ENERGY RESOURCES

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ENERGY RESOURCES

Written by David Dreier

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KEY ELEMENTS USED IN THIS BOOK
The Big Idea: We live in an energy-hungry culture. People's demand for electricity and fuel taxes Earth's supply of nonrenewable resources and forces us to find and use renewable and alternative sources. This book compares nine energy resources: crude oil, coal, natural gas, nuclear power, biomass, solar, wind, hydroelectric, and geothermal. It explains how they are each generated and used. Using each resource has both benefits and drawbacks.
Key words: atom, biofuel, biomass, carbon dioxide, CO_2, coal, crude oil, dam, electrons, electricity, energy, energy resource, ethanol, fossil fuel, fuel, fuel cell, gasoline, generator, geothermal energy, global warming, hydroelectric power, hydrogen, methane, natural gas, neutrons, nonrenewable resource, nuclear energy, nuclear fission, nucleus, oil spill, petroleum, pollution, power, power plant, protons, renewable resource, solar energy, turbine, wind energy, wind farm **Key comprehension skill:** Interpret graphs, charts, and diagrams *Other suitable comprehension skills:* Compare and contrast; classify information; cause and effect; identify facts; main idea and details; elements of a genre; using a glossary and boldfaced terms; using a table of contents and headings **Key reading strategy:** Retell *Other suitable reading strategies:* Ask and answer questions; connect to prior knowledge; summarize; visualize

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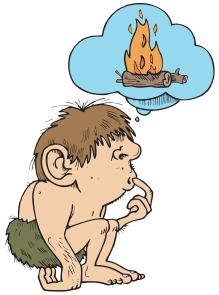

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Introduction

People long, long ago used very little **energy**. They got all the energy they needed from food. Then they learned how to control fire. People began to use fire for light, heat, and cooking.

Today we use large amounts of energy. We use it to fuel our cars and to make **electricity**. We also use energy to make many products. Our energy needs are always growing. This book will look at **energy resources** in the past, present, and future.

Electrical Energy

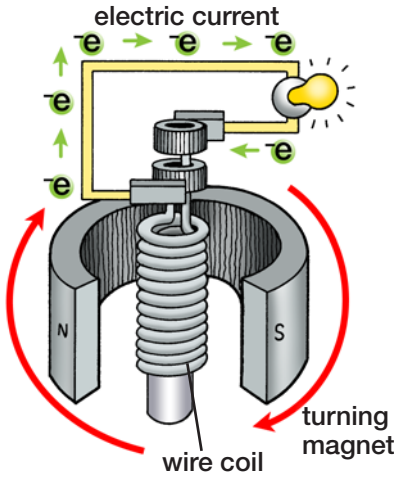
Without energy nothing can happen. Nothing can move and no work can get done. We need energy for everything we do.

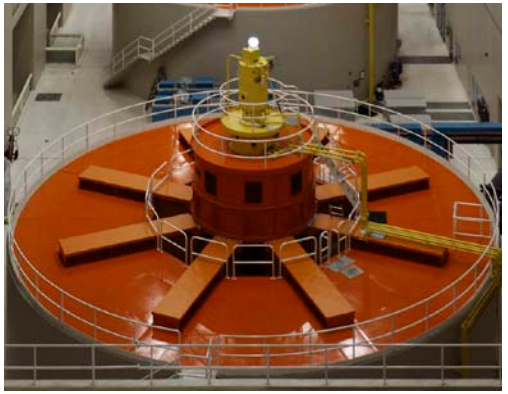
Energy can change from one form to another. For example, light energy can change to heat energy. Both heat and light can be used to make electricity. Electricity is our most important form of energy. Think about all the ways you have used electricity today.

Generators

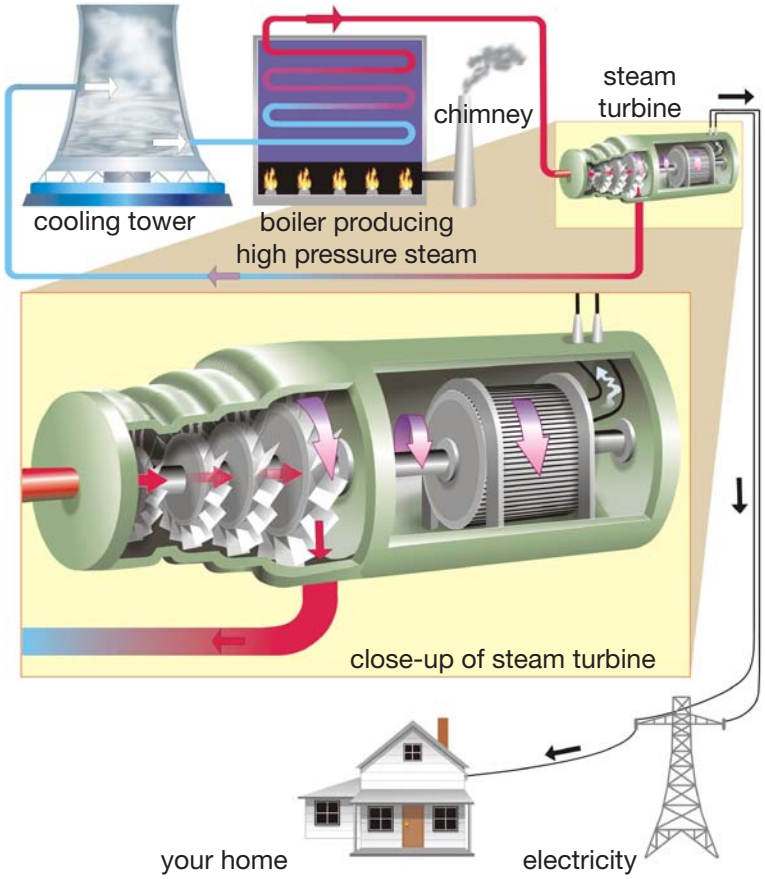
Electricity is a flow of tiny particles called *electrons*. All matter is made of *atoms*. Electrons whirl around the center of the atom. That center is called the *nucleus*.

Most of the electricity we use is made by large machines called **generators**. A generator has two main parts: magnets and coils of wire. The magnets make electrons flow through coils of wire. The flow of electrons creates an electric current.



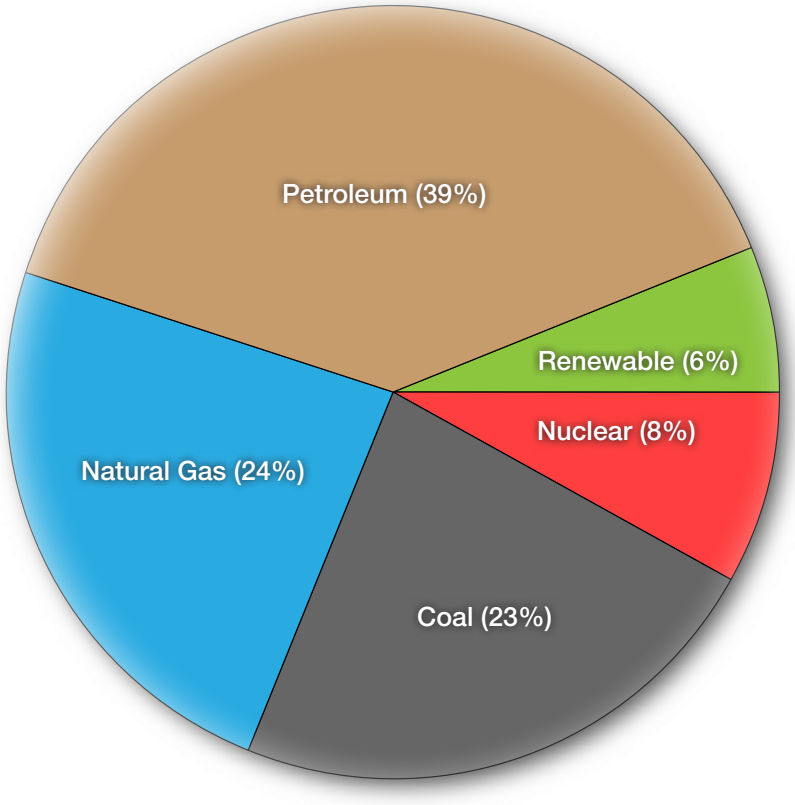


In a generator (above), magnets spin around a coil of wire. This makes electrons move inside the wire. The moving electrons create an electric current that can power lights and appliances. Giant turbines (left), generate electricity for whole cities.



A place where electricity is made is called a *power plant*. In most power plants, a fuel is used to boil water and make steam. The steam rushes through a machine called a *turbine*. The turbine has blades that spin when steam hits them. The turbine is attached to a generator and makes it spin. This makes electrons flow in wire coils and produces an electric current.

We use many sources of energy in today's world. These energy sources are either renewable or nonrenewable. **Nonrenewable resources** are fuels that cannot be replaced after they are used. Oil is as an example of a nonrenewable resource. **Renewable resources** never run out. These resources include energy from the Sun and wind.



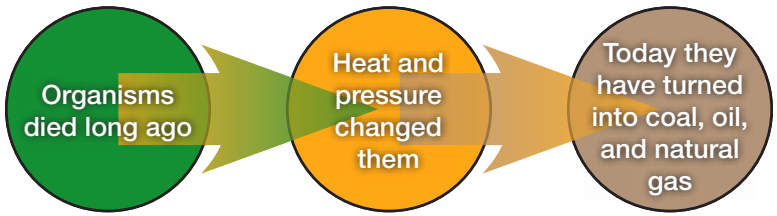
Total Energy Consumed in the U.S. – 2000

Nonrenewable Resources

The main nonrenewable energy resources are called **fossil fuels**. These fuels include oil, **coal**, and **natural gas**.

These fuels are called fossil fuels because of how they formed. They come from plants and tiny animals that lived many millions of years ago. All of those plants and animals absorbed energy from the Sun. Over time, as the plants and animals died, they settled into swamps or shallow seas. Layers of rock formed over them. Pressure and heat within Earth compressed the material and caused it to change. Over millions of years, it became coal or oil. As those fuels formed, they produced a gas called *methane*. Methane is natural gas.

Fossil fuels are the world's leading source of energy.



All of these products are made from crude oil.

Energy from Crude Oil

Oil straight from the ground is called **crude oil**. We get it by drilling down to rocks where oil is trapped. The oil flows to the surface through pipes. Crude oil is made into a number of fuels, including gasoline. It is also used to make products such as plastics.

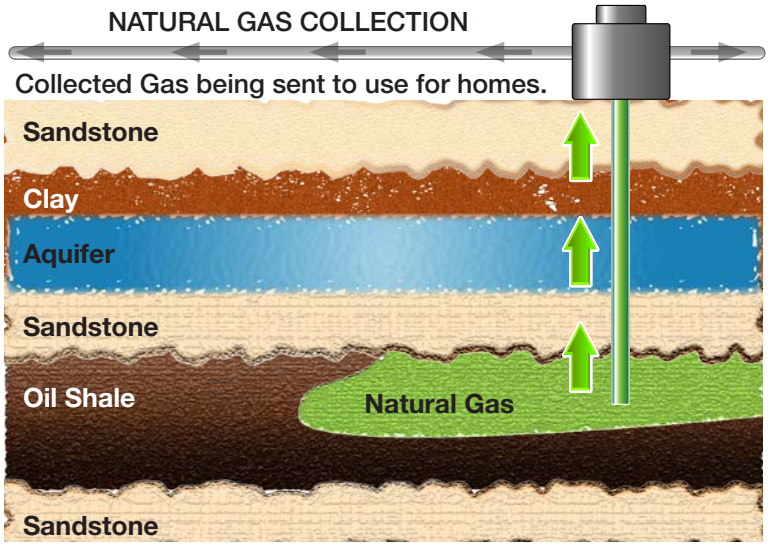
The United States has a lot of oil. But it still cannot produce enough oil for its needs. It imports more than half of the oil it uses. Most of that oil comes from Canada and Saudi Arabia. The world is running out of oil. The remaining oil may be gone in another 40 years.

Energy from Coal

Coal is the most abundant fossil fuel in use. It is used mostly to make electricity. The United States produces almost half of its electricity with coal. It has the world's largest coal reserves. But even though there is plenty of coal in the world, it won't last forever. The world's coal supply may last for only another 100 years.

The biggest problem with coal is that causes air pollution. Engineers are developing cleaner ways to burn coal and finding other energy sources.

China has been building coal-fired plants at a rate of two per week to feed its industrial expansion. As a result, China has the most polluted air in the world.



Energy from Natural Gas

Natural gas is found in many of the same places as crude oil. When the gas comes from the ground, it is usually mixed with several other gases. The other gases get removed, leaving mostly pure methane. That gas is delivered to users through pipes. The gas is used mostly in homes and factories and to make electricity.

There is a huge amount of natural gas in the ocean. It is in icy materials called *methane hydrates* in the seafloor. Experts say the hydrates could provide more energy than all other remaining fossil fuels combined.

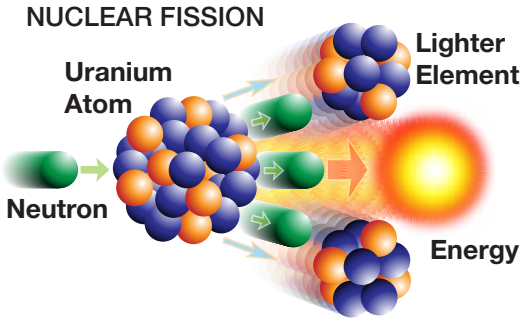
Pollution and Global Warming

Although fossil fuels are an important source of energy, they have problems (see page 15). Coal and oil cause air pollution. And all fossil fuels produce carbon dioxide gas (CO_2) when they burn. CO_2 in the air makes it harder for heat from Earth's surface to escape into space. That heat raises the temperature of the atmosphere. This effect is known as *global warming*. Scientists are concerned about global warming, which could be changing climates. They are searching for cleaner sources that do not produce CO_2.

Grinnell Glacier 1900

In the last 100 years, Montana's Grinnell Glacier has almost disappeared.

Grinnell Glacier 2008



The fission of a single gram of uranium—about the weight of a paper clip—releases as much energy as the burning of 2,700 kilograms (6,000 pounds) of coal.

Energy from the Atom

After fossil fuels, the next biggest source of power is **nuclear energy**. It may be hard to believe that tiny, invisible atoms can produce much energy. But the nucleus (plural, nuclei—NOO-klee-eye) of an atom is made of particles called *protons* and *neutrons*. These particles are held together by a very strong force. In a nuclear power plant, the nuclei of atoms are split apart. This releases large amounts of energy. Splitting an atom's nucleus is called *nuclear fission*.

The energy released by fission is used to heat water and produce steam. As in other power plants, the steam turns turbines connected to electric generators. As of 2007, there were 439 nuclear power plants worldwide. They made about 15% of the world's electricity.

Nonrenewable Resources

Resource *Cost per KWh*	Pro	Con
Crude oil *18¢*	Fairly inexpensive for the amount of energy it provides Can be made into many kinds of fuels Can be made into plastic products	Limited—only enough for about 40 more years Highly polluting—releases large amounts of CO_2 Only some parts of the world have access (can lead to conflicts) Oil spills harm the environment
Coal *5.5¢*	Very inexpensive for the amount of energy it provides Plentiful—probably enough for 100 years Can be found in most parts of the world	Leading cause of air pollution (CO_2) in the world Changes the land at mining sites Mining can be dangerous work Polluted air in mines can be harmful to miners
Natural gas *9¢*	Plentiful—enough for about 75 years Produces less pollution than oil or coal Very popular for warming homes, cooking, and heating water	Releases large amounts of greenhouse gases Expensive to transport over large distances Invisible and poisonous to breathe Risk of explosions
Nuclear *11–14¢*	Very little air pollution (does not use fossil fuels) Energy efficient Almost unlimited power	Power plants expensive to build and maintain Accidents very dangerous to plants and animals Need to safely transport and store waste—stays radioactive for thousands of years Can be used as a very powerful weapon

1 Kilowatt hour (KWh) is the power to run 1,000 watts of electricity for 1 hour, or a 100-watt lightbulb for 10 hours.

Renewable Resources

Energy from Biomass

Some energy resources can be replaced after being used. These are renewable resources. Resources that come from present-day living things are called **biomass**. Their name comes from bio-, meaning life.

One leading biomass resource is wood. People around the world burn wood to heat their homes and cook their food. But when a tree is cut down, it takes decades to grow a new tree to replace it.

Other biomass includes garbage, plants, and manure. Biomass can be burned to boil water and make steam to power generators. Or as biomass rots, it produces methane. The methane can also be burned to make steam to power generators.

Some plants are grown to be made into liquid fuels. These fuels are called *biofuels*. For example, corn is processed to produce a type of alcohol called *ethanol*. Ethanol can be burned or added to gasoline.

Solar cells are increasingly used to power small things such as lights on street signs, or big things such as a city's power grid.

Energy from the Sun

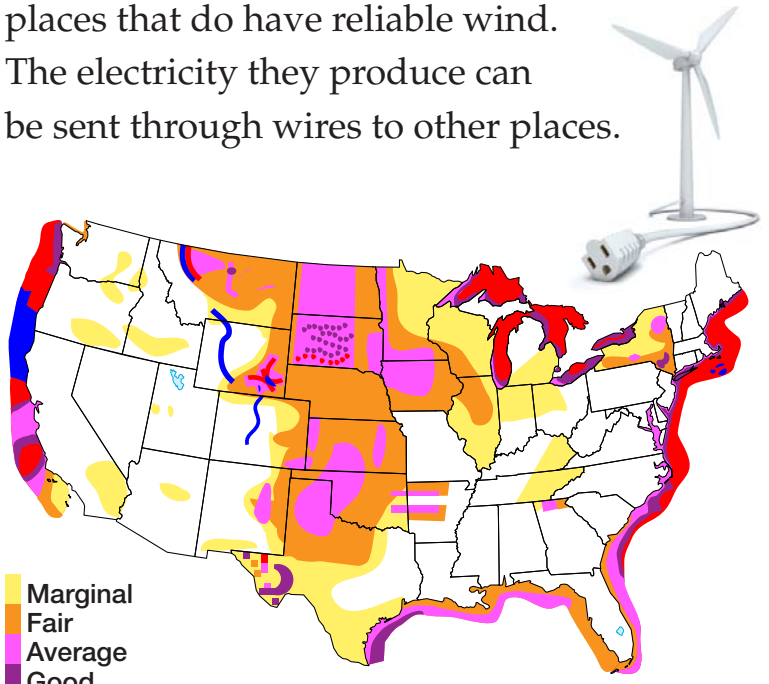
The Sun gives us lots of energy. Energy from the Sun is called **solar energy**. This energy can be used to heat water and homes. Sunlight can also be focused with large mirrors. The focused sunlight heats a fluid. The heat is then used to produce electricity.

Sunlight can also be used to make electricity directly. Thin panels called *solar cells* absorb sunlight and convert it into an electric current. Solar panels are being used on many buildings to produce electricity.

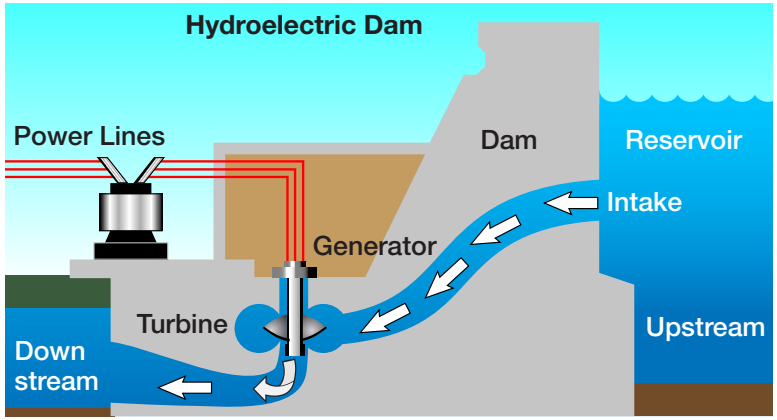
Energy from Wind

Wind is another kind of unlimited energy. Wind can be converted into electricity with machines called *wind turbines*. Most wind turbines look like a huge airplane propeller on a pole. In many areas of the world, "wind farms" have been built. A wind farm may contain hundreds of turbines.

Like solar energy, wind has drawbacks. Some areas of the world don't have steady winds. However, wind farms can be built in places that do have reliable wind. The electricity they produce can be sent through wires to other places.



This map shows regions of the U.S. that have reliable winds for wind farms.



Dams hold water back so we can make it flow through turbines. The turbines power generators. Big dams, like the Katse Dam can provide hydroelectricity for millions of people.

Energy from Moving Water

Fast-moving water contains a lot of energy. People control water by building dams to stop the flow of a river. This causes a lake to form behind the dam. Water from the lake flows through the bottom of the dam and spins turbines. The turbines power generators, just as they do in coal or nuclear plants. Electricity created by moving water is known as **hydroelectric power.**

Energy from Inside Earth

The inside of Earth is really hot. Heat from within the planet is called **geothermal energy**. This energy is used in some places where steam or hot water comes up to the surface. It comes up through openings in the ground. The energy from underground warms people's homes or heats their water. In other areas, people drill deep into the ground to access geothermal energy.

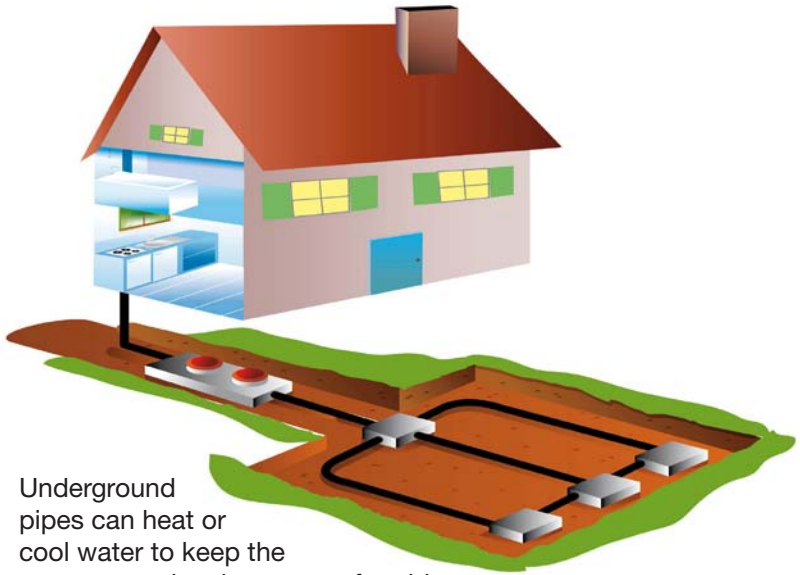
Geysers are powered by Earth's heat. Pressure builds in an underground chamber until water, steam and gases erupt.

The nation of Iceland, which has many volcanoes and hot springs, relies heavily on geothermal energy.

A geothermal power plant has pipes that go deep down inside Earth. They go to a body of extremely hot water. The water can have a temperature as high as 370° C (700° F). In most geothermal plants, the hot water that comes up in pipes expands in the plant to make steam. The steam then turns turbines that power electrical generators.

Think About It

Do you think drilling down into Earth to capture geothermal energy might have long-lasting effects on the planet? Explain.



Underground pipes can heat or cool water to keep the temperature in a house comfortable.

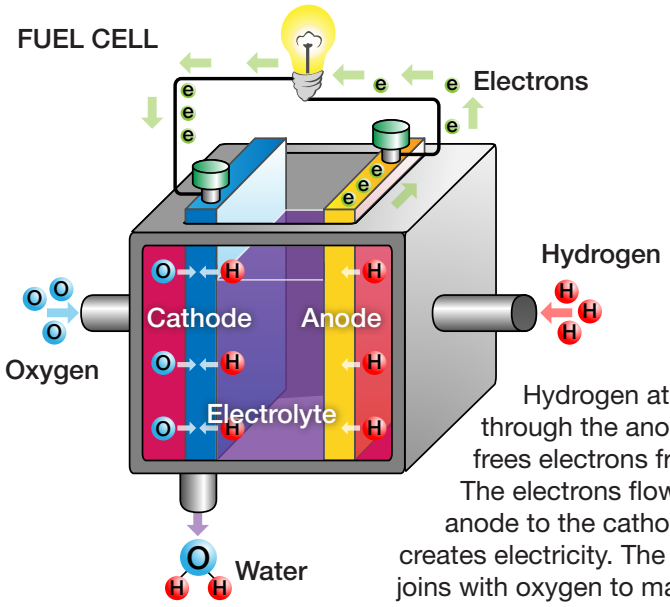
Renewable Resources

Resource *Cost per KWh*	Pro	Con
Biomass *6¢*	Very large supply available Reduces waste in landfills by putting it to good use Can be used anywhere in the world	Equipment can be expensive Raising crops for biomass can reduce available land for wildlife and food crops Releases some CO_2 (but less than burning fossil fuels)
Solar *15-30¢*	No pollution once up and running Little or no noise Can be used anywhere in the world Inexpensive after initial startup	Solar cells are expensive Not efficient on cloudy days or at night Large solar farms require large amounts of land
Wind *6¢*	Can be used in most parts of the world No pollution Inexpensive after initial startup	Large turbines are very expensive Not every location has predictable or steady winds Turbines require land, can be noisy, and can be dangerous to birds
Hydroelectric *11¢*	Can be used in most parts of the world Can store water to use during droughts Provides recreation in new lakes Clean energy resource—little pollution	Dams interrupt wildlife in rivers Dams drain water from deepest, coldest part of lake, which affects wildlife downstream Lakes may cover natural habitats and towns Depletes farmlands and rivers of natural silt cycles Dams can break and cause damaging floods
Geothermal *5–30¢*	Can be used in many parts of the world Little pollution—mostly gives off water vapor Requires small amounts of land Inexpensive after initial startup	Can be very expensive to produce, especially when first building facilities Cannot be used everywhere, so it would have to be sent to faraway locations

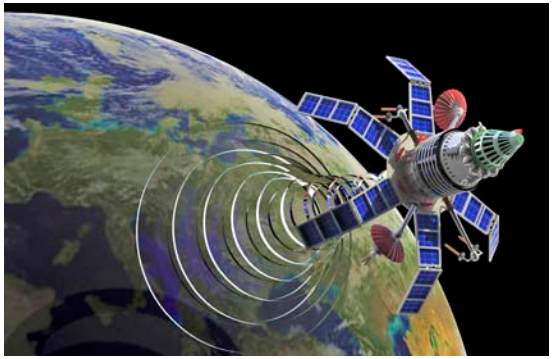
The Changing Energy Picture

The world will be needing new sources of energy as nonrenewable resources run out. Many nations are investing in cleaner, alternative sources of energy. Those resources will include sunlight, wind, and geothermal power. But there will probably also be others.

One resource that may play a big role in the future is hydrogen. This gas burns very cleanly, producing nothing but water as a by-product. Hydrogen can be used to make a fuel cell, which is like a battery. Some cars run on hydrogen fuel cells.



Hydrogen atoms pass through the anode, which frees electrons from them. The electrons flow from the anode to the cathode, which creates electricity. The hydrogen joins with oxygen to make water.



Where will we get energy for future cities? From space? Elsewhere? What do you think?

Some ideas for future energy sources seem like science fiction. One idea is to have huge energy satellites in orbit above Earth. The satellites would absorb sunlight and convert it to microwaves. That is the kind of energy used in a microwave oven. The satellites would beam the microwaves to receivers on Earth. On the ground, the microwaves would be converted into electricity.

The world will always need energy. Do you have any ideas for future energy sources?

Glossary

biomass organic matter from present-day living things—such as wood, garbage, or plant parts—that is used as an energy source (p. 16)

coal a dark-colored rock made of prehistoric plant and animal remains that is burned as a fuel (p. 9)

crude oil a liquid found under Earth's surface that is used to make fuels and many other products; also called petroleum (p. 10)

energy the power to do work, make a change, or move objects (p. 4)

energy resources supplies of things that can be used by people to do work and to supply power (p. 4)

electricity energy created by moving charged particles (p. 4)

fossil fuels energy sources—such as coal, oil, or natural gas—formed from living things that died long ago and changed while in the ground (p. 9)

generators machines that turn motion into electricity (p. 6)

geothermal energy heat from inside Earth, which can be used as a power source (p. 20)

hydroelectric power electricity produced when moving water turns turbines that are connected to generators (p. 19)

natural gas an odorless, colorless, clean-burning fossil fuel (p. 9)

nonrenewable resources supplies of things that cannot be replaced after they have been used (p. 8)

nuclear energy energy that is released when atoms, usually those of radioactive materials, are split or joined (p. 14)

renewable resources supplies of things that can be replaced and are not depleted after they have been used (p. 8)

solar energy the energy of the Sun, which can be used as a power source (p. 17)

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