Different Kinds Of Energy

Energy is defined as the ability to do work or cause change. Energy is found in many sources in nature, including sunlight, wind, water, plants, and animals. We use energy every day. You get energy from the food you eat. We use energy to light and heat our homes. Cars, trucks, planes, and trains all need fuel for energy.

There are many different forms of energy, including mechanical energy, electrical energy, nuclear energy, thermal energy, and solar energy. In photosynthesis, green plants convert the solar energy of light from the Sun into chemical energy. Each type of energy shares the ability to cause some kind of change or to do work. In fact, nearly anytime something moves or changes at all, energy is used.

What sources of energy can you see in these pictures?

The Different Forms of Energy

Kinetic energy is the energy an object possesses because it is moving. **Potential energy** is stored energy determined by an object's position.

A tennis ball thrown through the air has kinetic energy because it is moving. So does a dog when it jumps to catch the ball.

A tennis ball placed on a shelf has potential energy. If the ball falls from the shelf, its potential energy will be changed into kinetic energy because it will be moving. At the very top of its leap the dog also has potential energy. It is no longer moving up, and pauses slightly before falling back to the ground. In that short pause, the dog has potential energy. This potential energy changes into kinetic energy as the dog moves back toward the ground.

A dog has kinetic energy when it runs or jumps to catch a ball in its mouth.

Energy and Change

Almost all energy on Earth comes from the Sun. Plants convert the Sun's light energy into chemical energy when they make and store food. This stored energy is transferred to animals that eat plants, and then to animals that eat plant eaters. Fossil fuels come from the remains of organisms that got their energy from the Sun. They also store the Sun's energy.

Objects can be changed in many ways. A pile of books or magazines can be moved onto a tall shelf. A sculptor can take a slab of clay and mold it into a statue.

Each of these changes requires one thing: energy. When you change an object, you do some sort of work on it by transferring energy to that object.

The energy in the wind can blow objects around in the air.

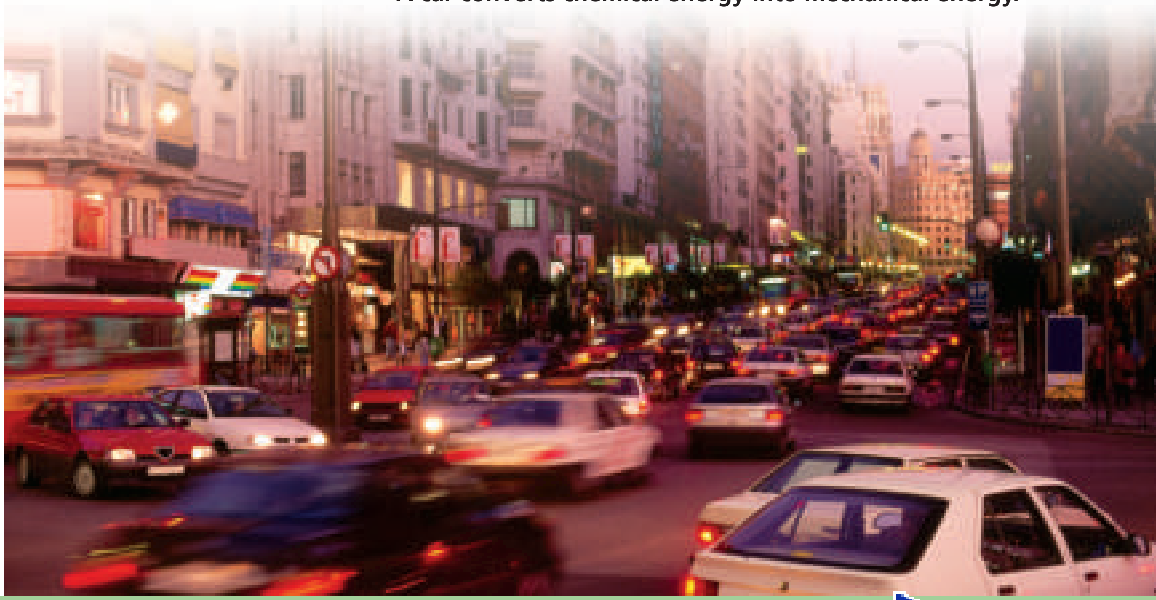
Conservation Laws

Energy is changed and transferred all the time, but it is never lost. A piece of wood has a certain amount of chemical energy. When the wood burns, this energy is changed into heat and light energy. The energy changes form, but the same amount of energy is still present.

For hundreds of years, scientists believed there were no exceptions to this rule. They called it the law of conservation of energy. A similar rule, called the law of conservation of mass, stated that matter was never lost or gained, only changed.

But in the early 1900s, scientists found that these laws were not exactly correct. The famous scientist Albert Einstein came up with the idea that under certain conditions matter could change directly into energy, and energy could be changed into matter. For example, inside the Sun, nuclear reactions turn hydrogen into helium. But not all of the hydrogen is changed into helium; some of it is converted directly into energy. A new rule stated that although matter can change into energy and energy can change into matter, the total amount of matter and energy never changes. This is called the law of conservation of mass and energy.

A car converts chemical energy into mechanical energy.



Electricity And Magnetism

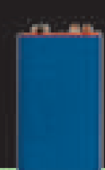
Electric Current

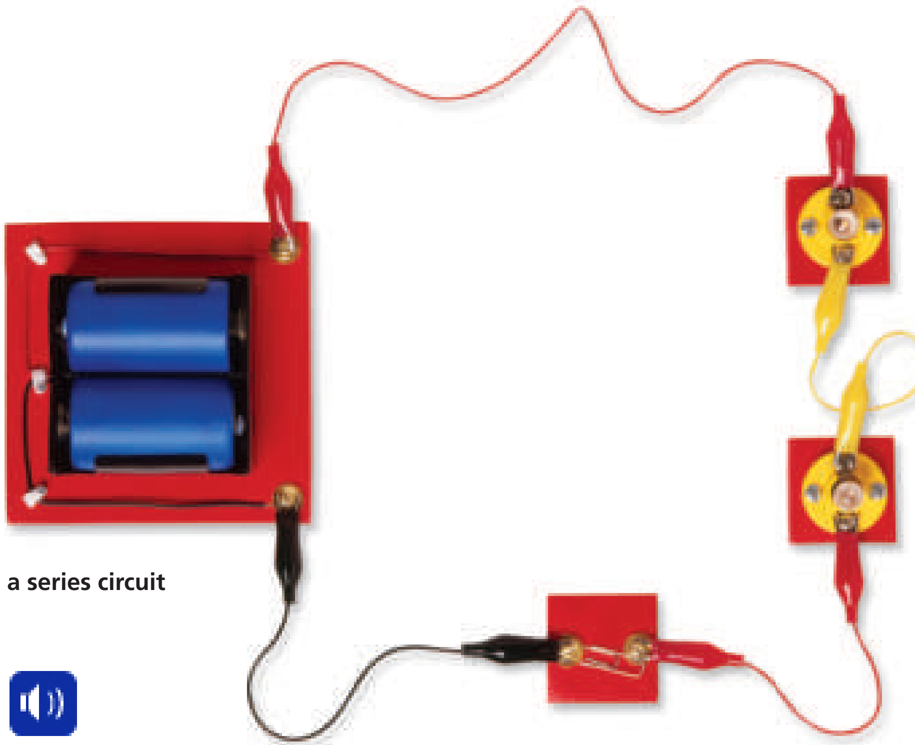
Hardly a moment goes by when we are not using electricity. Whether you are watching television, riding in a car, or simply checking your watch, electricity is at work. But what exactly is electricity? Electricity is the movement of charged particles.

Atoms have a central nucleus surrounded by moving electrons. An atom's nucleus has protons that have positive charges, and neutrons that have no charge. The atom also has electrons that have negative charges. These negative charges hold them near the nucleus. Most atoms have no charge, since their positive and negative charges cancel each other out.

In some materials, the electrons are not tightly held to the atoms and can move from one atom to another. The flow of these electrons from atom to atom causes an electrical charge. Since all electrons have negative charges, they repel each other. As they repel each other, the electrons flow from one nucleus to the next, producing an **electric current.** Materials that allow current to flow through them are good conductors of electricity.

The voltage of a battery or other electrical source measures the force of the electrons as they are pushed. It takes a source of energy, such as a battery, to make the electrons leave their nucleus and force them along a wire.





a series circuit

Electric Circuit

A closed path along which current can flow is an **electric circuit.** A circuit must have a source of electrical energy, a wire through which current can flow, and a device that can change the electrical energy into a useful energy form.

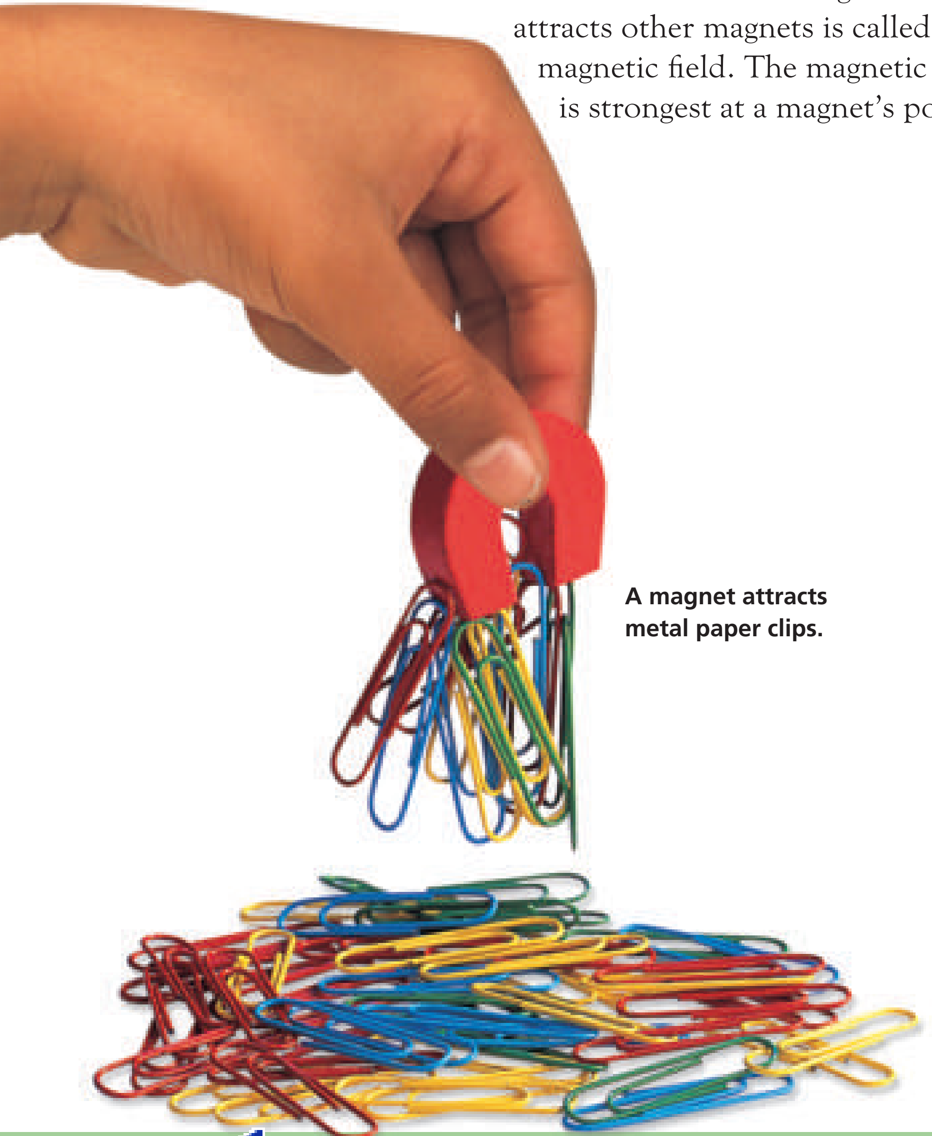
The device can be any type of object that runs on household electricity or batteries, such as a flashlight, a refrigerator, or a computer. Wires inside the appliance slow the flow of the electrons and the resistance causes electrical energy to change into other types of energy. In a flashlight, for instance, the resistance turns the electrical energy into light energy and thermal energy.

Circuits can be set in series—with one path along which current can flow—or in parallel—with more than one path along which current can flow. In a parallel circuit, if you remove one bulb, the others will still work; in a series circuit if one bulb burns out, the rest will not light up until that one is replaced.

Magnetic Fields

All magnets have their power concentrated in their two ends, called poles. One pole is called south and the other is called north. The north pole of a magnet is always attracted to the south pole of another magnet. Two north poles or two south poles always repel each other. However, the entire magnet attracts objects containing a lot of iron, such as pins or paper clips.

The area around a magnet that attracts other magnets is called a magnetic field. The magnetic field is strongest at a magnet's poles.



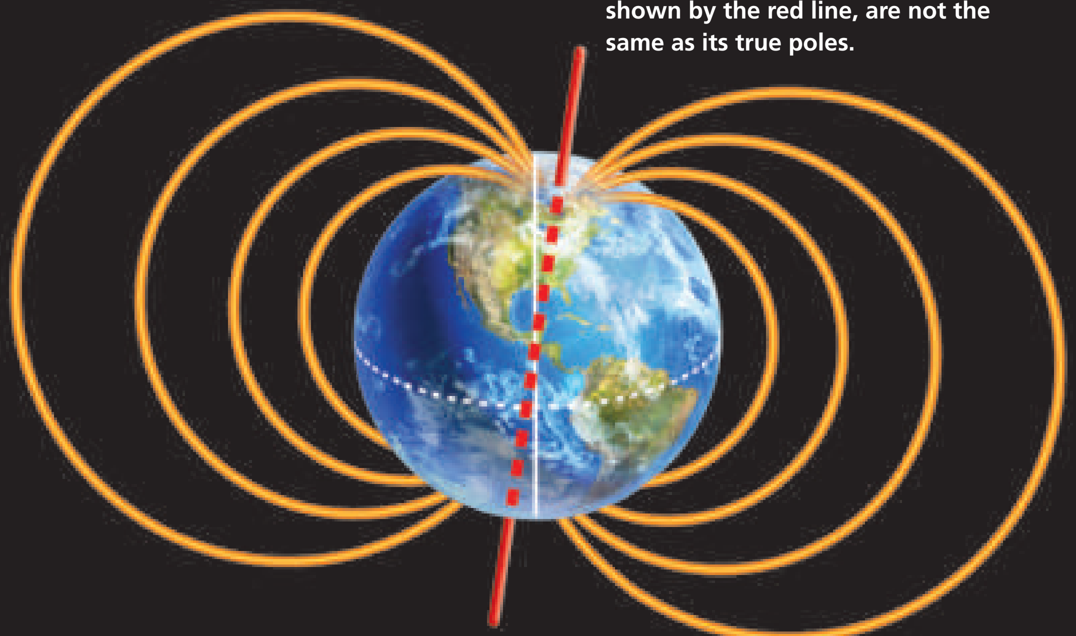
A magnet attracts metal paper clips.

Many materials can never be magnetic. The magnetic fields within these materials face in different directions and cancel each other out. In other materials, such as iron, cobalt, and nickel, the atoms line up in groups called domains. A large number of atoms with their magnetic fields pointing in the same direction is called a **magnetic domain.** When a piece of metal becomes magnetized, all of its magnetic fields are pointed in a single direction.

Earth's Magnetic Field

Earth acts as a giant magnet and is surrounded by a magnetic field. Scientists think this is the result of Earth spinning on its axis and the movement of hot iron in its core. The poles of this giant magnet are located near, but not exactly at, Earth's geographic poles. You can use a compass to point in the direction of Earth's magnetic north pole.

Earth's magnetic poles, which are shown by the red line, are not the same as its true poles.



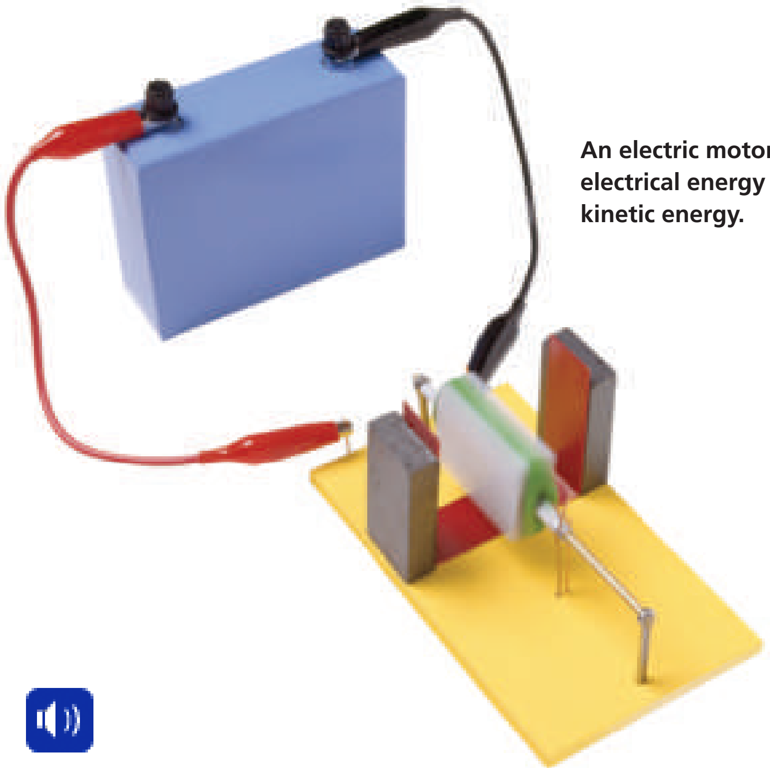
Electromagnets

A magnet that works only when electricity is run through it or around it is called an electromagnet. Unlike regular magnets, its magnetism can be switched on and off.

Electromagnets are made from a coil of wire that's attached to a power supply. When current flows into the coil, it becomes a magnet. If you add more coils, you can make the magnetic field stronger. The coils in an electromagnet are usually made out of copper wire. Copper is a good conductor of electricity.

Electromagnets only attract magnetic objects. When the current is turned off, the electromagnets are not magnetic.

This powerful electromagnet is used to pick up scrap metal. The operator can turn the electromagnet on to lift the metal and turn it off to drop the metal.



An electric motor converts electrical energy into kinetic energy.

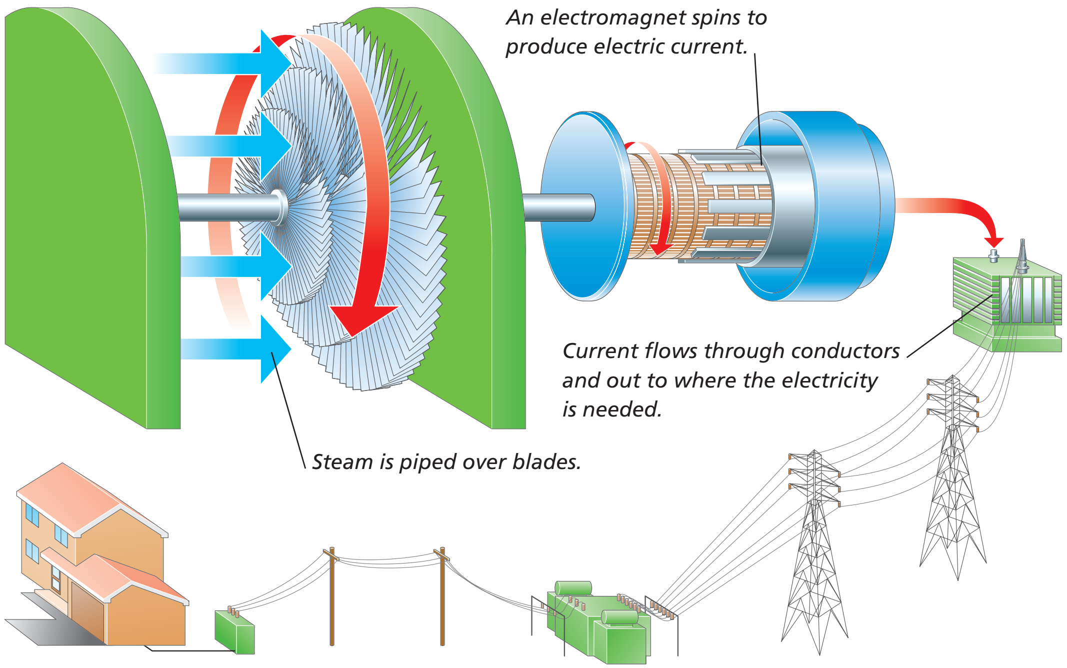
A device that changes electrical energy into kinetic energy is called an **electric motor.** An electric motor has a permanent magnet, an electromagnet, and a device that changes the direction of the current that flows through the electromagnet. When current passes through the electromagnet, each pole is attracted to the opposite pole of the fixed magnet. This attraction causes the electromagnet to spin. The current is then reversed so the poles of the electromagnet are flipped, causing the electromagnet to move again. This happens over and over, producing a constant spinning motion.

We use electromagnets in our everyday life. The speakers in a stereo use rapid electromagnetic movements to produce sound vibrations. When the electric current is turned on, it flows at a very fast rate, producing a magnetic field. This magnetic field causes a cone in the speaker to move back and forth. If you look at the cone of a speaker playing loud, low tones, you can see it moving.

Changing Magnetism Into Electricity

An English scientist named Michael Faraday found that a magnetic field can be used to produce electricity. Faraday knew that when an electric current flows in a wire, it makes a magnetic field. He found that if a wire was moved into a magnetic field, an electric current would be generated in the wire. A current is also generated if a magnet is moved across a piece of wire. Moving the wire or the magnet faster will produce a stronger current. This is called electromagnetic induction.

generators inside a hydroelectric power plant



Many power plants use steam to spin generators. The steam pushes on the blades of a turbine, which spin to turn the generator.

A device that transforms mechanical energy into electrical energy is called a **generator.** The generator is based on the principle of electromagnetic induction.

Electric generators, which work with magnets, produce the electricity that we use in our homes and schools. Generators create an electric current by spinning a magnet inside a coil of wire. They can also work by moving a coil of wire inside a magnetic field.

In order to produce electricity, a generator needs more than a wire coil and a fixed magnet. It also needs something to provide the spinning motion. Usually power plants use a device called a turbine. Steam, water, or wind pushes on blades in the turbine, causing them to spin. The spinning motion turns the generator. Most power plants in the United States burn fossil fuels to generate steam.

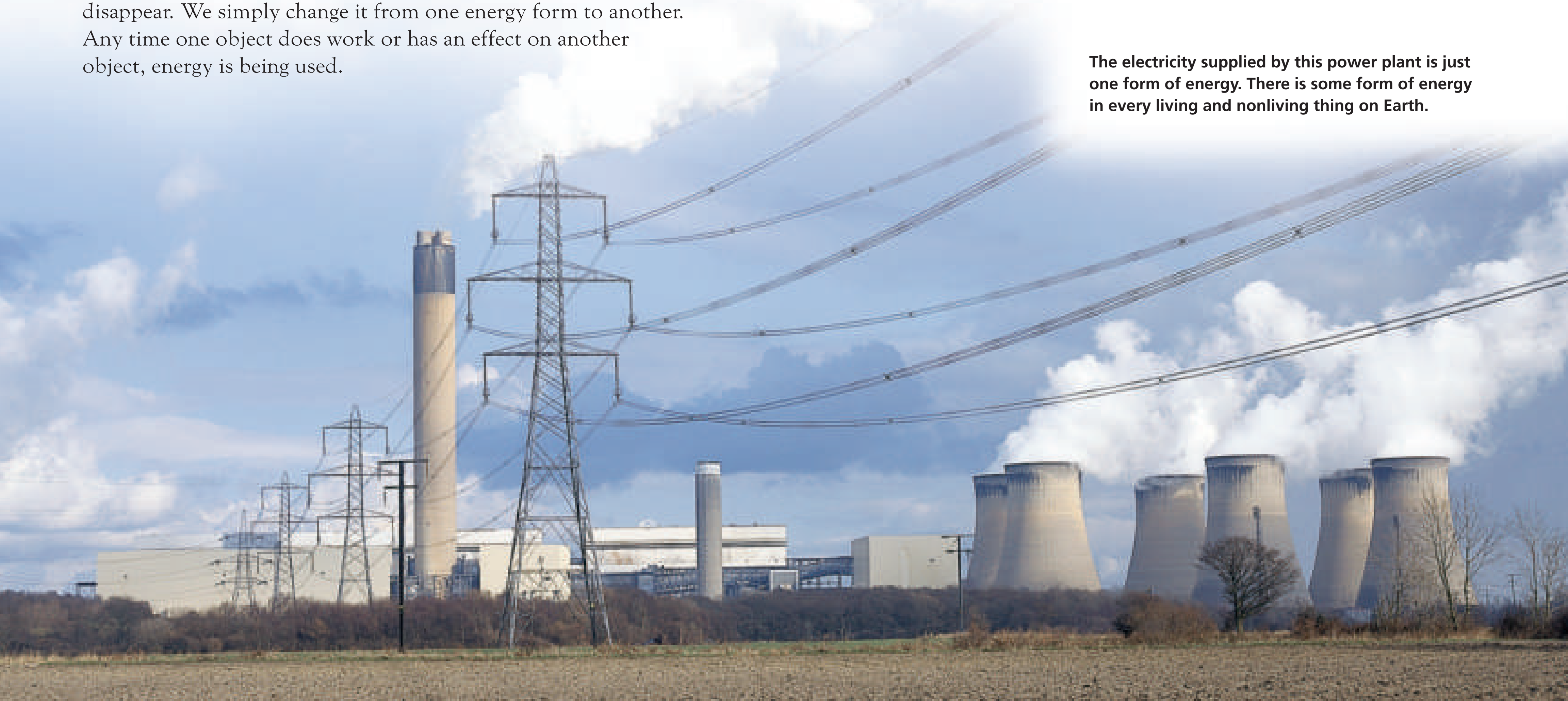
There is a fixed amount of energy in the world. Energy is constantly being transferred from one object to another. Energy is also constantly changing from one form to another.

A car's engine burns gasoline. The engine converts the fuel's chemical energy into mechanical energy to make the car run. Solar energy panels convert the Sun's radiant energy into electrical energy. Your body has chemical energy that it gets from the foods you eat. You expend that energy through your muscles. This energy allows your body to do work.

When we use energy, it doesn't get used up and it doesn't disappear. We simply change it from one energy form to another. Any time one object does work or has an effect on another object, energy is being used.

Electricity is a form of energy that we use every day to power everything from pocket calculators to trains. We generate electricity by harnessing other forms of energy, such as the burning of fuels, nuclear reactions, wind, or flowing water.

All things possess some type of energy. Even inanimate objects have energy. Energy moves waves to the shore and pushes sailboats through the water. Energy is what bakes our cookies in the oven. It heats and lights our homes, and runs our radios, televisions, and computers. It is the ever-changing nature of energy that makes our lives on Earth possible.



The electricity supplied by this power plant is just one form of energy. There is some form of energy in every living and nonliving thing on Earth.

Glossary

electric circuit	a closed path along which current can flow
electric current	the flow of electrical charges through a material
electric motor	a device that changes electrical energy into kinetic energy
energy	the ability to do work or cause change
generator	a device that transforms mechanical energy into electrical energy
kinetic energy	the energy of something that is moving
magnetic domain	a large number of atoms that have their magnetic fields pointing in the same direction
potential energy	stored energy that is determined by an object's position

What did you learn?

1. Describe the difference between potential energy and kinetic energy.
2. What discoveries made scientists give up on the law of conservation of energy? What law has replaced it?
3. Based on what you have read, explain how a magnet and a coil can produce an electric current.
4. **Writing** in Science Energy has many forms, and it can change from one form to another, such as when spotlights change electrical energy into light. Write to explain some other ways energy changes from one form to another.
5. **Sequence** Describe the steps needed to produce an electric current.