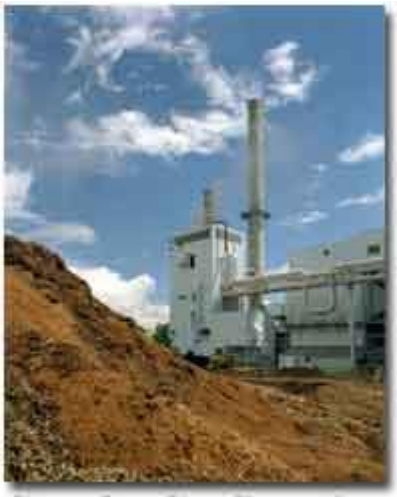
Name: _____ Period: _____

Energy Source: Biomass

Textbook Resource: *Biomass Fuels.* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 169.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter10.html

Biomass is matter usually thought of as garbage. Some of it is just stuff lying around -- dead trees, tree branches, yard clippings, left-over crops, wood chips (like in the picture to the right), and bark and sawdust from lumber mills. It can even include used tires and livestock manure.



Biomass Power Plant - Photo credit: U.S. Department of Energy, Energy Efficiency & Renewable Energy Network (EREN)

This stuff nobody seems to want can be used to produce electricity, heat, compost material, or fuels. Composting material is decayed plant or food products mixed together in a compost pile and spread to help plants grow. With 60 million tons of biomass, you **could** make close to 2,000 megawatts of electricity. That's enough energy to make electricity for about two million homes!

How biomass works is very simple. The waste wood, tree branches and other scraps are gathered together in big trucks. The trucks bring the waste from factories and from farms to a biomass power plant. Here the biomass is dumped into huge hoppers (bins). This is then fed into a furnace where it is burned. The heat is used to boil water in the boiler, and the energy in the steam is used to turn turbines and generators.

Photo credit: U.S. Department of Energy, Energy Efficiency & Renewable Energy Network (EREN)

Biomass can also be tapped right at the landfill with burning waster products. When garbage decomposes, it gives off methane gas. Natural gas is made up of methane. Pipelines are put into the landfills and the methane gas can be collected. It is then used in power plants to make electricity. This type of biomass is called landfill gas.

A similar thing can be done at animal feed lots. In places where lots of animals are raised, the animals - like cattle, cows and even chickens - produce manure. When manure decomposes, it also gives off methane gas similar to garbage. This gas can be burned right at the farm to make energy to run the farm.

Today, new ways of using biomass are still being discovered. One way is to produce ethanol, a liquid alcohol fuel. Ethanol can be used in special types of cars that are made for using alcohol fuel instead of gasoline. The alcohol can also be combined with gasoline. This reduces our dependence on oil - a non-renewable fossil fuel.

Name: _____ Period: _____

Energy Source: Coal (Fossil Fuel)

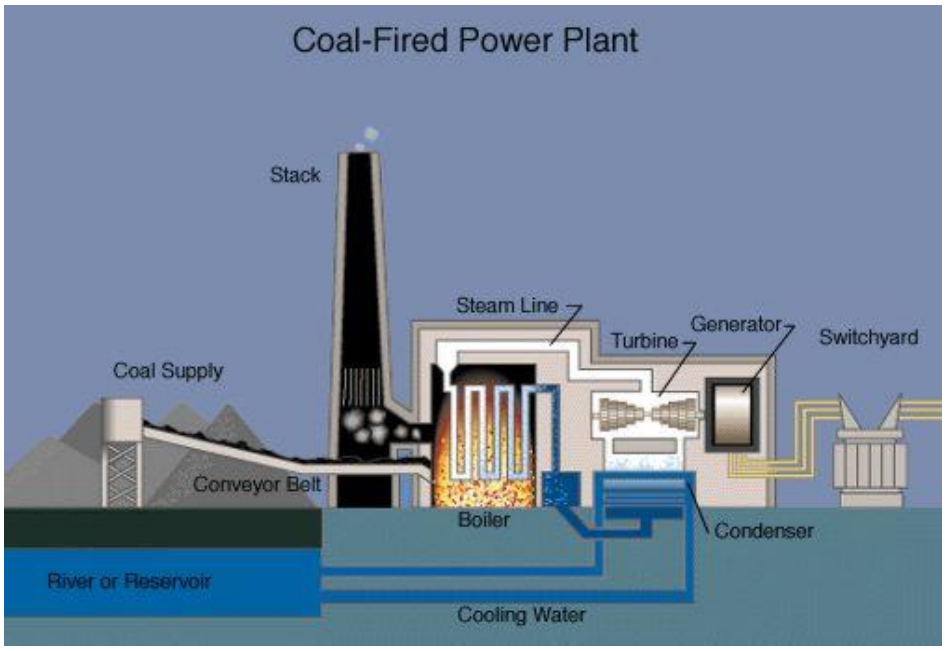
Textbook Resource: *What Are Fossil Fuels? (Coal).* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 160–161.

TVA's Cumberland Fossil

Edited excerpt from http://www.tvakids.com/electricity/fossil.htm
(Permission Granted by: http://www.tvakids.com/teachers/resources.htm : "These materials can be used to enrich any science curriculum and are graded for students at all levels".)

Coal is a rocklike mineral found beneath Earth's surface that can be burned to release energy. Coal fired plants burn coal to make electricity. They are also called "fossil" plants because the coal they burn was formed from the remains of prehistoric plants.

How does a fossil plant work?



Electricity is made at a fossil plant by burning coal, which heats water in a boiler to produce steam. The steam, under a lot of pressure, flows into a turbine, and the turbine spins a generator to make electricity. (See a diagram of a coal-fired power plant.)

Burning 14,000 tons of coal a day, an amount that would fill 140 railroad cars, generates about 10 billion kilowatt-hours a year, or enough electricity to supply 700,000 homes.

Coal use and the environment

People have been mining and burning coal to produce heat (and later, power) for many centuries. Today, about half the world's six billion people cook their food and heat their homes with coal.

Coal is easy to find and inexpensive. In the United States, we use coal to create about 50 percent of the electricity we use. The burning of coal to produce power can help cause air pollution. Scientists have also linked fossil plants to climate change, the gradual, possibly harmful, warming of the world's climate.

Name: _____ Period: _____

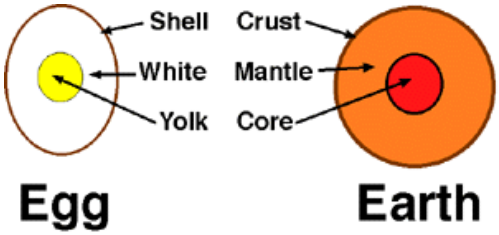
Energy Source: Geothermal

Textbook Resource: *Tapping Earth's Energy.* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 170.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter11.html

Geothermal Energy has been around for as long as the Earth has existed. "Geo" means earth, and "thermal" means heat. So, geothermal means earth-heat.

Have you ever cut a boiled egg in half? The egg is similar to how Earth looks like inside. The yellow yolk of the egg is like the core of Earth. The white part is the mantle of Earth. And the thin shell of the egg, that would have surrounded the boiled egg if you didn't peel it off, is like Earth's crust.



Below the crust of Earth, the top layer of the mantle is a hot liquid rock called magma. The crust of Earth floats on this liquid magma mantle. When magma breaks through the surface of Earth in a volcano, it is called lava.


Photo Credit:
National Park Service

For every 100 meters you go below ground, the temperature of the rock increases about 3 degrees Celsius. Or for every 328 feet below ground, the temperature increases 5.4 degrees Fahrenheit. So, if you went about 10,000 feet below ground, the temperature of the rock would be hot enough to boil water.

Deep under the surface, water sometimes makes its way close to the hot rock and turns into boiling hot water or into steam. The hot water can reach temperatures of more than 300 degrees Fahrenheit (148 degrees Celsius).

Geothermal Electricity

Some areas have so much steam and hot water that it can be used to generate electricity in a geothermal power plant. A geothermal power plant is like in a regular power plant except that no fuel is burned to heat water into steam. Holes are drilled into the ground and pipes are lowered into the hot water, like a drinking straw in a soda. The hot steam or water comes up through these pipes from below ground and goes into a special turbine. The turbine blades spin and the shaft from the turbine is connected to a generator to make electricity. The steam then gets cooled off in a cooling tower. The white "smoke" rising from the plants in the photograph above is not smoke. It is steam given off in the cooling process. The


Photo credit: California Energy Commission

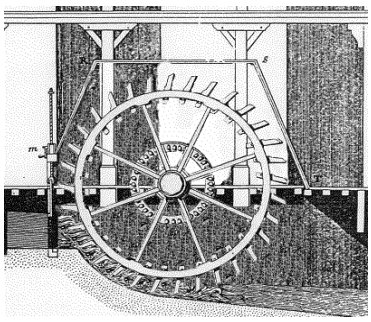
cooled water can then be pumped back below ground to be reheated beneath Earth's surface. The hot water flows into turbine and out of the turbine.

Name: _____ Period: _____

Energy Source: Hydro (Water)

Textbook Resource: *Hydroelectric Power.* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 168.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter12.html



The moving or falling water can be used to do work. Energy, you'll remember is the ability to do work. So moving water, which has kinetic energy, can be used to make electricity.

For hundreds of years, moving water was used to turn wooden wheels that were attached to grinding wheels to grind (or mill) flour or corn. These were called grist mills or water mills.

Today, moving water can also be used to make electricity. **Hydro** means *water*. Hydro-electric means *making electricity from water power.*

Photo credit: U.S. Bureau of Reclamation

Hydroelectric power uses the kinetic energy of moving water to make electricity. Dams can be built to stop the flow of a river. Water behind a dam often forms a reservoir. Dams are also built across larger rivers but no reservoir is made. The river is simply sent through a hydroelectric power plant or powerhouse.

Photo credit: U.S. Bureau of Reclamation

Hydro is one of the largest producers of electricity in the United States. Water power supplies about 10 percent of the entire electricity that we use. In states with high mountains and lots of rivers, even more electricity if made by hydro power. Some of that electricity is exported from the state and used in other states.

How a Hydro Dam Works

The water behind the dam flows through the intake and into a pipe called a penstock. The water pushes against blades in a turbine, causing them to turn. The turbine is similar to the kind used in a power plant, but instead of using steam to turn the turbine, water is used.

The turbine spins a generator to produce electricity. The electricity can then travel over long distance electric lines to your home, to your school, to factories and businesses.

Hydro power today can be found in the mountainous areas of states where there are lakes and reservoirs and along rivers

Name: _____ Period: _____

Energy Source: Natural Gas (Fossil Fuel)

Textbook Resource: *What Are Fossil Fuels? (Natural Gas).* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 163.

Edited excerpt from
http://www.energyquest.ca.gov/story/chapter09.html


Photo courtesy: corbisimages.com

Natural gas is a fossil fuel. It is a gaseous molecule that's made up of two atoms - one carbon atom combined with four hydrogen atom. Its chemical formula is CH_4. Natural gas is lighter than air. Natural gas is mostly made up of a gas called methane. This gas is highly flammable.

Natural gas is usually found near petroleum underground. It is pumped from below ground and travels in pipelines to storage areas.

Don't confuse natural gas with "gasoline," which we call "gas" for short. Like oil, natural gas is found under ground and under the ocean floor. Wells are drilled to tap into natural gas reservoirs just like drilling for oil. Once a drill has hit an area that contains natural gas, it can be brought to the surface through pipes. The natural gas has to get from the wells to us. To do that, there is a huge network of pipelines that brings natural gas from the gas fields to us. Some of these pipes are two feet wide.

Natural gas is sent in larger pipelines to power plants to make electricity or to factories that use lots of gas. Other businesses use natural gas for heating their buildings or heating water. From larger pipelines, the gas goes through smaller and smaller pipes to your neighborhood. In some homes, natural gas is used for cooking, heating water and heating the house in a furnace.


Photo credit: Southern California Gas Company

When natural gas is burned to make heat or burned in a car's engine, it burns very cleanly. When you combine natural gas with oxygen (the process of combustion), you produce carbon dioxide and water vapor; plus the energy that's released in heat and light.

Some impurities are contained in all natural gas. These include sulphur and butane and other chemicals. When burned, those impurities can create air pollution. The amount of pollution from natural gas is less than burning a more "complex" fuel like gasoline.

Name: _____ Period: _____

Energy Source: Nuclear - Fission and Fusion

Textbook Resource: *Nuclear Energy*. Environmental Science: Prentice Hall-Science Explorer, 2005, p. 174–178.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter13.html

Another major form of energy is nuclear energy, the energy that is trapped inside each atom. Atoms are made up of smaller particles -- a nucleus of protons and neutrons, surrounded by electrons which swirl around the nucleus much like Earth revolves around the Sun.

Nuclear Fission

An atom's nucleus can be split apart. When this is done, a tremendous amount of energy is released. The energy is both heat and light energy.

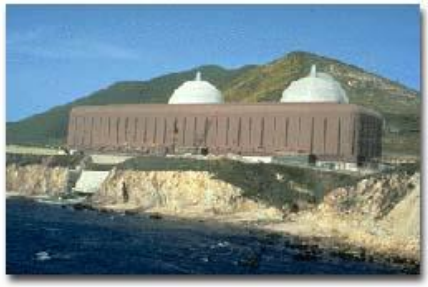
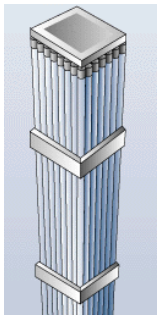


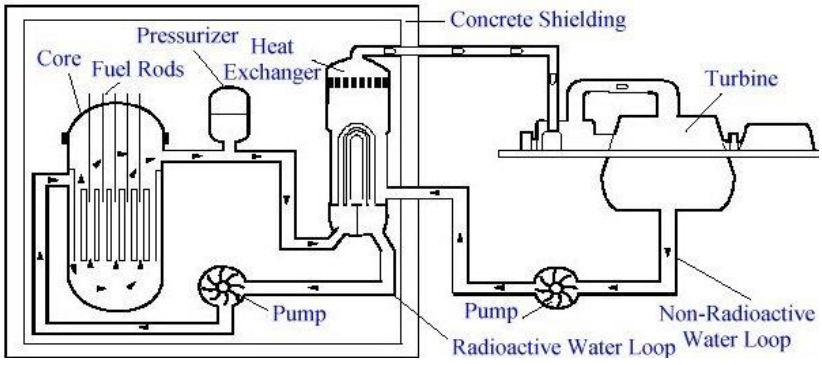
Photo credit: Pacific Gas & Electric Company

A nuclear power plant (like Diablo Canyon Nuclear Plant shown on the right) uses uranium as a "fuel." Uranium is an element that is dug out of the ground many places around the world. It is processed into tiny pellets that are loaded into very long rods that are put into the power plant's reactor.



The word *fission* means to split apart. Inside the reactor of an atomic power plant, uranium atoms are split apart in a controlled chain reaction. In a chain reaction, particles released by the splitting of the atom go off and strike other uranium atoms splitting those. Those particles given off split still other atoms in a chain reaction. In nuclear power plants, control rods are used to keep the splitting regulated so it doesn't go too fast.

The reaction also creates radioactive material. This material could hurt people if released, so it is kept in a solid form. The very strong concrete dome in the picture is designed to keep this material inside if an accident happens. This chain reaction gives off heat energy. This heat energy is used to boil water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the chain reaction of atoms splitting to change the energy of atoms into heat energy.



This water from around the nuclear core is sent to another section of the power plant. Here, in the heat exchanger, it heats another set of pipes filled with water to make steam. The steam in this second set of pipes turns a

turbine to generate electricity. Below is a cross section of the inside of a typical nuclear power plant.

Power plant drawing courtesy Nuclear Institute

Name: _____ Period: _____

Energy Source: Oil or Petroleum (Fossil Fuel)

Textbook Resource: *What Are Fossil Fuels? (Oil).* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 162.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter08.html

Oil is another fossil fuel. Oil and natural gas are found under ground between folds of rock and in areas of rock that are porous and contain the oils within the rock itself. The folds of rock are formed as Earth shifts and moves. To find oil and natural gas, companies drill through Earth's surface to the deposits deep below the surface. The oil and natural gas are then pumped from below the ground by oil rigs (like in the picture). They then usually travel through pipelines or by ship. In the entire U.S., more than 50 percent of all the oil we use comes from outside the country...most of it from the Middle East.

Photo credit: California Energy Commission

Refineries

The petroleum or crude oil must be changed or refined into other products before it can be used. Oil is stored in large tanks until it is sent to various places to be used. At oil refineries, crude oil is split into various types of products by heating the thick black oil.

Oil is made into many different products - fertilizers for farms, the clothes you wear, the toothbrush you use, the plastic bottle that holds your milk, the plastic pen that you write with. They all came from oil. There are thousands of other products that come from oil. Almost all plastic comes originally from oil. Products include gasoline, diesel fuel, aviation or jet fuel, home heating oil, oil for ships and oil to burn in power plants to make electricity.

Photo credit: California Energy Commission

Name: _____ Period: _____

Energy Source: Solar (Sun)

Textbook Resource: *Harnessing the Sun's Energy.* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 166–167.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter15.html

The Sun is our nearest star. Plants use the Sun's light to make food. Animals eat plants for food. Decaying plants hundreds of millions of years ago produced the coal, oil and natural gas that we use today. So, fossil fuels is actually sunlight stored millions and millions of years ago.

Photo credit:
California Energy Commission

Solar Hot Water

In the 1890s solar water heaters were being used all over the United States. By 1920, ten of thousands of solar water heaters had been sold. By then, however, large deposits of oil and natural gas were discovered in the western United States. As these low cost fuels became available, solar water systems began to be replaced with heaters burning fossil fuels.

Today, solar water heaters are making a comeback. They heat water for use inside homes and businesses. Panels on the roof of a building, like this one on the right, contain water pipes. When the Sun hits the panels and the pipes, the sunlight warms them.

Solar Thermal Electricity

Photo credit: California Energy Commission

Solar energy can also be used to make electricity. Some solar power plants, like the one in the picture to the right, use a highly curved mirror called a parabolic trough to focus the sunlight on a pipe running down a central point above the curve of the mirror. The mirror focuses the sunlight to strike the pipe, and it gets so hot that it can boil water into steam. That steam can then be used to turn a turbine to make electricity. Huge rows of solar mirrors arranged in what's called "solar thermal power plants" use this idea to make electricity for homes. The problem with solar energy is that it works only when the Sun is shining. So, on cloudy days and at night, the power plants can't create energy. Some solar plants, are a "hybrid" technology. During the daytime they use the Sun. At night and on cloudy days they burn natural gas to boil the water so they can continue to make electricity.

Photo credit:
U.S. Department of Energy

Another form of solar power plants to make electricity is called a Central Tower Power Plant, like the one to the left. Sunlight is reflected off 1,800 mirrors circling the tall tower. The mirrors are called heliostats and move and turn to face the Sun all day long. The light is reflected back to the top of the tower in the center of the circle where a fluid is turned very hot by the Sun's rays. That fluid can be used to boil water to make steam to turn a turbine and a generator, transforming heat into mechanical energy in the turbine.

Solar Cells or Photovoltaic Energy

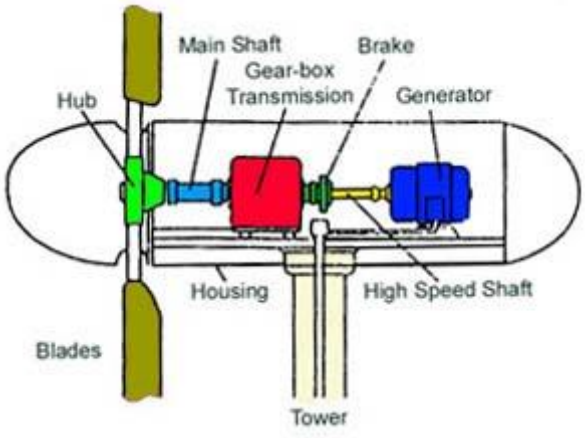
We can also change the sunlight directly to electricity using solar cells. The electrical energy from solar cells can then be used directly. It can be used in a home or business for lights and appliances. Solar energy can be stored in batteries to light a roadside billboard at night. Or the energy can be stored in a battery for an emergency roadside cellular telephone when no telephone wires are around.

Name: _____ Period: _____

Energy Source : Wind

Textbook Resource: *Capturing the Wind.* Environmental Science: Prentice Hall-Science Explorer, 2005, p. 168.

Edited excerpt from http://www.energyquest.ca.gov/story/chapter16.html



Wind can be used to do work. The kinetic energy of the wind can be changed into other forms of energy, either mechanical energy or electrical energy. Blowing wind spins the blades on a wind turbine -- just like a large toy pinwheel. This device is called a wind turbine and not a windmill. A windmill grinds or mills grain, or is used to pump water.

The blades of the turbine are attached to a hub that is mounted on a turning shaft. The shaft goes through a gear transmission box where the turning speed is increased. The transmission is attached to a high speed shaft which turns a generator that makes electricity. If the wind gets too high, the turbine has a brake that will keep the blades from turning too fast and being damaged.

Photo credit: American Wind Energy Association - AWEA

You can use a single smaller wind turbine to power a home or a school. The small turbine on the right makes enough energy for a house. In the picture on the left, the children at this Iowa school are playing beneath a wind turbine that makes enough electricity to power their entire school.

The only problem with wind is that it is not windy all the time. In order for a wind turbine to work efficiently, wind speeds usually must be above 12 to 14 miles per hour. Wind has to be this speed to turn the turbines fast enough to generate electricity. The turbines usually produce about 50 to 300 kilowatts of electricity each. A kilowatt is 1,000 watts (kilo means 1,000). You can light ten 100 watt light bulbs with 1,000 watts. So, a 300 kilowatt wind turbine could light up (300,000 watts) 3,000 light bulbs that use 100 watts!

Photo credit: Warren Gretz, Natl. Renewable Energy Lab

Once electricity is made by the turbine, the electricity from the entire wind farm is

collected together and sent through a transformer. There the voltage is increase to send it long distances over high power lines.