONNECTIONS

1. If you could decide on the source of energy used to generate electricity for your community, which energy source(s) would you choose and why?

2. Using the forms of energy, describe the transformation of energy in a car.

3. After completing *The Energy I Used Today* and the *Household Rating Guide*, list 5 things you would change to save energy.

LESSON 2

Background Information: Lighting

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 11% 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.

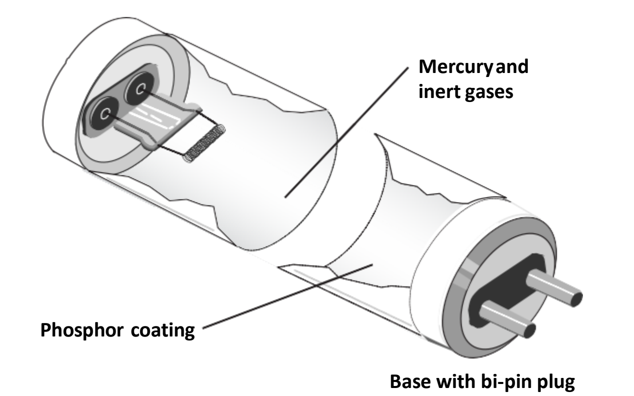
Fluorescent lights use 75 percent less energy than traditional incandescents and reduce environmental impacts. Converting to compact fluorescent light bulbs (CFLs) in your home is one of the quickest and easiest ways to decrease your electricity bill. You will save a $30-$80 in electricity costs over the lifetime of every 100-watt incandescent bulb you replace. CFLs provide the same amount of light and save energy.

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.

Fluorescent lights have ballasts that help move the electricity through the gas inside the bulb. There are two types of ballasts, magnetic and electronic. Electronic ballasts are more efficient than magnetic ballasts and can eliminate flickering and noise.

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.

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.

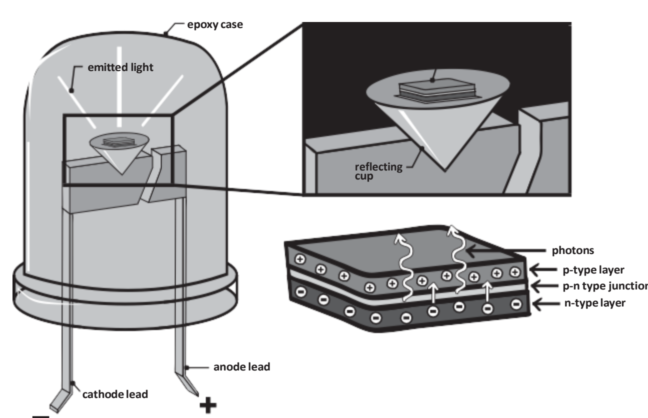
Compact Fluorescent Light Bulbs

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

Did You Know?

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

Inside an LED



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 the n-type layer to the p-type layer. When the electrons move back again, they emit light that we see. The section of text called "How Light Emitting Diodes Work" below explains this process in more detail.

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:

③switch incandescent bulbs to CFLs or LEDs;
③shut off lighting when exiting the room; and
③use natural light by opening blinds or curtains when possible.

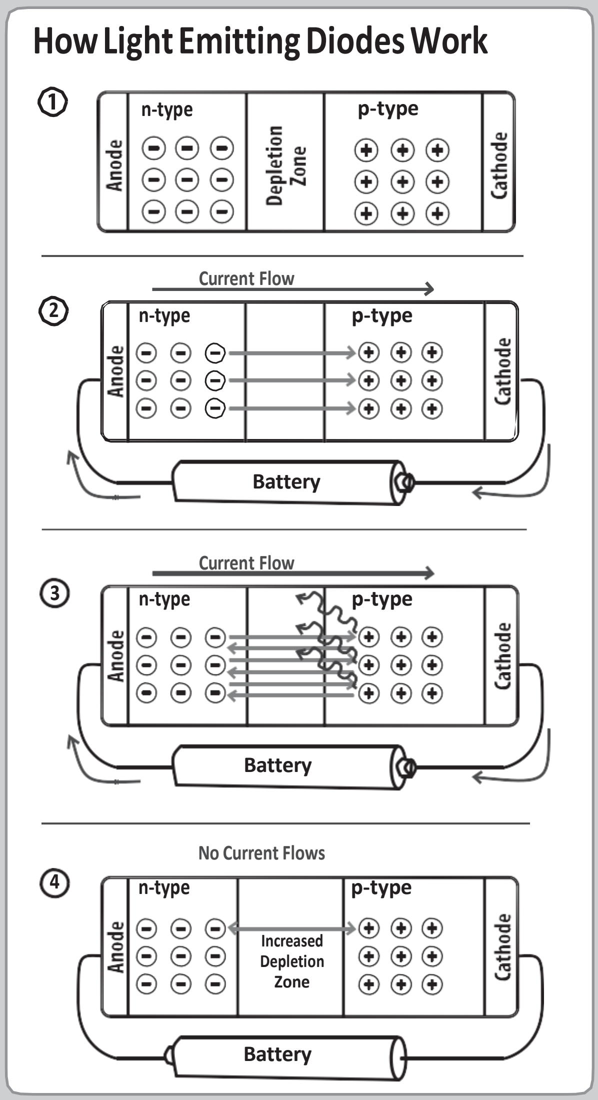
Facts of Light

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

- Lumens: a measure of the amount of light falling on an object at a given distance, often referred to as "brightness."
- Watts: units of power, the rate at which a bulb or appliance uses energy.
- Kilowatts: 1000 watts (It is more useful when talking about electricity use than a single watt because we use so many thousands of watts.)
- Kilowatt-hour: the unit in which we buy electricity. It is a unit for energy. It is equal to 1000 watts used for one hour. Kilowatt-hours are calculated by multiplying kilowatts by hours used.

How Light Emitting Diodes Work

1. Diodes are made of semiconductors and conducting materials that need to be added to the semiconductor. In an LED the most common conductor added is aluminum-gallium-arsenide (AlGaAs). The AlGaAs is "doped" by adding small amounts of another material. One material will have more valence electrons than AlGaAs, and another doping material will have fewer electrons. The two doped materials are put together in a crystal. The material with more electrons is the "n-type" (n for negative) and the material with fewer electrons is the "p-type" (p for positive). When these materials are sandwiched together, the electrons move to balance themselves out. The area between the materials, called the p-n junction, is also called the "depletion zone."
2. Connecting a power source to the diode, such as a battery, provides electric current that carries electrical energy. The electrons in the n-type are repelled by the electric current, and move through the depletion zone to the p-type. They are energized and will want to return to their original, unenergized state in the n-type.
3. When the electrons move back through the depletion zone to the n-type, they release energy as light. This is the light that we see from the LED. This process continues over and over again–electrons absorbing energy, moving, then moving back and releasing the energy until the power supply is disconnected or depleted.
4. Connecting the power supply in the wrong orientation does not allow the LED to work. Instead, it merely increases the size of the depletion zone. Therefore, it is important that LED's be wired to their power supply in the correct orientation.



Lighting Investigation

Question

Of the three types of light bulbs, incandescent, CFL, and LED, which produces the greatest temperature change in ten minutes?

Materials

③3 lamp bases
③1 Incandescent bulb (IL)
③1 Fluorescent bulb (CFL)
③Powerstrip, if available
③1 Light emitting diode bulb (LED)
③3 Digital thermometers
③Ruler
③Timer

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 on the table beneath 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. Make a line graph of your results. Use a different color line 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.

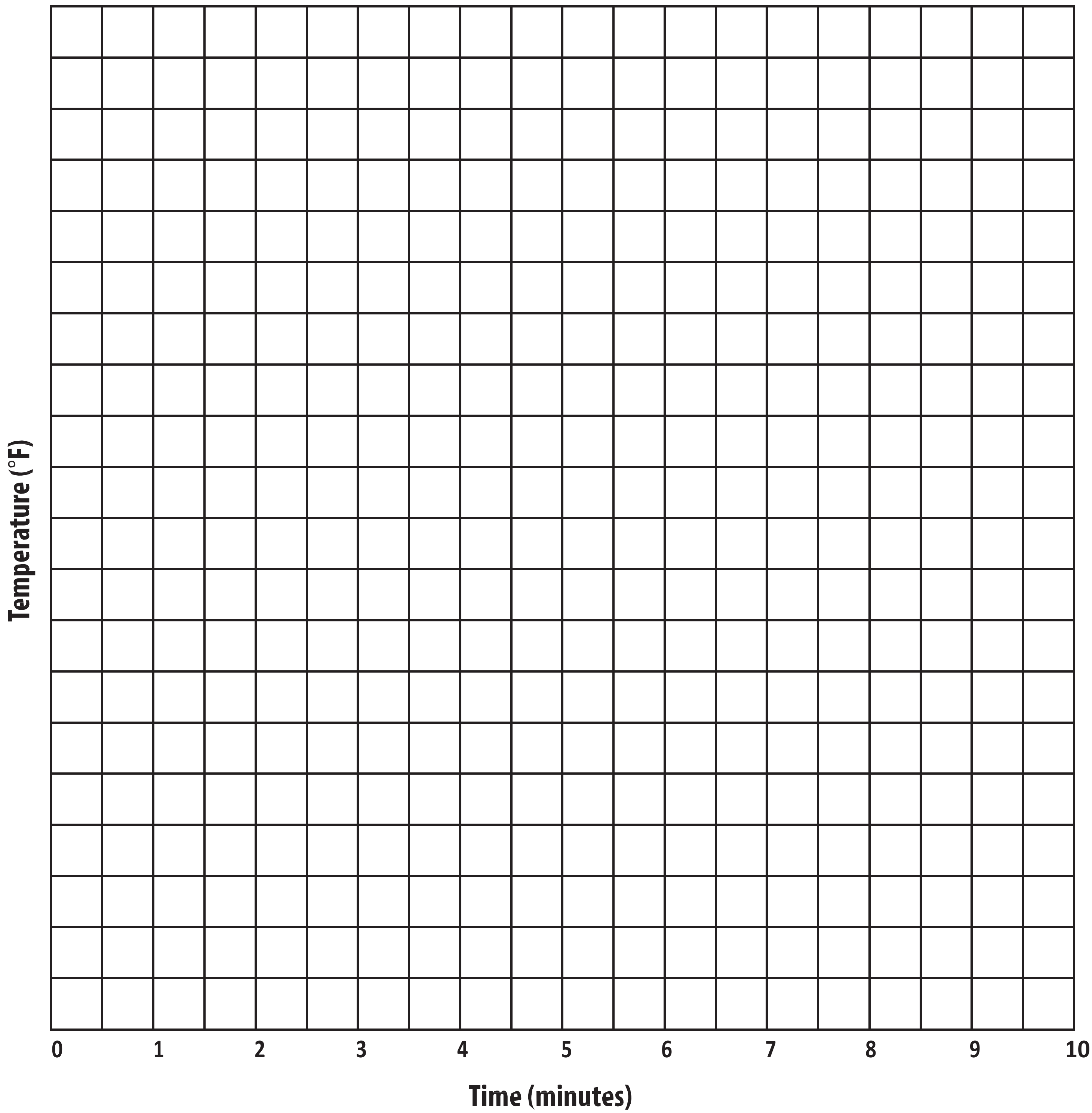
Lighting Investigation

DATA SHEET

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

Lighting Investigation

GRAPH TITLE____



COLOR KEY: ☐ IL ☐ CFL ☐ LED

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?

LESSON 2

Facts of Light Worksheet

How Much Can You Save With Energy Efficient Bulbs?

The graphic on the next page shows three light bulbs that produce the same amount of light. You might put bulbs like these into a bright overhead light. One bulb is an incandescent light bulb, one is a compact fluorescent light bulb (CFL), and another is a light emitting diode (LED). Which one is the better bargain? Let's do the math and compare the three light bulbs using the residential cost of electricity at $0.10/kWh.

1. Determine how many bulbs you will need to produce 25,000 hours of light by dividing 25,000 by the number of hours each bulb produces light.
2. The price of each bulb has been given to you in the chart on the next page.
3. Multiply the number of bulbs you will need by the cost of each bulb to determine the cost of bulbs to produce 25,000 hours of light.
4. Multiply the wattage of the bulbs (using the kW number given) by 25,000 hours to determine kilowatt-hours (kWh).
5. Multiply the number of kilowatt-hours by the cost per kilowatt-hour to determine the cost of electricity to produce 25,000 hours of light.
6. Add the cost of the bulbs plus the cost of electricity to determine the life cycle cost for each bulb.
7. Compare the environmental impact of using each type of bulb. Multiply the total kWh consumption by the average amount of carbon dioxide produced by a power plant. This will give you the pounds of carbon dioxide produced over the life of each bulb.

Facts of Light

All bulbs provide about 850 lumens of light.

COST OF BULB	INCANDESCENT (IL)	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Life of bulb (how long it will light)	1,000 hours	12,500 hours	25,000 hours
(1) Number of bulbs to get 25,000 hours			
x Price per bulb	$0.50	$3.00	$5.00
(2) = **Cost of bulbs for 25,000 hours of light**			
COST OF ELECTRICITY	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
Total Hours	25,000 hours	25,000 hours	25,000 hours
x Wattage	60 watts = 0.060 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
(3) = Total kWh consumption			
x Price of electricity per kWh	$0.10	$0.10	$0.10
(4) = **Cost of Electricity**			
LIFE CYCLE COST	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
(5) Cost of bulbs			
(6) + Cost of electricity			
(7) = **Life cycle cost**			
ENVIRONMENTAL IMPACT	**INCANDESCENT BULB**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
(8) Total kWh consumption			
x Pounds (lbs) of CO_2 per kWh	1.5 lb / kWh	1.5 lb / kWh	1.5 lb / kWh
(9) = **Pounds of CO_2 produced**			

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.

INCANDESCENT 	COST OF INCANDESCENT BULBS	+	COST OF ELECTRICITY	=	INCANDESCENT LIFE CYCLE COST
CFL 	COST OF CFL BULBS	+	COST OF ELECTRICITY	=	CFL LIFE CYCLE COST
LED 	COST OF LED BULBS	+	COST OF ELECTRICITY	=	LED LIFE CYCLE COST

LESSON 2

Home Activity

Installing Light Bulbs

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

Materials

③Light Bulbs
③LED 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? ______________

   _____ family/living rooms

   _____ kitchen (including appliances)

   _____ all closets

   _____ garage

   _____ bathrooms

   _____ bedrooms

   _____ basement

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 0 points

   _____ 1-2 CFLs or LEDs 2 points

   _____ 3-4 CFLs or LEDs 4 points

   _____ > 4 CFLs or LEDs 6 points

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.

7. When you replace an incandescent bulb with a CFL or LED, what measurement should you use to make sure you are getting a comparable light bulb?

8. Below, complete the sentences with the type of bulb and wattage for each of the bulbs that you replaced in your home.

   1. I replaced a___________watt bulb with an___________bulb.
   2. I replaced a___________watt bulb with an___________bulb.
   3. I replaced a___________watt bulb with an___________bulb.

LESSON 2 – 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. 10 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 2 – Lighting Investigation

CONNECTIONS

1. Explain how you would convince someone to replace an incandescent bulb with CFLs or LEDs.

2. Discuss the energy consumption of a CFL versus an IL using the results of the *Lighting Investigation*.

3. How did you calculate how much money you could save your family by replacing one incandescent bulb with a CFL?

4. Using what you learned in energy transformations, write out the energy transformations beginning with electricity for an incandescent light bulb.

Background Information: Water Heating

Water Heating

Water heating is a significant 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:

③use less hot water;

③turn down the thermostat on your water heater;

③insulate your water heater and water pipes; and

③buy an ENERGY STAR® or energy efficient water heater, dishwasher, and washing machine.

CHANGE FOR THE BETTER WITH ENERGY STAR

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.

Natural Gas Safety

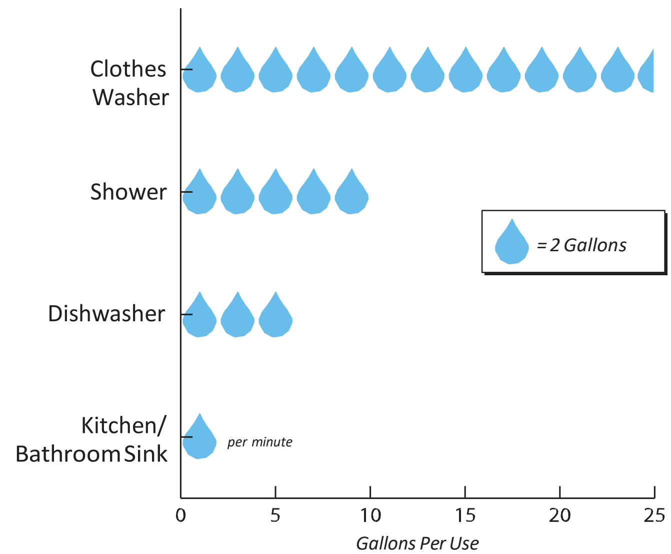
Because natural gas is colorless, odorless and tasteless, a chemical called mercaptan is added to the gas before distribution. Mercaptan gives it a “rotten eggs“ smell so that people can detect natural gas leaks.

Natural gas lines are buried underground going to your home. 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.

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.

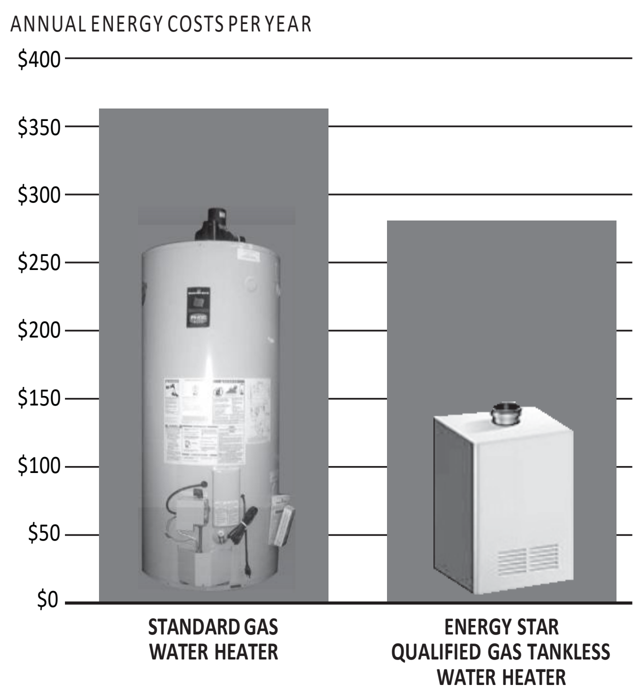
Water Consumption of Common Devices



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.

Water Heater Comparison



Data: ENERGY STAR®

Water Heating Investigation

Question

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

Materials

③1 Flow meter bag
③1 Hot water gauge
③Digital 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.** *NOTE: if there is no color change on the hot water gauge, the temperature is below 120oF.
4. Compare the actual temperature to the recommended temperature of 120oF.
5. Gather data from the other teams and add below.

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

Comparing EnergyGuide Labels

Comparing EnergyGuide Labels

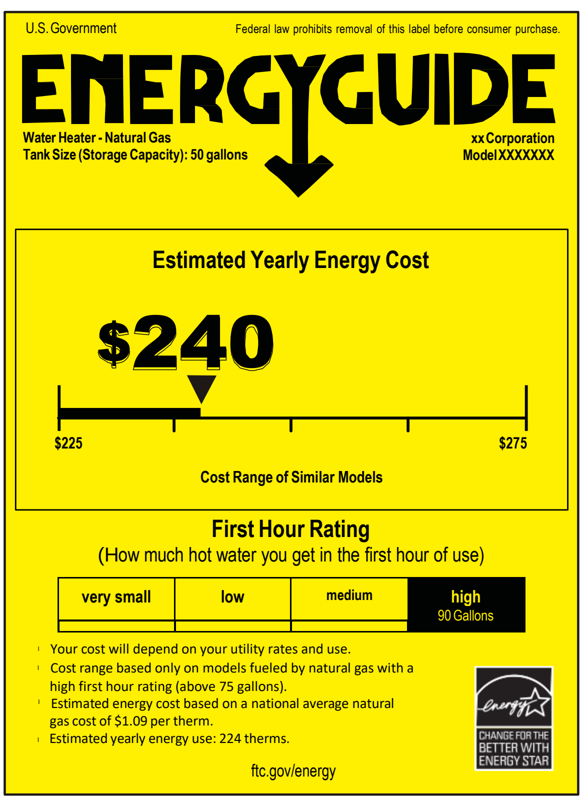
Your family needs to buy a new water heater. Water heaters usually last a long time—10 years or more—so you can save a lot of money using an energy-efficient one. Use the chart below to figure out which water heater to buy, comparing the information on the EnergyGuide labels.

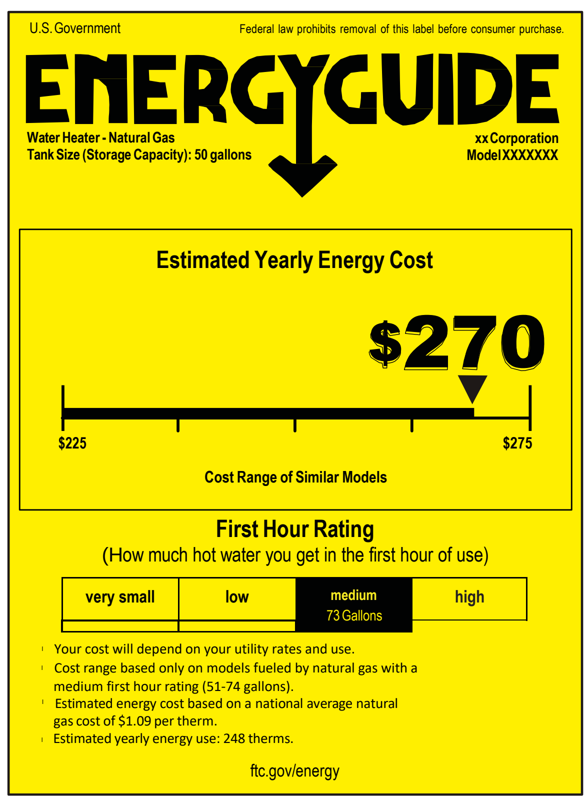
How many years will it take before you begin to save money?________________________________

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

Water Heater 1—Purchase Price: $750.00 **Water Heater 2— Purchase Price: $650.00**

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

③Hot water gauge
③Flow meter bag
③Kitchen sink aerator (if available)
③Bathroom sink aerator (if available)
③Low flow showerhead (if available)
③Teflon tape (if available)
③Natural 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. Locate the EnergyGuide label and record the efficiency rating. _________________

_____uses the most energy 0 points
_____uses more than average energy 2 points
_____uses average energy 3 points
_____uses less than average energy 4 points
_____uses the least energy 6 points

4. Use the hot water gauge to measure the temperature of the hot water in your bathroom sink. Is the temp greater than 120oF? __________
5. 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.
6. 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.

WATERFLOW	BEFORE INSTALLATION	AFTER INSTALLATION
Main Shower		
Main Bathroom Sink		
Kitchen Sink		

7. Share the natural gas scratch n' sniff card (if available) with family members to ensure everyone can recognize the smell of a gas leak.
8. Visit your local utility's website (listed on the front cover) to find out about other residential energy saving programs including rebates and online audits.

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. 100º F   b. 200º F   c. 120º F   d. 180º 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 3 – Water Heating

CONNECTIONS

1. What did you learn using the hot water gauge and the flow meter bag?

2. Describe 3 ways your family could reduce your hot water use.

3. Explain how buying an energy efficient appliance can save money, even if it costs more to buy.

Background Information: Insulation, Heating, and Cooling

Heat Seeks Balance

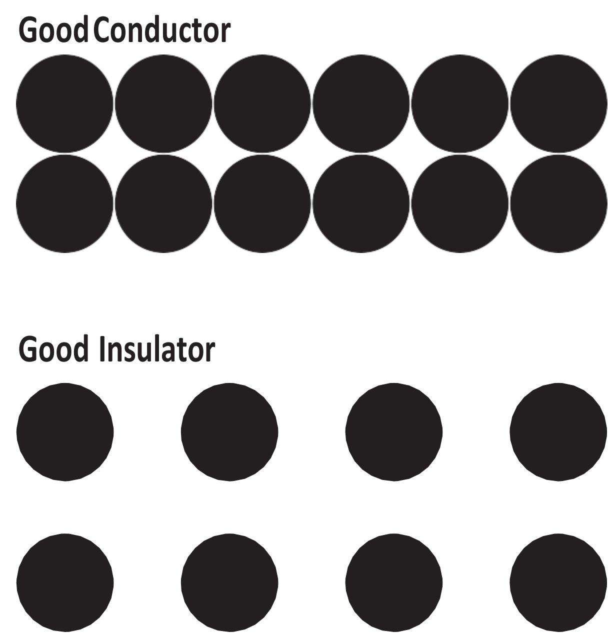
Everything in nature seeks balance. Heat seeks balance, too. Heat flows from areas of higher energy to areas of lower energy and from hotter substances to colder substances. What happens if you pour hot water into a cold tub? The molecules of hot water have more energy. They are fast moving. They crash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



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 would 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 4: 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

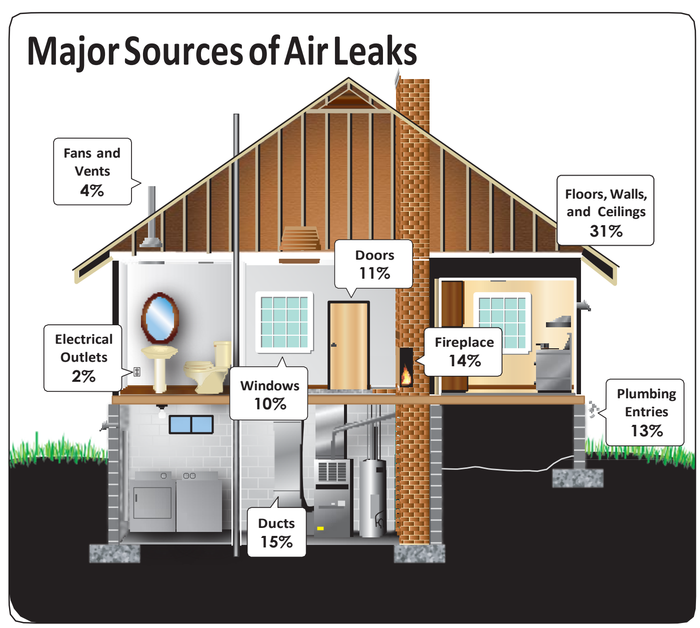
Some of a home's air leaks occur around and through the doors and windows. Doors should seal tightly and have door sweeps at the bottom to prevent air leaks. Insulated storm doors provide added barriers to leaking air.

AIR CONDITIONING SYSTEM

PROGRAMMABLE THERMOSTAT

INSULATION

Image courtesy of Owens Corning



Heat Transfer

WHAT IS THE DIRECTION OF HEAT TRANSFER?

Cup of Coffee

Glass of Ice Water

House on a Summer Day

House on a Winter Day

Bathtub of Hot Water

Child in the Snow

Insulation, Heating and Cooling Investigation (part 1)

Question

Are certain materials better for insulating than others?

Materials

③2 Insulation containers
③2 Thermometers
③Insulating material
③Masking tape
③1 Rubber band
③Hot water (provided by teacher)

Hypothesis

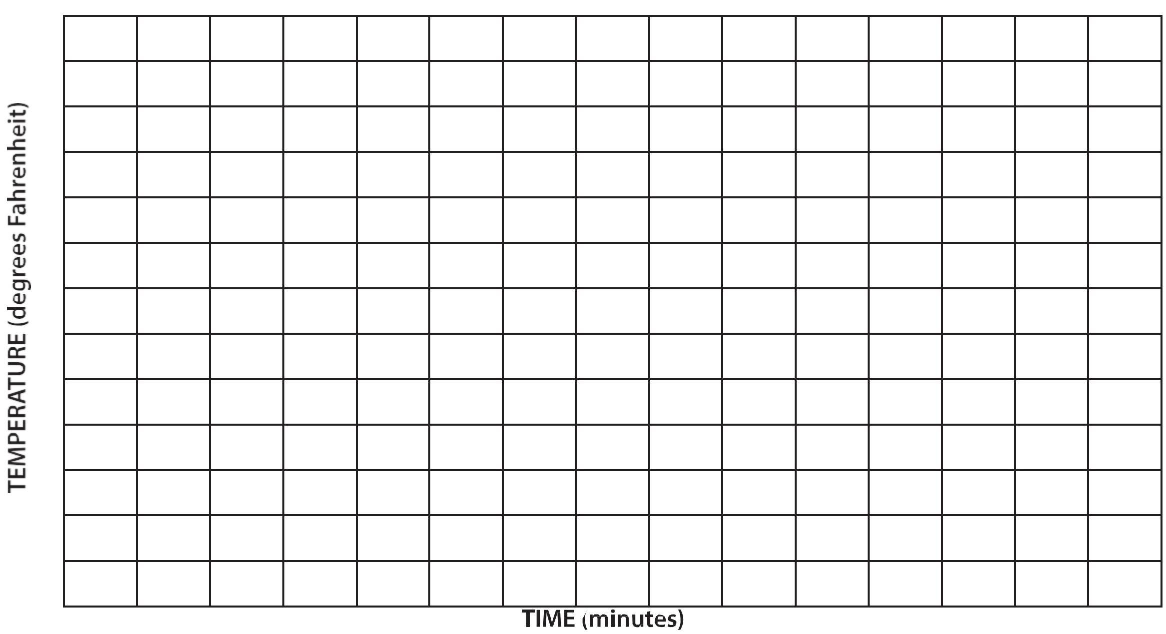
Procedure

1. Remove the tops from the containers.
2. Use the insulating material to insulate one container 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 containers 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 containers.
5. In the chart below, record the temperature (°F) of the water in the container at one-minute intervals for 10 minutes. Calculate the overall change in temperature (ΔT) for both containers.
6. Graph the results on the space below.

Data Table

TYPE OF INSULATION: ____________________________________

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



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? ____________________________

____

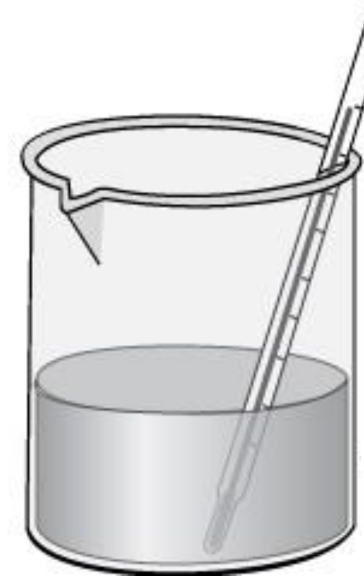
3. After 10 minutes, what was the difference in temperature between the insulated and uninsulated container? __________________

____

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 4

Insulation, Heating and Cooling Investigation (part 2)

Questions

③Which rooms in the school will have the highest and lowest temperature?

③Which room in the school will have the most heat?

Materials

③Digital thermometer or Thermostat Temperature Guide

Hypothesis

____

____

✔ Procedure

1. Find out the answers to the following questions:

   Which system is in operation (heating or cooling)? ______________________________

   What energy source fuels the heating system? ______________________________

   What energy source fuels the cooling system? ______________________________

2. Locate the thermostat in the classroom. Record the temperature setting of the thermostat. ______________________
3. Using the thermometer, record the actual temperature of the classroom. ____________________
4. Using the *Thermostat Temperature Guide* at the bottom of the page, determine whether your classroom is saving or wasting energy and by how much. ____
5. Visit other rooms in the school and record the temperature, thermostat setting, and percent of energy saved or wasted in the chart below.

Room	Thermostat Setting (°F)	Actual Temperature (°F)	Energy Saving/Wasting Percentage

6. Which room in the school had the highest temperature?____________The lowest temperature? ____________
   The most heat (thermal energy)? ______________
7. Is your school saving or wasting energy today with heating and cooling? ______________

Thermostat Temperature Guide *IN FAHRENHEIT*

RECOMMENDED HEATING

ENERGY SAVING | *ENERGY WASTING*

-20%	-10%	0%	+10%	+20%	+30%	+40%	+50%	+ + + +	+ + + +
64°	66°	68°	70°	72°	74°	76°	78°	80°	82°
+ + + +	+ + + +	+ + + +	+ + + +	+30%	+20%	+10%	0	-10%	-20%

ENERGY WASTING | *ENERGY SAVING*

RECOMMENDED COOLING

LESSON 4

Home Activity

Investigating Home Insulation and Thermostats

Materials

③Weather stripping
③Door sweep and draft stoppers (if available)
③*Thermostat Temperature Guide* on page 44

✔Procedure

1. Open your outside doors and check the condition of the weatherstripping between the doors and the door-frame.

_____none	0 points
_____poor	2 points
_____fair	4 points
_____good	6 points

2. Using the graphic below, "How Air Escapes," decide with your family the five areas of your home you will check for air leaks.

I. ____________________________ IV. ____________________________

II. ____________________________ V._

III. ____________________________

3. With the help of an adult, record the thermostat settings for your home:

Cooling Season:

_____< 74°	0 points
_____74°-75°	2 points
_____76°-77°	4 points
_____> 77°	6 points

Heating Season:

_____>74°	0 points
_____72°-74°	2 points
_____69°-71°	4 points
_____< 69°	6 points

4. Using the *Thermostat Temperature Guide* on page 44, calculate the percent of energy saved or wasted at this temperature setting.

___________% energy saved OR____________% energy wasted

5. Decide with your family two ways you can save energy on heating and cooling.

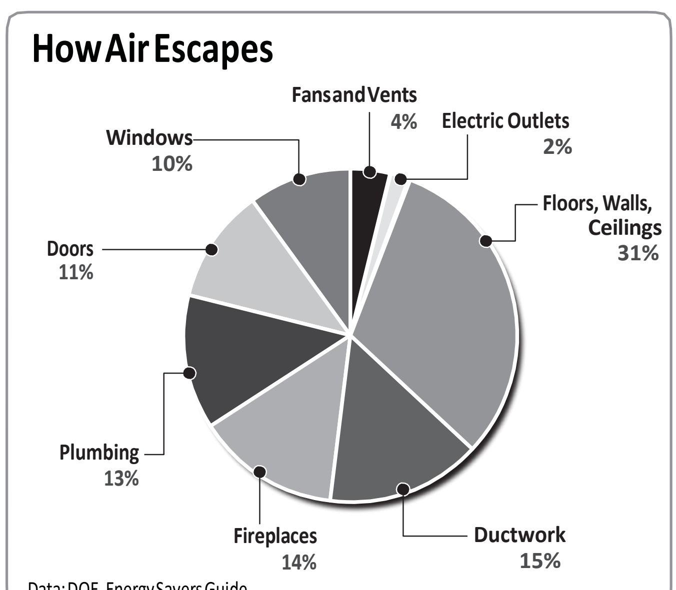
I. ________________________________

II. ________________________________

Actions

1. With an adult, install the weather stripping (and door sweep and draft stoppers if available).

2. Discuss changing the thermostat to the recommended settings of 68oF in the winter and 78oF in the summer.



Lesson 4 - Insulation, Heating, and Cooling

ASSESSMENT

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

Cup of Coffee

House on a Summer Day

2. Weatherstripping resists the transfer of heat and works as a thermal___________.

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

3. A material that allows heat to transfer easily (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 4 - Insulation, Heating and Cooling

CONNECTIONS

1. List two animals and discuss how they use “natural “insulation to maintain body temperature.

2. What are some ways you can be comfortable in your home without adjusting the temperature and using more energy?

3. List and explain two ways your family could save energy when heating and cooling your home.

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 as well as home appliances, were rated by watts (60, 75, 100), 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.

How Much Is a Watt?

1 WATT
Small, LED fl t

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

Cost of Electricity

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

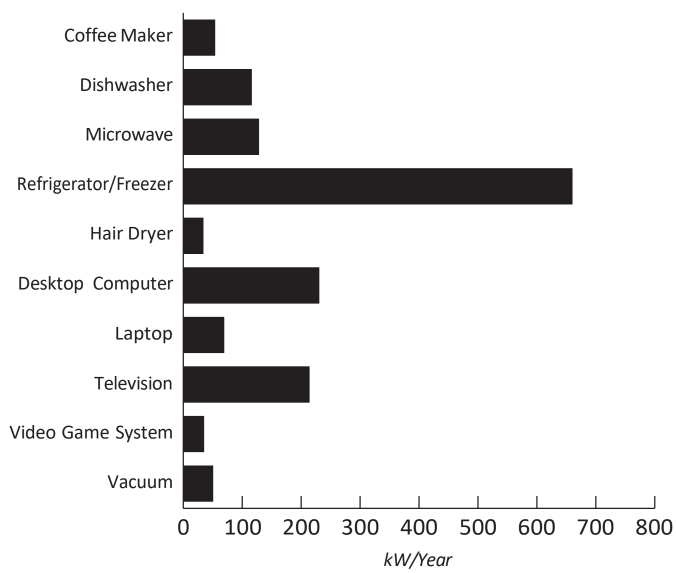
③**Fuel Cost**: The major cost of generating electricity is the cost of the fuel. Many energy sources can be used.

③**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.

③**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 Electricity Do Appliances Use?



Data: DOE, Buildings Data Book

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®

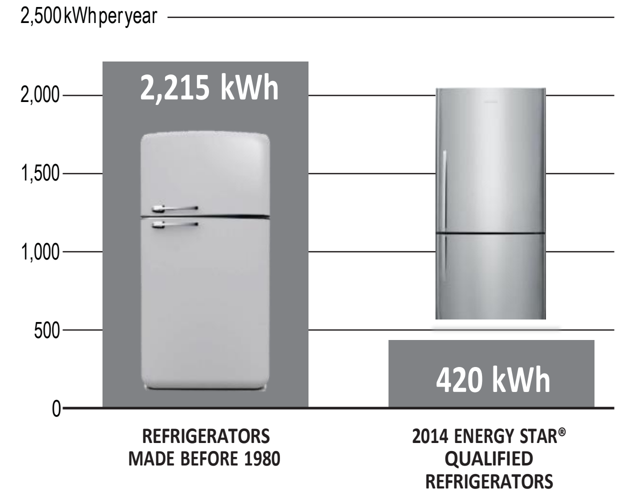
When you shop for a new appliance, look for the blue **ENERGY STAR®** label—your guarantee that the product saves energy. ENERGY STAR® qualified appliances incorporate advanced technologies that use less energy and water than standard models. A list of energy efficient appliances can be found on the 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" is referred to as vampire power.

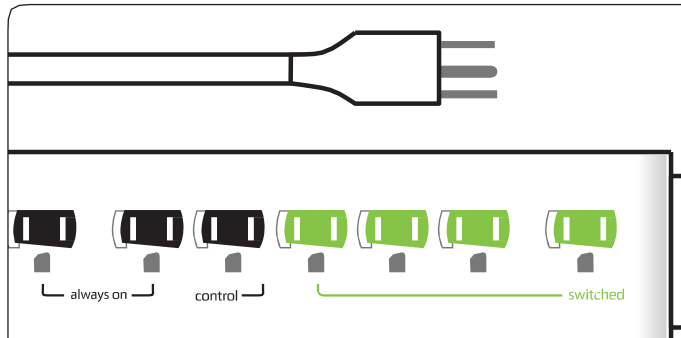
Many everyday appliances and electronics use significant power while in standby mode. The use and amount depends on the individual product; however, some of these appliances that use vampire power include: clock radios, satelitte/cable boxes and digital video recorder (DVR) equipment, televisions, DVD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

③Kill A Watt™ meter
③Pluggable 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 52 to get the yearly use. Using the desk lamp as an example, if it is used for twenty hours each week, we can find the yearly use like this:

Yearly use = 20 hours/week x 52 weeks/year = 1,040 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 desk lamp used 12 watts on the watt meter you would divide like this:

kW = W/1,000
kW = 12/1,000 = 0.012

The average **cost of electricity in Ohio is about ten cents ($0.10)** a kilowatt-hour. You can use this rate or find out the actual rate from your home's electric bill. Using the average cost of electricity, we can figure out how much it costs to run the desk lamp for a year by using this formula:

Yearly cost	**=**	**Hours used**	**x**	**Kilowatts**	**x**	**Cost of electricity (kWh)**			
Yearly cost	**=**	**1040 hours/year**	**x**	**0.012 kW**	**x**	**$0.10/kWh**			
Yearly cost	**=**	**1040**	**x**	**0.012**	**x**	**$0.10/kWh**	**=**	**$1.25**	

**Hint*: multiply shaded areas to calculate annual cost.

MACHINE OR APPLIANCE	HOURS PER WEEK (estimate)	HOURS PER YEAR (x52)	WATTS (W) (measured)	KILOWATTS (kW) (/1000)	RATE ($/kWh) ($0.10)	ANNUAL COST
Desk lamp	*20*	*1040 hours*	*12 W*	*0.012 kW*	*$0.10*	*$1.25*

The Environment and You

When we breathe, we produce carbon dioxide. When we burn fuels, we produce carbon dioxide, too. Carbon dioxide (CO_2) 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. This is causing the average temperature of the Earth's atmosphere to rise, resulting in 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:

CO_2 a year = wattage x hours of use x rate of CO_2/kWh

CO_2 a year = 0.012 kW x 1040 hr/yr x 1.5 lb/kWh = 18.72 lbs

MACHINE OR APPLIANCE	KILOWATTS (kW)	HOURS PER YEAR	RATE OF CO_2/kWh (LBS)	CO_2/YEAR (LBS)
Desk Lamp	*0.012 kW*	*1040 hours*	*1.5*	*18.72*

LESSON 5

Home Activity

APPLIANCES AND ENERGY STAR® LOGOS

Materials

③Refrigerator / freezer thermometer, if available
③Dollar 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 0 points

    _____ comes out fairly easily 2 points

    _____ comes out with difficulty 4 points

    _____ does not move 6 points

2. Use the refrigerator thermometer to measure the temperature of your refrigerator and freezer and record in the chart below. Leave the thermometer in place 24 hours to get an accurate reading.

APPLIANCE	TEMPERATURE	SAFE ZONE (oF)
Refrigerator		37o-40o
Freezer Section		0o-5o
Separate Freezer (if applicable)		0o 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?

CHANGE FOR THE
BETTER WITH
ENERGY STAR

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.

____

____

____

____

LESSON 5 – APPLIANCES AND MACHINES

CONNECTIONS

1. Describe a Kill A Watt™ monitor and explain how it can be used to help save energy.

2. Share how reducing carbon dioxide in the atmosphere can have an impact on the environment.

3. Looking at the appliances in your home, how can you make your current appliances more efficient? What will you look for when your family purchases a new one?

Home Activity – Your Family Rating

In many of the activities, you and your family rated your energy consumption and efficiency. Now you will add all of those points together to determine your family's overall rating. Share this information with your family.

Your Ratings

Page 26:	Weatherstripping Points:	_____
	Cooling Points:	_____
	Heating Points:	_____
Page 32:	Water Heater Points:	_____
Page 44:	Lighting Points:	_____
Page 51:	Refrigerator Points:	_____
	TOTAL Points	_____

Rating Guide

28 - 36	EXCELLENT
21 - 27	GOOD START but there's more we can do
20 or fewer	Make a commitment today to save energy at home and at school

Savings Plan

Make a list of things your family can do to save energy and money.

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?

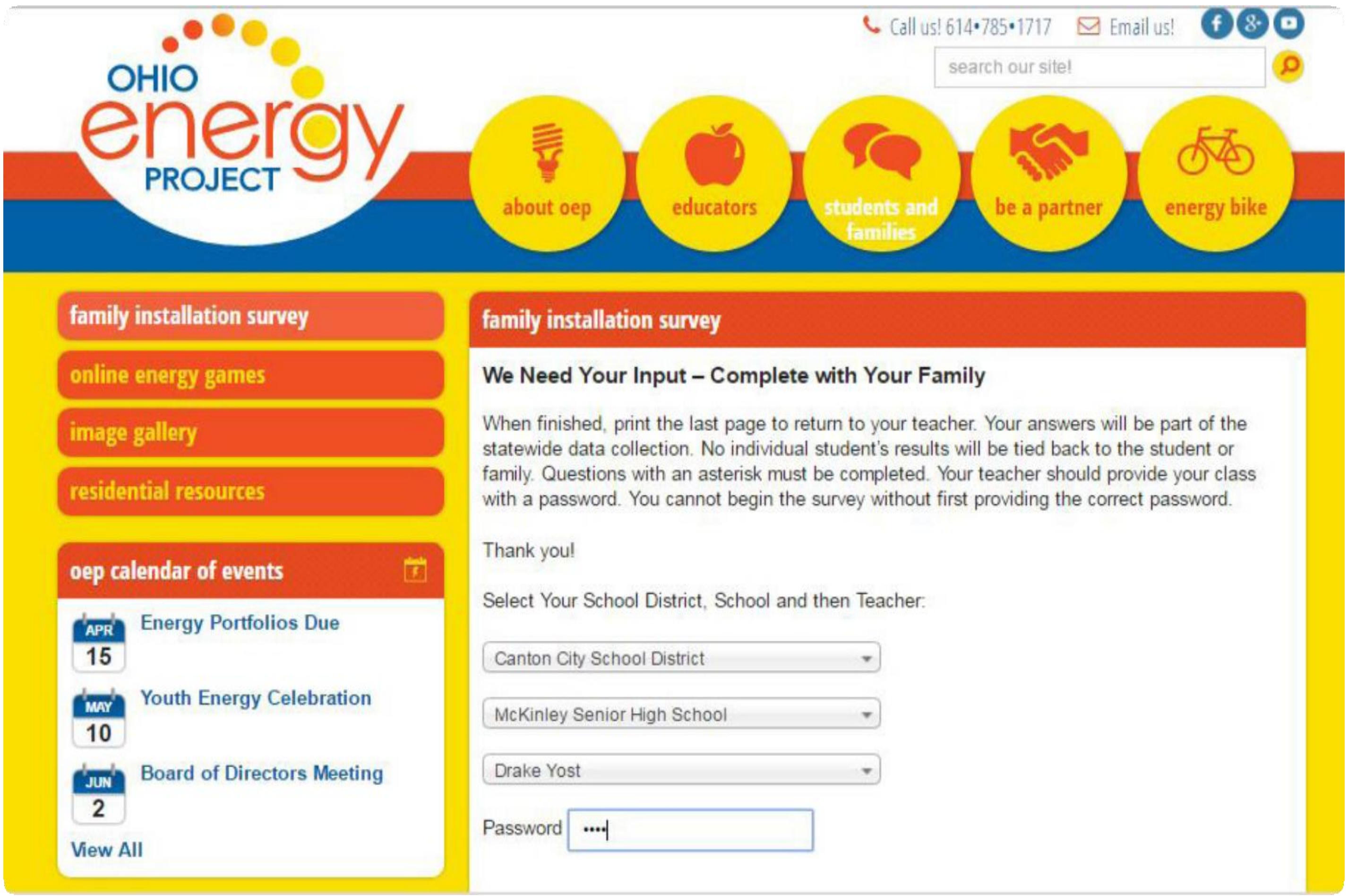
3. What things do you think you and your family will do to save energy at home?

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

What Have We Learned – 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.



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

Ohio Energy Project Programs and resources for teachers in grades 3-12. www.ohioenergy.org.

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.energyhog.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

The Ohio Energy Project thanks The NEED Project for permission to adapt NEED's Saving Energy curriculum for use with OEP's energy efficiency education programs.

AEP - 700 Morrison Drive Gahanna, Oh 43230
Columbia Gas of Ohio - 290 W. Nationwide Blvd Columbus, OH 43215
Dayton Power & Light - 1900 Dryden Road Dayton, Oh 45439
Vectren - 6500 Clyo Rd. Dayton, OH 45459
Ohio's Electric Cooperatives - 6677 Busch Blvd. Columbus, OH 43229

OHIO energy PROJECT

NEED National Energy Education Development