# Energy Sources

## Think About It...

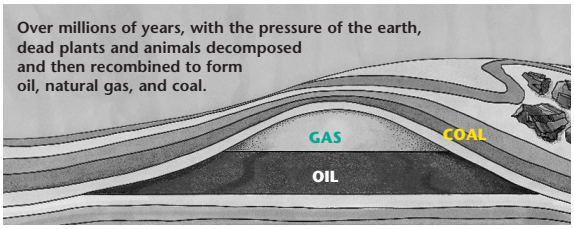
- Where does the energy you use every day come from?
  - Are the energy sources we depend on the same as those in the past?

## Learn About It...

Over the years, Americans have used several energy sources to meet our energy needs. Before 1900, wood was burned to provide most of our energy. Then people began to depend on coal—to power trains, steamboats, factories, and furnaces, and eventually to generate electricity. Today, the United States—and California—rely on a variety of energy sources. In California, all of our energy sources—except oil—are used at least in part to help generate electricity.

### Fossil Fuels

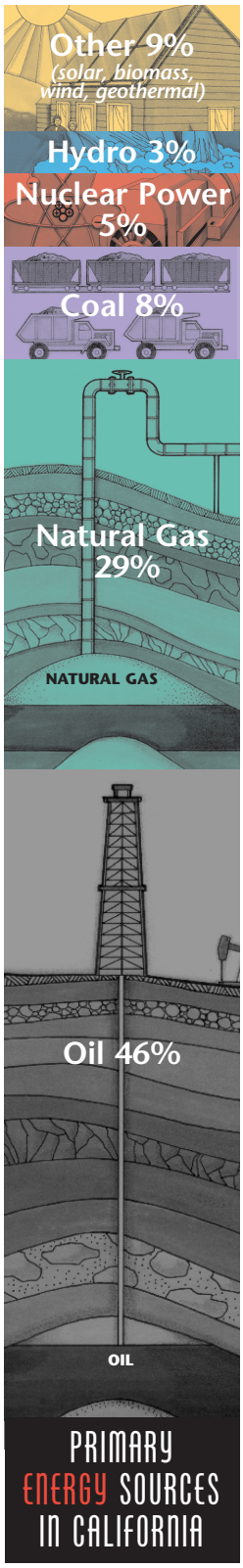
Petroleum (oil), natural gas, and coal are *fossil fuels*. Millions of years ago, when the plants and animals that lived on Earth died, they were covered with water, mud, and rock.

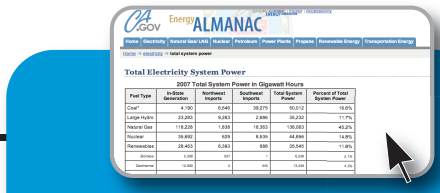



Over millions of years, under pressure, the dead plants and animals decomposed and then recombined to form oil, natural gas, and coal. These fuels are rich in stored up energy. When we burn fossil fuels, the stored energy is released as heat.

**Oil,** a thick, brown liquid, is found under land and water. We drill holes to find the oil and then pump it out of the ground.

Most oil is used to make gasoline and other vehicle fuels. It is also used to make heating oil to burn in furnaces and to make *petrochemicals*, which are used to make such products as plastic, fabrics, and cosmetics.




## CHECK THIS OUT:

Go online to http://energyalmanac.ca.gov/electricity/total_system_power.html to see the percentage of electricity generated by each energy source.

**Natural gas** is an invisible, odorless gas that is sometimes found along with oil. Drills are used to reach the natural gas, which then rises through pipes to the surface.

Most natural gas is delivered to homes and businesses through underground pipes and is used in furnaces and stoves. Natural gas is also used in power plants to generate electricity and, like oil, used to make chemicals used in such products as ink, glue, and nylon.

**Coal**, which looks like rough black rocks, must be dug out of the ground. The primary use of coal is to generate electricity in power plants, though it is also burned in some buildings and factories to provide heat.

Fossil fuels have been fairly easy to obtain and to use. We have established systems for using them in our cars, homes, factories, and power plants. In California, fossil fuels provide more than 80% of our total energy, and they generate more than 50% of our electricity.

But there are disadvantages to using fossil fuels.

- First, fossil fuels are nonrenewable. They are becoming more difficult to find and recover, and once they are used up, they cannot be replaced.
- Second, the use of fossil fuels causes environmental problems. Whether they are burned in power plants or in our cars, fossil fuels release harmful pollutants into the air, causing smog and other air pollution problems.

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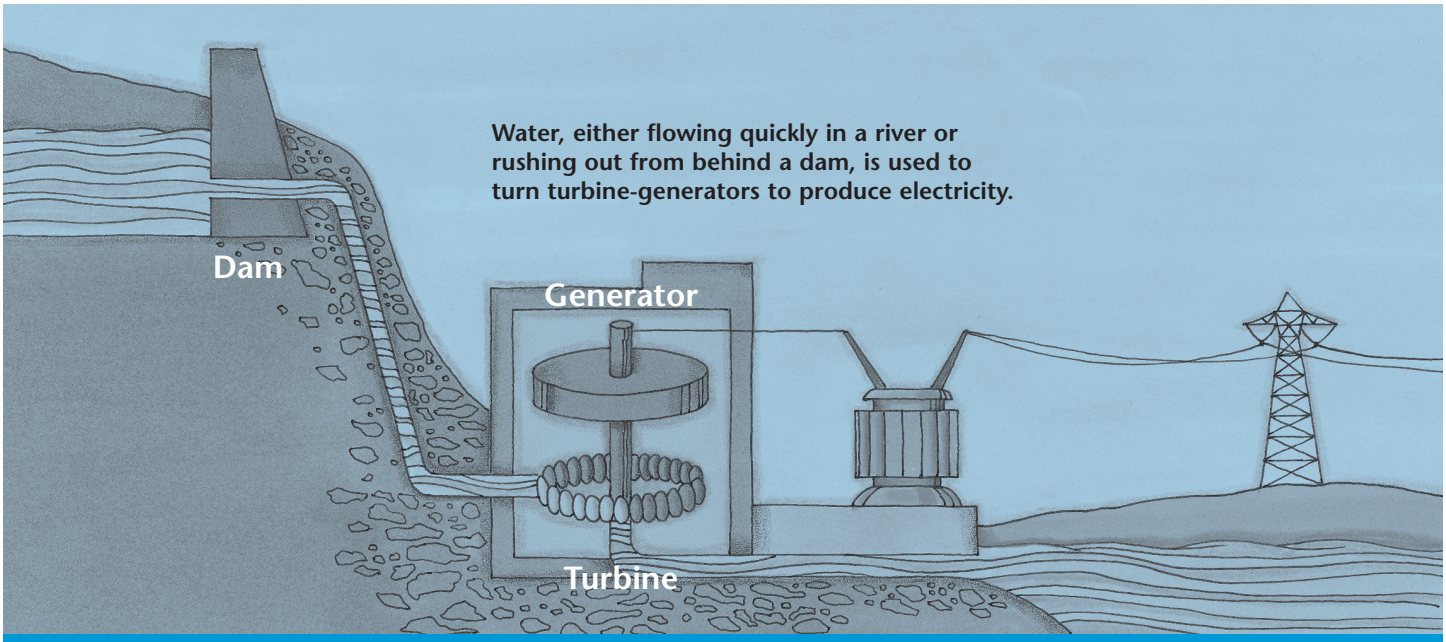
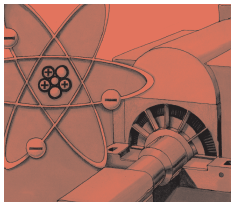



HYDROELECTRIC POWER PLANT

## Nuclear Power

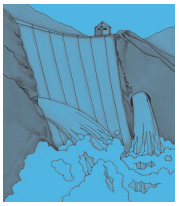


*Nuclear energy* comes from the tiny dense core of the *atom*—the *nucleus*. In a nuclear power plant, the nuclei of atoms of *uranium*, a heavy mineral, are split apart. As each one splits, it releases *neutron*s, which travel at high speed, hitting other atoms, splitting them apart, causing a chain reaction. This splitting of millions of atoms—called *fission*—creates a lot of heat, which is then used to make steam to turn *turbine-generators* in a nuclear power plant.

There are two nuclear power plants in California, Diablo Canyon near San Luis Obispo and San Onofre between Los Angeles and San Diego, producing about 15% of our electricity.

Uranium, the fuel for nuclear fission, is nonrenewable; however, it is a common, inexpensive mineral found worldwide. The primary problem with nuclear energy is that the material left over after the atoms are split apart is radioactive, which means that it gives off radiation that can be harmful to us. Thus, the waste material must be stored carefully since it remains radioactive for hundreds of years.

## Hydropower



*Hydro* means water. So *hydropower* means "water power." Water, either flowing quickly in a river or rushing out from behind a dam, is used to turn turbine-generators to produce electricity. Hydropower is an important source of electricity for the nation and for California. About 12% of the total electricity in California comes from nearly 400 hydro plants.

Some hydroelectric power plants are both producers and consumers of electricity. Here's how it works. During times when a lot of electricity is being used—such as on hot summer days—water is released from a dam at a high elevation to generate electricity. The water ends up in a reservoir at a lower elevation. Then at night, when less electricity is needed, the water is pumped from the lower reservoir back to the higher reservoir to be used again.

Hydropower is a renewable energy source, as long as rivers and streams continue to flow. But there are only so many places with water that we can use for hydropower.

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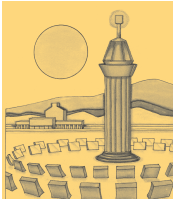
## Solar



*Solar energy*—energy from the sun—is the principal source of all the Earth's energy. Sunlight heats the land and warms the water. It causes the winds to blow and the rains to fall. It allows plants to grow, providing the stored energy on which all animals live. Even fossil fuels are "stored sunshine." Without the sun, the Earth as we know it could not exist. But the energy source that powers the planet can also power the many machines that have become a part of our lifestyle.

There are basically two different ways in which we can capture and use the sun's energy.

- *Thermal heat* – The sun's heat can be used to heat water, which can be used directly or used to generate electricity.
- *Photovoltaic cells* – These devices actually convert sunlight into electric current.

SOLAR POWER PLANT

SOLAR CELL PANELS

### Thermal Heat

The intense energy of the sun has long been used to heat water. Pioneer families had homes equipped with solar water heaters. Today, homes across the nation have solar hot water heaters installed. In these systems, cold water from the home's regular water line is pumped to a thermal collector on the roof, where the sun's heat warms the water. The heated water then flows into the regular hot water tank. These systems are used to heat water for homes and businesses and for swimming pools.

Solar heat can also be used to heat water in power plants. At a solar thermal power plant, huge mirrors—solar collectors—are used to focus sunlight onto a tank filled with water or other fluids. The sun heats the fluid to a very high temperature, creating steam to power turbine-generators to produce electricity. California's Beacon Solar Energy Project covers about 2,000 acres in Kern County.

### Photovoltaic Cells

Photovoltaic cells—or PVs or, more commonly, solar cells—are composed of thin layers of silicon and other materials. When sunlight strikes a solar cell, chemical reactions release electrons, generating a little electric current. We find solar cells in calculators, camera light meters, sidewalk lighting systems, and freeway phones for stranded motorists.

Solar cells can also be put together into solar panels or modules to provide electricity for homes and businesses.

The panels are usually placed on rooftops of individual homes and businesses that have clear access to the sun for most of the day. They might be simply attached to the roof or actually part of the roofing material. In some cases, a PV system can be connected to the electric utility's system. Then, if the solar panels are providing more power than the home or business uses, the extra electricity goes to the utility, and the home or business's electricity meter actually spins backwards!

Electric utilities can use their own PV systems to supplement the electricity they provide. Los Angeles Department of Water and Power has several rooftop installations on municipal buildings throughout the city. Besides using conventional PV technology, LADWP is planning to feature building-integrated photovoltaic (BIPV) systems at several area libraries.

Southern California Edison has begun installing the nation's largest solar cell system on the unused roofs of commercial buildings. Over the next few years, Edison will install solar cell panels on approximately 65 million square feet—about 2 square miles—of roofs. Eventually, these solar units could provide enough electricity for about 160,000 homes.

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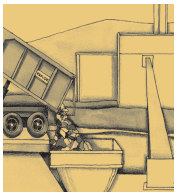
## Biomass



*Biomass* is organic matter from plants and animals. Some examples of biomass fuels are:

- wood, especially lumber waste
- crops, such as corn and sugar cane
- trash and garbage from our homes and businesses

To get energy out of biomass, we can burn it or convert it into *biofuel*.

**Burning** biomass releases heat. Wood, along with wood waste (bark, sawdust, wood chips, wood scraps), is the most common form of biomass. It is burned in homes, industries, and businesses, and by electric power companies, who use the heat to create steam to turn turbine-generators to generate electricity.

Trash that comes from plant or animal products is also biomass—food scraps, lawn clippings, paper packaging, leaves. Californians create about 85 million tons of household garbage and industrial waste each year—nearly 3,000 pounds each second! About half can be recycled, but that leaves a lot of garbage that could be burned to produce electricity.

In California, there are about 30 biomass power plants. Two plants that burn municipal solid waste—trash and garbage—are located in Los Angeles County—one in Long Beach and one in the city of Commerce. Biomass produces about 2% of the total electricity in California.

**Converting** biomass creates biofuels, which are used to power cars and trucks. Crops like corn and sugar can be fermented to produce ethanol, which can be mixed in with gasoline. Biodiesel, which can run diesel engines, can be produced from leftover vegetable oil—like french-fry oil! Biofuel is even starting to be made from algae. Several companies—some in California—are growing algae either in open ponds or in tanks and converting it to fuel.

BIOMASS

GEOTHERMAL POWER PLANT

Biomass is a renewable energy source; we can always grow more crops, and waste will always exist. Using biomass to generate electricity helps keep waste out of rapidly filling landfills, and using biofuels does reduce air emissions from vehicles. But burning biomass in power plants does release some pollutants into the air, and growing crops for fuel requires a lot of land.

## Geothermal

*Geothermal* energy comes from heat inside the Earth. We can see the results of that heat in volcanoes, geysers, and hot springs. The heat underground often heats water or creates steam that we can tap to generate electricity in power plants. The hot water can also be used directly by piping it through buildings to heat them.

The city of San Bernardino has one of the largest direct-use geothermal projects in North America. Hot water from below ground is used to heat public buildings. After being pumped up, the hot water runs through about 15 miles of insulated pipelines to about 40 buildings—from City Hall to retirement homes and animal shelters.

California has more than 40 geothermal power plants that produce almost 5% of the state's total electricity—a little more in southern California. Geothermal energy is considered to be renewable since heat from the core of the Earth is expected to last indefinitely. However, geothermal energy can be tapped only in areas where the heat is close enough to the surface. Also water that is removed must be reinjected into the ground so that the land doesn't sink and the source doesn't "dry up."

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## Wind

People have been using wind for energy for thousands of years. Wind has powered sailboats, pumped water from wells, and turned grinding stones to mill wheat or corn.

Today, wind also turns wind turbines to make electricity. A wind turbine is similar to a child's pinwheel or the propeller of an airplane. The giant blades are connected to a shaft, which in turn is connected to a generator that produces electricity. Often, hundreds of wind machines are grouped together in wind farms in particularly windy areas—areas with average wind speeds of at least 13 miles per hour.

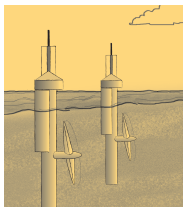
WIND

California has 5 major areas producing wind power. Two of those areas are in southern California—Tehachapi, which is southeast of Bakersfield, and San Gorgonio, which is east of Los Angeles near Palm Springs. Approximately 14,000 wind turbines in California produce about 2% of our electricity.

**Where does your city get its energy?**

Wind is, of course, a renewable energy source—but it's not reliable. Winds must blow at a constant high speed to generate electricity, and that condition is not found in very many places and never all year long. In California, ¾ of our wind energy is produced during the spring and summer. Wind farms also use large areas of land and may disturb the area's wildlife, including birds.

## Ocean Energy



There is tremendous energy in **ocean tides and waves.**

Caused by the gravitational pull of the moon and sun, **ocean tides** flowing on and off shore or between ocean and rivers can be a source of electricity. Tidal turbines basically resemble and function like sturdier wind turbines. Placed where there are strong tidal currents, the turbines turn as the water flows in during high tide, and then reverse as the water flows out to sea during low tide. Currently, only two tidal plants are in operation—one in Canada and one in France.

OCEAN ENERGY

The energy in **ocean waves** comes from the movement of the ocean and the changing heights and speed of the swells as the wind blows across the sea. But it's not easy to harness this energy and convert it into electricity in large amounts. There are several methods of getting energy from waves. Most all of them involve wave machines outfitted with turbines and/or pistons to capture the energy of ocean waves and turn it into electricity.

Currently, installations have been built or are under construction in a number of countries—Scotland, Portugal, Norway, China, Japan, Australia, and India. The west coast of the United States, including California, has many areas with the necessary wave patterns or strength. Two wave farms are under construction in northern California.

Ocean energy is renewable. Waves continue to break, and the daily movement of tides is predictable. But only limited locations have the needed tidal currents or strong ocean waves to produce energy economically. And the effects on the aquatic plants and animals must also be considered.

# COMPARE ENERGY SOURCES

**What are some advantages and disadvantages of each of our energy sources?**

**Think about:** **supply** **cost** **environmental effects**

| Energy Source | Advantages | Disadvantages |
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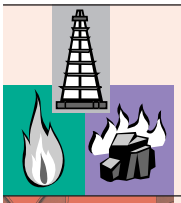
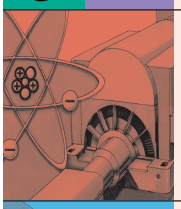
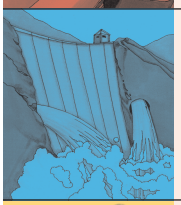
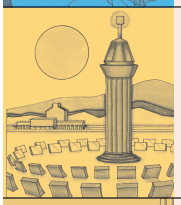
|  fossil fuels | | |
|  nuclear power | | |
|  hydropower | | |
|  solar | | |
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| geothermal | | |
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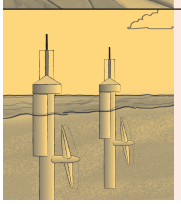
|  ocean energy | | |