CONSERVATION CONNECTION

WATER & ENERGY IN SOUTHERN CALIFORNIA

STUDENT BOOK

How Are Water and Energy Used?

List all the ways you can think of that people use water and energy in homes, in businesses, in the community, on farms.

Water Uses

Energy Uses

Water, Energy, & You

Think About It...

- What would a day be like **without** water or energy?
- How have you personally used water and energy today?
- How do you think your use of water and energy compares to people's use 100 years ago?
- Is there enough water and energy to last forever?

CHECK THIS OUT:

Go online to surveys.bewaterwise.com to print out and begin the Water and Energy Survey for Home and/or School.

Learn About It...

We need water and energy.

Water makes up about 65% of our bodies; we cannot live more than about a week without drinking water. And we need water to grow our food and make products that we use every day.

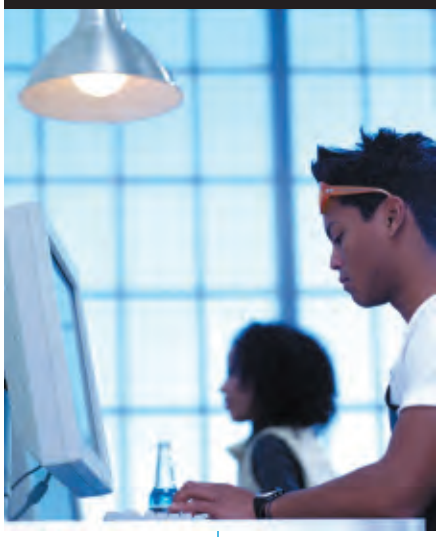
Energy is essential to life; we could not exist without the heat, light, and food that are created by the energy the sun provides. And, of course, we use energy in so many other ways, from cooking our food to running our cars.

We use **a lot** of water and energy every day. Is there a never ending supply? Well, yes...and no.

Water does fall from the sky, but it is not "new" water, just recycled water. The amount of water on Earth never increases or decreases. We have a fixed supply.

Heated by the sun, water on the ground in oceans, lakes, rivers, streams, and other areas *evaporates*; water vapor is also released from plants through *transpiration*. All this water vapor rises into the air, cools, and *condenses* into tiny droplets that gather and form clouds or fog. Finally, when the clouds meet cool air over land, *precipitation* in the form of rain, hail, sleet, or snow is triggered, and water returns to the land or sea. Thus, the water you use is the same water used by dinosaurs, early Native Americans, pilgrims, and your great grandparents.

WE NEED WATER AND ENERGY



Energy—which produces heat, light, or motion—comes from many sources, such as:

- fossil fuels (oil, natural gas, coal)
- the sun
- the wind
- the ocean

Some of our energy sources are *renewable*; they can keep on providing energy. For example, we expect the sun to keep shining and the wind to keep blowing. However, the energy sources that we depend on the most—oil, natural gas, and coal—are *non-renewable*. There is only a limited supply of these fossil fuels in the earth. Once they're gone, they're gone forever.

Our supply of water and energy meets our needs most of the time. But, in times of drought and during periods of high energy demand, we don't have enough water and energy. And as the population grows every day so does our demand for water and energy, yet our supply is decreasing as we find more ways to use these precious resources.

So how can we be sure we have enough for the future?

PERSONAL WATER USE LOG

For one day, keep track of everything you do that uses water and the number of minutes the water is running for each use. LATER, you will fill in the number of gallons used and then compare your daily water use to that of others.

Name:_____ Date:_____

Water Use	Number of Minutes Water Running	Gallons Used
Example: shower	12 minutes	

TOTAL _____ gallons

PERSONAL ENERGY USE LOG

For one day, keep track of everything you do that uses energy and the number of minutes or hours that you use that energy. LATER, you will fill in the number of kilowatt hours or BTU used and then compare your use to that of others.

Name:_____ Date:_____

Energy Use	Number of Minutes or Hours Energy Used	Kilowatt Hours* OR	BTU Used**
Example: radio	25 minutes		

*One kilowatt-hour (kWh) is 1,000 watts of electricity use for one hour—e.g., a 1,000 watt hair dryer used for one hour, or a 100 watt light bulb burning for 10 hours.

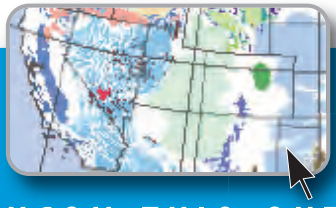
**TOTAL _____ kWh _____ BTU

**One BTU, which stands for British Thermal Units, signifies the quantity of heat needed to raise the temperature of one pound of water by one degree Fahrenheit; it is a very small unit.

Water Sources

Think About It...

- Where does the water you drink and use every day come from?
  - How much of the water from rain, and other precipitation, is available for us to actually use?



CHECK THIS OUT:
Go online to www.nationalatlas.gov/natlas/Natbsstart.asp for a map showing all aquifers and surface water in California.

Learn About It...

We get all the water we use from only two places – **on** the ground and **under** the ground.

Surface Water

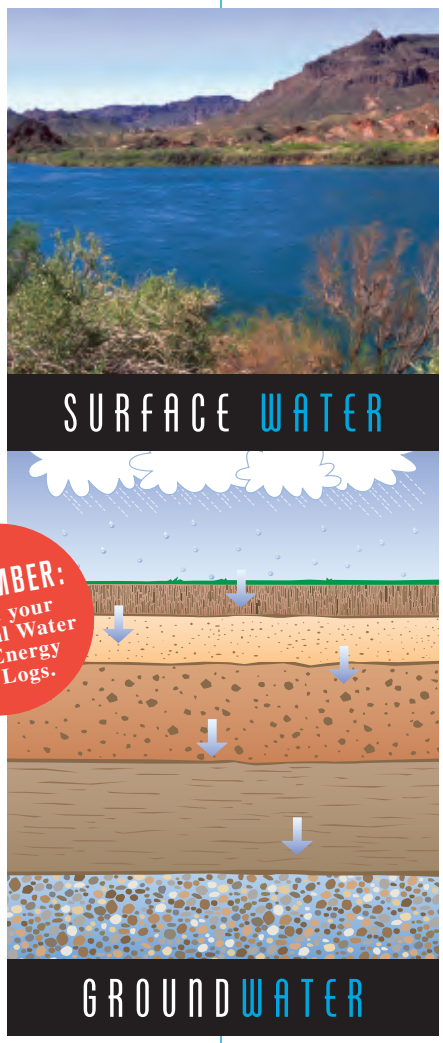
Water on top of the ground is called *surface water*. We can see this water in:

- lakes
- rivers
- streams
- oceans

How does the water get there? From rain, of course, and snow and sleet and hail. In California, about 200 million *acre-feet* of water falls from the sky every year; that's about the same as 200 million football fields each filled a foot deep with water. One acre-foot is about 326,000 gallons, so that's a lot of water. But only about ⅓ of that water actually ends up in rivers, lakes, and streams. The rest of it is either used by trees, plants, and animals or soaks into the ground or evaporates.

REMEMBER: Fill in your Personal Water and Energy Use Logs.

Most of California's rivers, streams, and lakes are in the north because that's where about 75% of the precipitation falls. Southern California has much less rain; therefore, southern California has few natural lakes and rivers.



Groundwater

Water that soaks into the ground collects in basins called *aquifers*. These aquifers are not like lakes above ground. They are more like sponges, holding water in spaces between particles of sand and gravel and in cracks in rocks.

Where does your city get its water? Go to www.bewaterwise.com to find your local agency.

California has about 500 aquifers. Some are just the size of small pools; others are miles long and hundreds of feet deep. Some are just a few feet underground; others are thousands of feet underground. In all of them, the water gets there by soaking into the ground from:

- rain
- irrigation of crops
- river and stream beds
- recharge ponds where water is purposely spread on the ground to refill the aquifer.

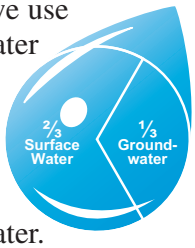
That's how water gets into the ground. How do we get it out? Wells are drilled into the ground and electric pumps push the water up to the surface. But even though a lot of water is stored underground, we can't pump it all up. Some of it is too deep and too expensive to reach, and some of it is too salty or too polluted.

Even if we could, we shouldn't pump out all the *groundwater* because that can cause *overdraft*, which causes problems, such as:

- The ground may compact and never be able to hold water again.
- Land may sink, causing buildings, roads, and pipelines to crack or break.
- Plants depending on the groundwater may die.

For the entire state of California, during most years—

- about ⅔ of the water we use comes from surface water
- about ⅓ of the water we use comes from groundwater.



In southern California, like the rest of the state, about ⅓ of the water we use during most years comes from groundwater. However, local surface water supplies southern California with only about 2% of our water, not 60-70% like the entire state.

So where do you think the rest of the water we use in southern California comes from?

Water Distribution

Think About It...

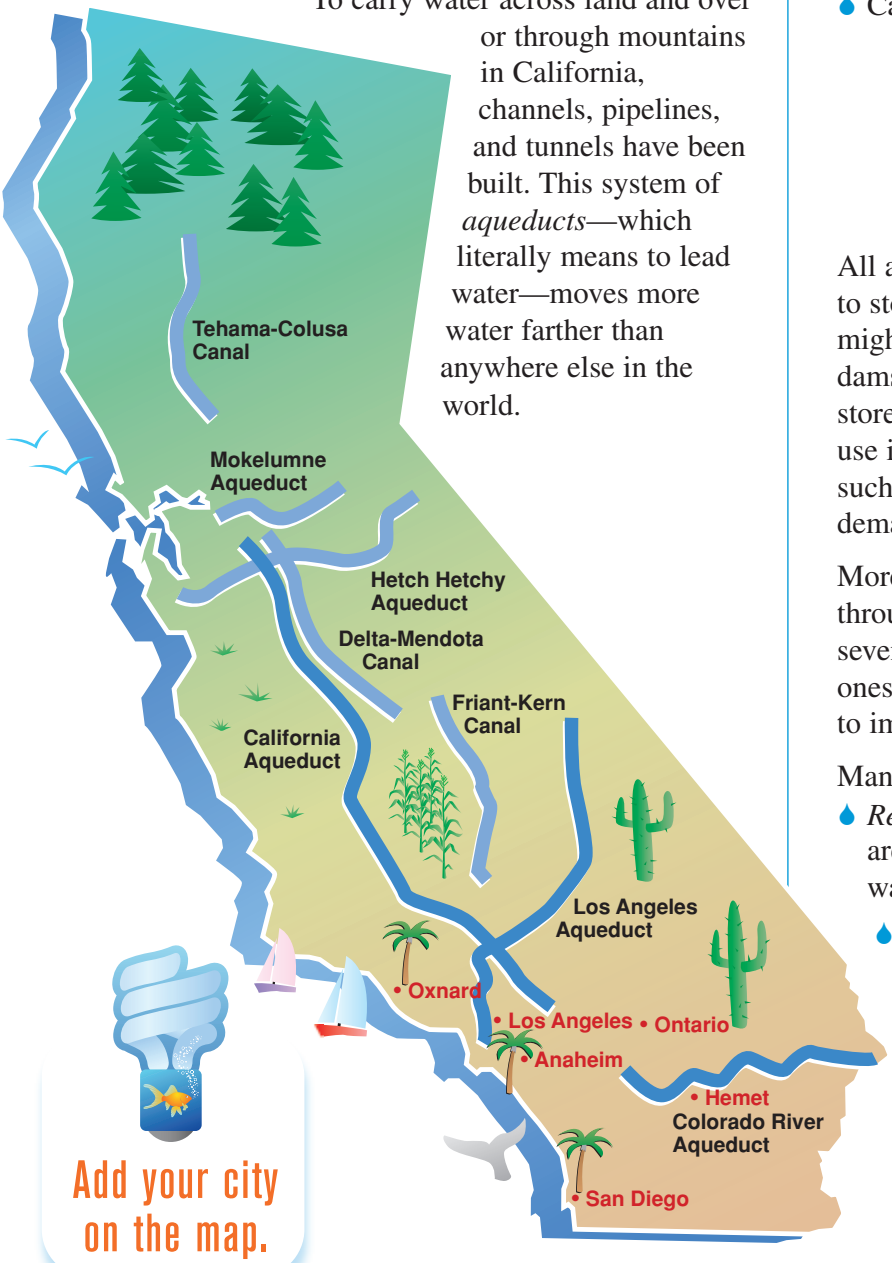
- 75% of the people in California live in the central and southern part, but 75% of the rain and snow falls in the northern part of the State, so how does the water get to where it is needed?
  - What do we do in drought years when less rain falls and less water is available to use?

Learn About It...

Throughout California—especially in southern California—more water is needed in some places than is locally available. So we move water to where it is needed.

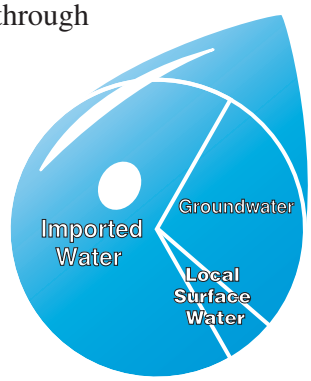
Aqueducts

To carry water across land and over or through mountains in California, channels, pipelines, and tunnels have been built. This system of *aqueducts*—which literally means to lead water—moves more water farther than anywhere else in the world.



In southern California, about 66% of the water we use is imported through three aqueducts:

- Los Angeles Aqueduct
- Colorado River Aqueduct
- California Aqueduct



Reservoirs

All along the aqueducts are *reservoirs* that are used to store the water until it is needed. These reservoirs might be large storage tanks or lakes formed by dams. In times of heavy rain, excess water can be stored in the reservoirs. The water can be saved for use in case of a severe drought or an emergency—such as an earthquake—or in times of high water demand—such as in hot summer months.

More than a thousand reservoirs store water throughout California. In southern California, seven major reservoirs—as well as many smaller ones—store water from the three aqueducts used to import water into the region.

Many reservoirs provide other benefits:

- *Recreation.* Like natural lakes, some reservoirs are used for fishing, swimming, boating, and water-skiing.
- *Flood control.* Reservoirs and the dams that create them can protect land from flooding by holding back water.
- *Clean, low-cost electricity.* Some reservoirs have hydroelectric power plants that produce electricity when water is released from dams to turn turbine-generators. This electricity contributes to the energy needed to pump water.

Water Use

Think About It...

- Besides personal uses, what else is water needed for?
  - What do you think the most water is used for in California?

Learn About It...

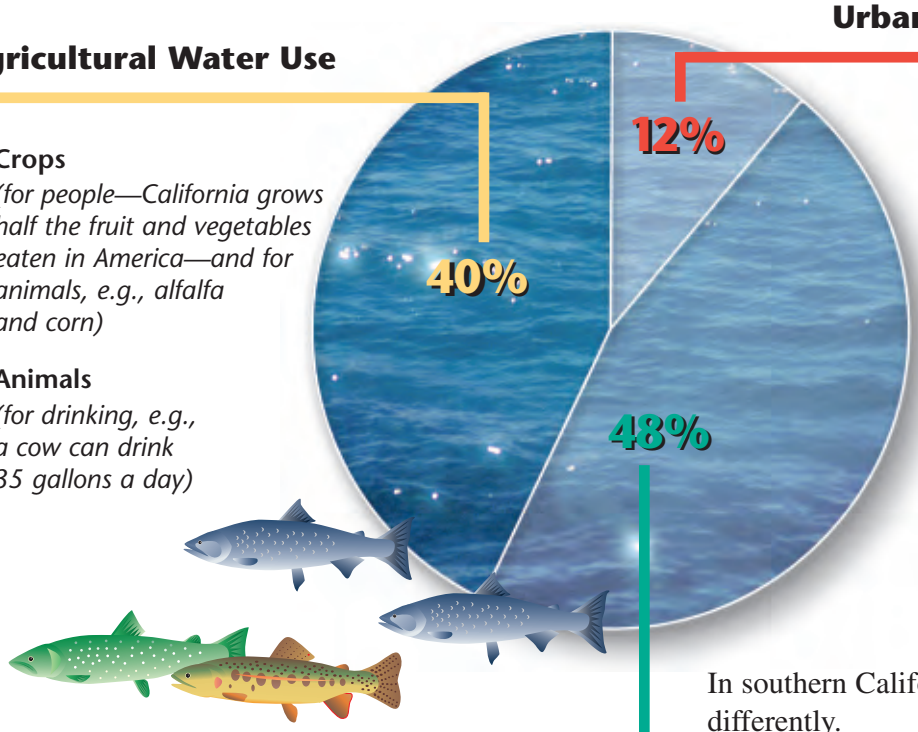
In California, we use all the water we have available to use. We even bring extra water into California from other states. Here's where the water goes:

Agricultural Water Use

- **Crops** *(for people—California grows half the fruit and vegetables eaten in America—and for animals, e.g., alfalfa and corn)*
- **Animals** *(for drinking, e.g., a cow can drink 35 gallons a day)*

Urban Water Use

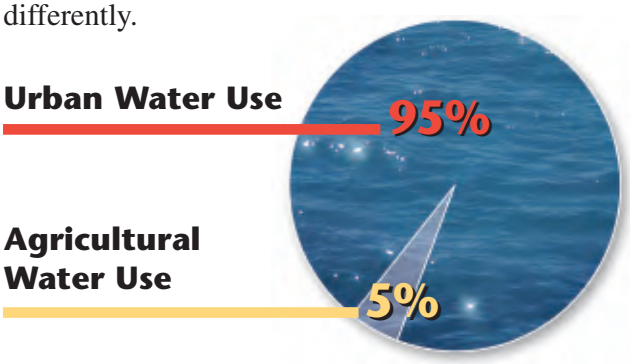
- **Homes** *(toilets, faucets, hoses, etc.)*
- **Businesses** *(shops, office buildings, restaurants, hotels, car washes, etc.)*
- **Industry** *(to make products, to cool machinery, to produce food, etc.)*
- **Public services** *(street cleaning, fire fighting, park watering, etc.)*



Environmental Water Use

- **Streams** *(to keep flowing)*
- **Plants and trees** *(to live)*
- **Wetlands** *(to stay healthy)*
- **Fish and other animals** *(for habitat and to drink)*
- **Coastal freshwater basins** *(to keep ocean water out)*

In southern California, water is divided up differently.



Why is water use in southern California so different from the state as a whole?

How is water used in your area? Go to www.bewaterwise.com to find your local agency.

How Much Water Do You Use?

- Use the figures below and your Personal Water Use Log to calculate how much water you used in one day.
- Is it more or less than the average?
- How can you reduce your total water usage?

Water Use	Estimated Regular Amount	Estimated Water Conserving Amount
Toilet Flush	1.6 gallons per flush	1.28 gallons per flush for high-efficiency toilets
Shower	2.5 gallons per minute	2.0 gallons per minute with low-flow showerhead
Bath	30 gallons bathtub full	15 gallons bathtub half full
Brush Teeth	8 gallons water running for 3 minutes	1/2 gallon water running for 12 seconds and then turned off
Wash Hands	2 gallons water running for 45 seconds	1/2 gallon with sink half full of water
Wash Dishes by Hand	30 gallons water running for 12 minutes	5 gallons with sink full of water
Automatic Dishwasher	10 gallons regular cycle	5 gallons short cycle
Clothes Washer	30 gallons	18 gallons for water-efficient washer
Water Yard with Automatic Sprinkler	250 gallons for 30 minutes	180 gallons for 22 minutes
Water Yard with Hose	180 gallons for 45 minutes	100 gallons for 25 minutes
Faucet	2.5 gallons per minute	1.5 gallons per minute with aerators

Water Challenges

Think About It...

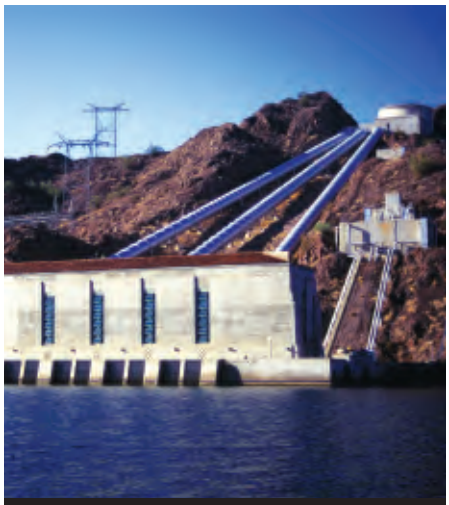
- We have water on the ground and under the ground; we move water to where we need it; we store water for when we need it; we use water over and over. So, what's the problem?

Learn About It...

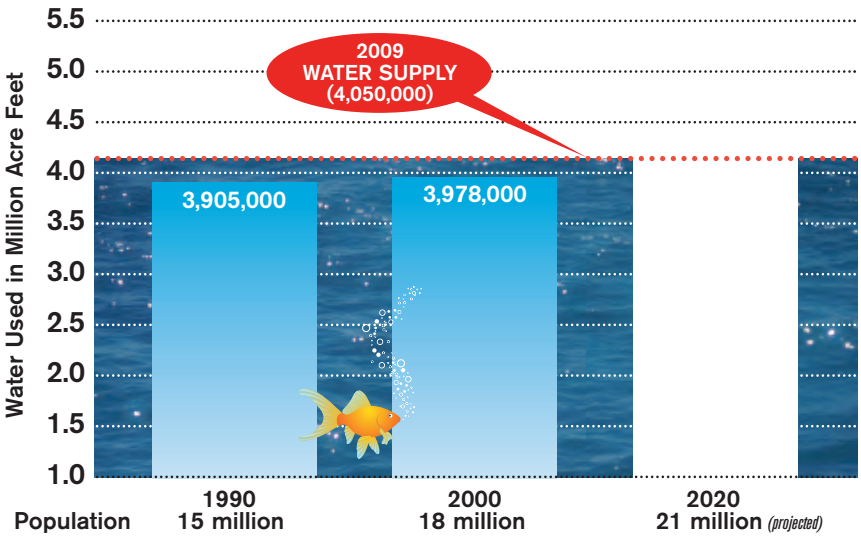
Providing water to all the people that need it is not a cheap and easy job. And the job is only getting tougher. Why?

- **First, cost.**
  It is very expensive to build and maintain aqueducts and reservoirs. Water must be pumped along the way and lifted over huge mountains. Great amounts of electricity are used, which costs a lot of money.
- **Second, the environment.**
  Taking water out of rivers and streams can have negative impacts on the plants and animals that depend on them and on the people that enjoy them. Water companies try to affect the *environment* as little as possible. But even so, large amounts of land are taken up by aqueducts, pumping plants, dams, and reservoirs. And when dams are built to form reservoirs, land is flooded, which obviously affects the people, animals, and plants that live there.
- **Third, population.**
  More people are being born and more people are moving into California every year. According to California's Department of Finance, the state's population can increase by as much as 500,000 people a year. Thus, more water is needed every year, not just for personal uses but also to build more houses, to grow more food, to make more products, and to generate more electricity.

So where will we get more water?



Population and Water Use in Southern California*



The graph above shows the growth in population and water use in southern California. Currently, every 1 million people account for approximately **213,000 acre feet** of water a year for both direct and indirect uses (an acre-foot of water is about 326,000 gallons). If the population in 2020 reaches 21 million as expected, how much water will be needed? **Show your answer on the graph.**

**From Metropolitan Water District of Southern California*

Water & the Future

Is recycled water used in your area? For what purposes?

Think About It...

- If there's only a fixed supply of water, how can we get more?
- Do you waste any water?

Learn About It...

We can't manufacture water. The surface water and groundwater that we have are all that we'll ever have. But we can stretch our supply.

Recycling

Water that goes down the drain ends up at a wastewater treatment facility. At these facilities, water goes through a series of cleanings and treatments. Some of this *"reclaimed"* water is put back into the environment—rivers, lakes, the ocean, the ground. But some of it, after even more cleaning, is *recycled*—that is, it is delivered to people to use.

California has been using reclaimed water for irrigation for about 70 years. Now recycled water can be used for all purposes, even drinking in some places. Most recycled water is used:

- to water school grounds, cemeteries, golf courses, nurseries, parks, greenbelts
- to irrigate crops and pastures
- to manufacture products and cool industrial machinery
- to make snow, fight fires, clean streets
- to flush toilets
- to recharge groundwater

In southern California, there are many water recycling facilities—some very small, some quite large. One facility in Irvine, part of Municipal Water District of Orange County, supplies recycled water to commercial high-rise buildings to flush toilets. But reclaiming water to recycle it is expensive. First, of course, money must be spent to clean the water. Then we must also build separate pipelines, pumps, and storage reservoirs for the recycled water. However, as more facilities are built and more recycled water is used, the cost of recycled water will decrease. Using more recycled water can help California maintain a reliable supply of fresh water.

WATER RECYCLING

DESALINATION

Desalination

Where is most of the surface water on the earth? In the ocean, of course. But ocean water is too salty to drink. We can, however, take the salt out of the water in a process called *desalination.*

California already has several desalination plants. One plant on Santa Catalina Island, off the coast of southern California, produces 25% of the island's drinking water. The desalination plant in the Monterey Bay area is the largest in the state.

Because California is next to the ocean, plenty of salt water is available. However, turning seawater into fresh water is much more expensive than other methods of supplying fresh water. Money must be spent not only to build and maintain the plants but also to pay for the huge amounts of energy it takes to remove the salt. Then the salt must be disposed of. It is often put back into the ocean, where it may upset the delicate ecological balance of the marine environment.

In Long Beach, part of Metropolitan Water District of Southern California, a desalination research and development facility has been built to study new technologies to reduce energy use and minimize environmental impact.

As technology improves and as we need more water to meet our growing demand, desalination may become a cost-effective reliable source of water.

Water & the Future

Continued....

Conservation

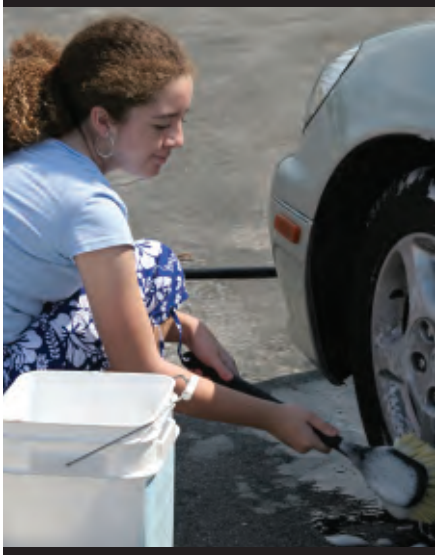
The best way to stretch our water supply is to conserve water. *Conservation* means not wasting water and using water efficiently, that is getting the same results using less water.

Californians are familiar with conservation. California, especially southern California, has always had *droughts*—long dry periods without much rain or snow. The longest drought in California lasted 60 years! During these times, people had no choice but to use less water. But if we used less water **every day**, we could:

- make our water supply go further
- reduce costs for distributing water
- benefit the environment by taking less fresh water out and putting less wastewater back in.

Water can be conserved in homes, on farms, at businesses, and in industries—through both improved technology and non-wasteful practices.

NEW TECHNOLOGIES



CONSERVATION PRACTICES

Improved Technologies

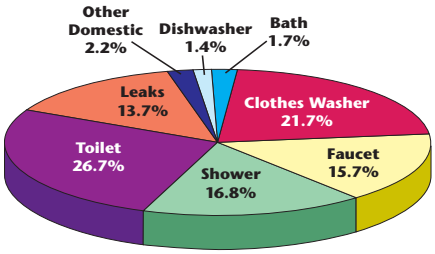
Advances in *technology* are helping us conserve water indoors and outdoors. Improvements in *water efficiency* include:

- faucets and showerheads that put out fewer gallons per minute
- toilets that use less water with every flush
- clothes washers and dishwashers that use 40% less water
- recycling systems for water used in car washes, laundromats, amusement parks, factories, power plants
- drip irrigation systems that put water only where it is needed
- evapotranspiration (ET) systems that monitor the evaporation from soil and the transpiration from plants to determine the exact amount of water lawns and plants need
- irrigation systems that return runoff from the bottom of a field to be used again.

Water-Saving Practices

In southern California, 95% of water use is in the urban sector. Therefore, reducing water use in our homes is especially important. For example, everyone can:

- turn water off when brushing teeth or washing dishes
- take shorter showers
- wash only full loads in clothes washers and dishwashers



Typical Household Water Use (Indoor)
From Metropolitan Water District of Southern California

Though very important, the amount of water used indoors is far less than the amount of water used outdoors in southern California—especially for landscape watering. Up to 70% of a household's water use can go outdoors. To help reduce that amount, people can:

- plant low-water use California Friendly® plants
- turn off sprinklers when it's raining
- use a broom instead of a hose to clean pavement.

Conservation—with both water-saving devices and practices—can save millions of gallons of water, as well as millions of dollars, every day.

How can you conserve water?

WATER MATH

Part A: **Look at the sample water rates and water bills to answer the following questions.**

CITY WATER AGENCY WATER RATES
SINGLE FAMILY RESIDENTIAL

TIER	UNITS USED	COST/UNIT
1	0-10	$2.04
2	11-22	$2.72
3	over 23	$3.40

Bill #1 **CITY WATER AGENCY**

From 1-5-09 to 3-2-09 Days of service – 57

Current Meter Read		807
Previous Meter Read		793
		14 units*
Base Charge	=	41.00
First Tier 10 units	=	20.40
Second Tier 4 units	=	10.88
		$72.28 TOTAL AMOUNT DUE

Bill #2 **CITY WATER AGENCY**

From 7-3-09 to 9-2-09 Days of service – 61

Current Meter Read		885
Previous Meter Read		852
		33 units*
Base Charge	=	41.00
First Tier 10 units	=	20.40
Second Tier 12 units	=	32.64
Third Tier 11 units	=	37.40
		$131.44 TOTAL AMOUNT DUE

**1 unit = 100 cubic feet (HCF) = 748 gallons*

1. How many units of water were used on Bill #1? _____
   How many units of water were used on Bill #2? _____
2. Why do you think the amounts for water use are different? *(Hint: Look at the dates.)*
3. What is this family's average daily use of water in gallons for each billing period?
   Bill #1 =_____gallons/day Bill #2 =_____gallons/day
4. Estimate how much water this family might use in a year.
   _____Units (HCF) = _____ Gallons
5. What would be the total cost of water for a year? $_____

Part B: **Use the figures from your "Personal Water Use Log" to answer the following questions:**

1. a. How many gallons of water would you use in a year? _____
   b. How many gallons of water have you used in your life so far? _____
   c. How many would you use by the time you are 50? _____
2. a. What is the range of daily water use in your class?
   From _____ to _____
   b. What is the average use? _____
   c. What is the median use? _____
   d. Estimate how much water would be used each day for personal uses...
   by your class? _____
   by the entire school? _____
   by your community? _____
   by people in southern California *(population 19 million)*? _____
   by people in the entire State *(population 38 million)*? _____
3. How many fewer gallons would you have to use every day to reduce your water use
   by 10%? _____
   by 20%? _____

How would you do it?

Energy Sources

Think About It...

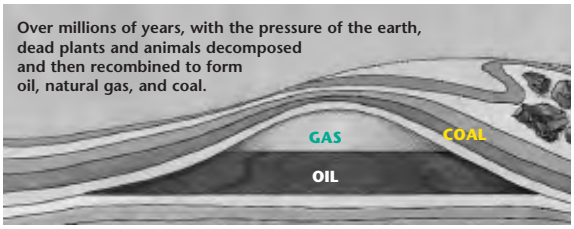
- Where does the energy you use every day come from?
  - Are the energy sources we depend on the same as those in the past?

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

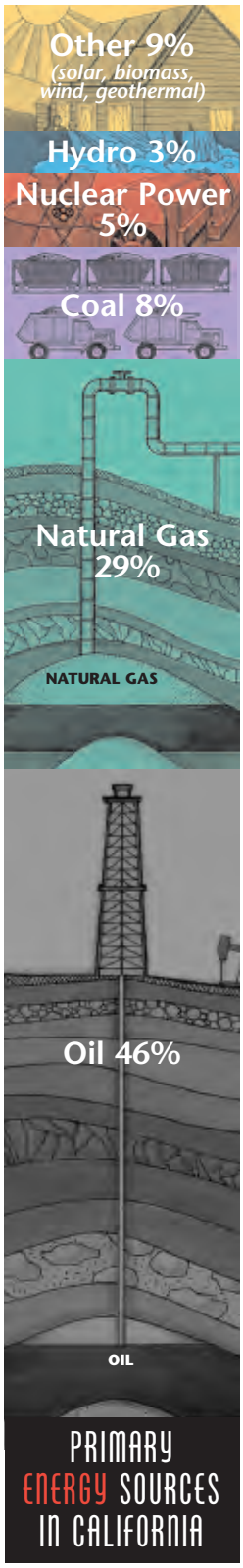
Petroleum (oil), natural gas, and coal are *fossil fuels*. Millions of years ago, when the plants and animals that lived on Earth died, they were covered with water, mud, and rock.

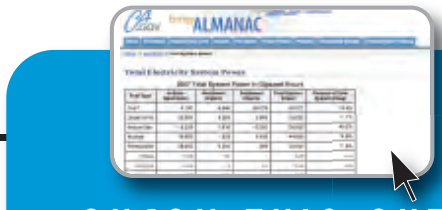


Over millions of years, under pressure, the dead plants and animals decomposed and then recombined to form oil, natural gas, and coal. These fuels are rich in stored up energy. When we burn fossil fuels, the stored energy is released as heat.

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.

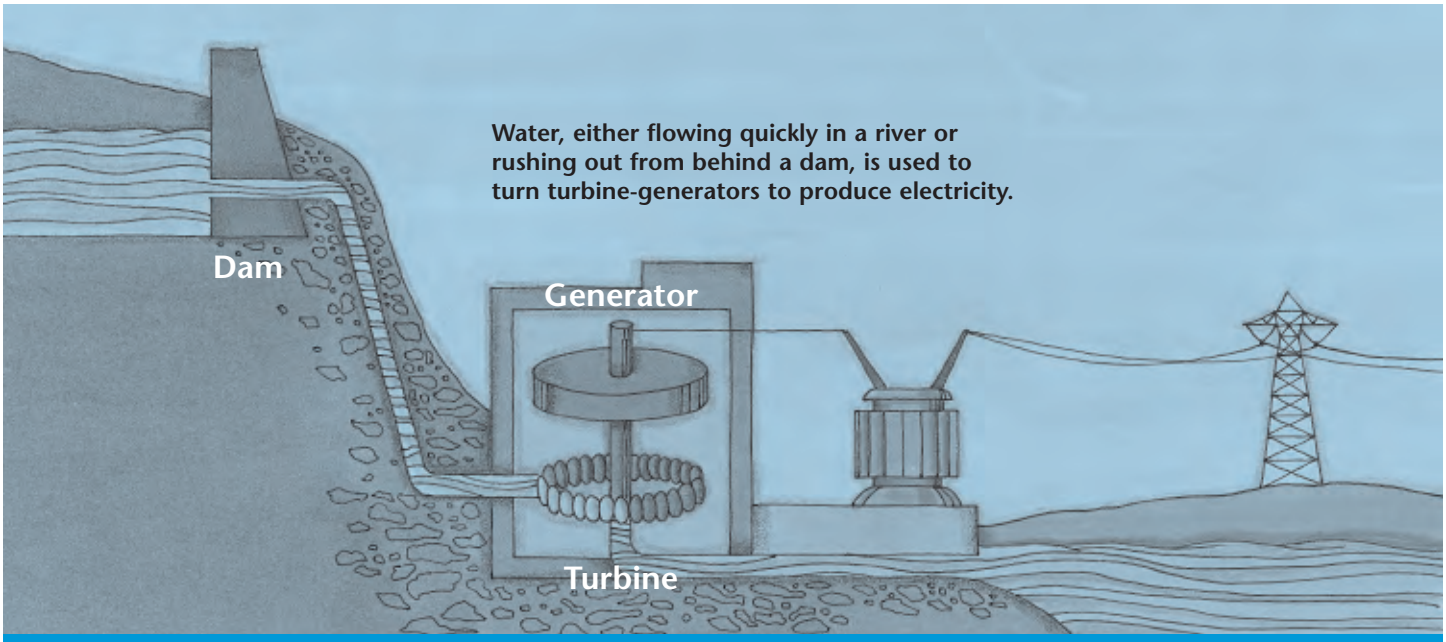
Coal, which looks like rough black rocks, must be dug out of the ground. The primary use of coal is to generate electricity in power plants, though it is also burned in some buildings and factories to provide heat.

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.

Continued....



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.

Energy Sources

Continued....

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.

Energy Sources

Continued....

Biomass

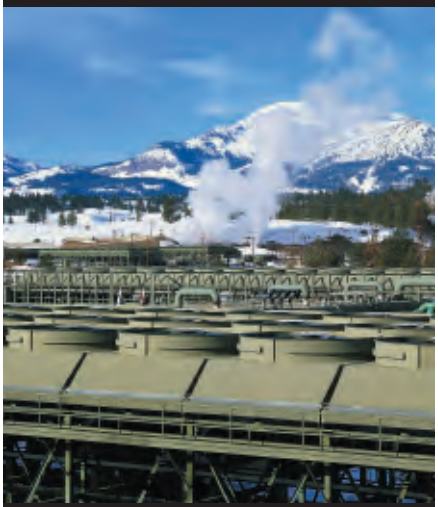
Biomass is organic matter from plants and animals. Some examples of biomass fuels are:

- 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.

BIOMASS



GEOTHERMAL POWER PLANT

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 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."

Energy Sources

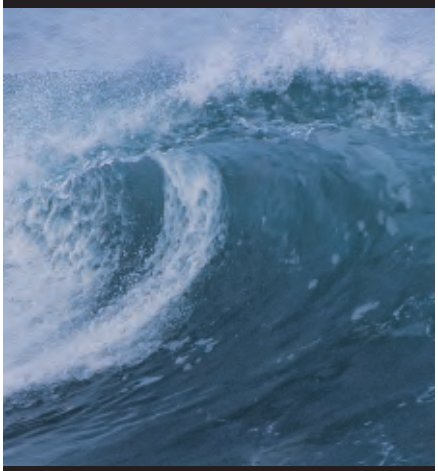
Continued....

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



OCEAN ENERGY

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.

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.

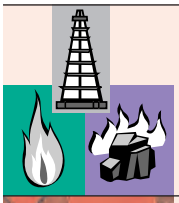
Currently, installations have been built or are under construction in a number of countries—Scotland, Portugal, Norway, China, Japan, Australia, and India. The west coast of the United States, including California, has many areas with the necessary wave patterns or strength. Two wave farms are under 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
 fossil fuels		
 nuclear power		
 hydropower		
 solar		
 biomass		
 geothermal		
 wind		
 ocean energy		

Energy Use

Think About It...

- Besides personal uses, what else is energy needed for?
- What do you think the most energy is used for in California?
- What costs are involved in making energy available for us to use?

Learn About It...

From 1960 to 2000, California's population doubled. But California's energy use almost tripled! And both our population and energy use have continued to increase.

What is all that energy used for?

Businesses 10%

- offices
- hotels
- restaurants
- stores
- schools
- other businesses

Transportation 46%

- cars & trucks
- airplanes
- trains
- ships
- other forms of transportation

Homes 13%

- heating
- lighting
- cooking
- running appliances
- powering computers
- other home uses

Industry 31%

- generate electricity
- make products
- manufacture steel
- produce & package food
- pump water
- other industrial uses

In California, we use a lot of energy for *transportation*; in fact, California ranks first in the nation in gasoline consumption! And southern California ranks first in California! Even without all our cars, SUVs, motor homes, trucks, trains, ships, and airplanes, we use a lot of energy; and each of us seems to be using more every year as more and more things are manufactured that use energy—from computers to cell phone chargers.

A lot of energy is used to generate *electricity*, which we then use in our homes and businesses. Almost ¾ of the electricity we use is generated here in California. The remaining ¼ comes from other states. For example, electricity generated at hydroelectric plants in Oregon and Washington and Nevada is delivered across power transmission lines.

How Much Energy Do You Use?

- Use the figures below and your Personal Energy Use Log to calculate how much energy you used in one day.
- Is it more or less than the average?*
- How can you reduce your total energy usage?

Appliance	Estimated Energy Use
Air Conditioner – Room	1.3 kWh per hour
Air Conditioner – Central	3.0 kWh per hour
Blender	0.4 kWh per hour
CD Player	0.01 kWh per hour
Clock	0.05 kWh per day
Clothes Dryer	3.0 kWh per load OR 18,000 BTU per hour
Clothes Washer	0.25 kWh per load
Coffee Maker	0.20 kWh per pot
Computer	0.12 kWh per hour
Dishwasher	1.5 kWh per load
Electric Blanket	0.75 kWh per night
Fan	0.17 kWh per hour
Frying Pan	1.20 kWh per hour
Furnace	15.0 kWh per hour OR 100,000 BTU per hour
Hair Dryer	1.0 kWh per hour
Heater – Portable	1.5 kWh per hour
Iron	1.0 kWh per hour
Microwave	1.5 kWh per hour
Oven	3.0 kWh per hour OR 18,000 BTU per hour
Radio	0.10 kWh per hour
Range Burner	1.5 kWh per hour OR 9,000 BTU per hour
Refrigerator	5.0 kWh per day
Stereo	0.10 kWh per hour
Television	0.20 kWh per hour
Toaster	0.10 kWh per use
Toaster Oven	0.75 kWh per hour
Vacuum Cleaner	0.75 kWh per hour
VCR/DVD Player	0.02 kWh per hour
Water Heater	13.0 kWh per day OR 36,000 BTU per hour
100-Watt Incandescent Light Bulb	0.10 kWh per hour
27-Watt Fluorescent Light Bulb	0.03 kWh per hour

*Average electricity use per household is about 17 kilowatt hours per day.

Energy Challenges

Think About It...

- We get energy from many sources—nonrenewable and renewable. So what's the problem?

Learn About It...

Energy comes in many forms—and we depend on it to live our lives. But there are challenges to getting—and using—the energy we need. What are those challenges?

First, supply.

The amount of energy we have doesn't always match the amount we need. In the 1970s, the "energy crisis" had people waiting in long lines and paying high prices to buy gasoline, sometimes only on specified days. In 2008, prices rose dramatically again. Because we depend on other countries for much of the oil we need to manufacture gasoline, our supply is not always certain.

In 2001, the "energy crisis" caused "rolling blackouts" throughout California, meaning that various areas were without electricity for periods of time. Along with other factors, the shortage of electricity was caused by:

- more demand during hot summer weather
- less supply from the hydroelectric plants in the Pacific Northwest where rainfall was low.

Second, the environment.

Most of our energy comes from burning fossil fuels, which emit pollutants into our air. Especially in southern California, these pollutants cause smog. In other parts of the country, fossil fuels also contribute to acid rain; and in the world they are causing climate changes, which can have many negative effects—such as polar ice melting, which could lead to rising sea levels and flooded coastal areas; more hurricanes and tornadoes; increased number of droughts; and changes in forests, crop lands, coral reefs, and wildlife habitats.

SUPPLY

ENVIRONMENT

POPULATION

Other energy sources also impact the environment—whether taking up space, flooding land behind dams, disrupting wildlife, or creating radioactive waste. The more energy we use, the more the environment is affected.

Third, money.

It's expensive to supply the energy we need. Fossil fuels must be drilled for or dug out of the ground and transported to where they are needed; power plants must be built; transmission lines must be connected. When we import energy, even more money must be spent. As the demand goes up and our supply goes down, consumers will be spending even more each month for the energy they use.

Fourth, population.

California is the fastest growing state in the nation.

- In 2008, our population was approximately 38 million.
- By 2050, it is projected to be 55 million.

Energy will be needed to make the products and distribute the water consumed by all these people. And, of course, each person will use energy every day just to live their lives.

So how will we have enough energy for the future?

Energy & the Future

Think About It...

- What can we do to have enough energy for the future?
  - Do you waste any energy?

Learn About It...

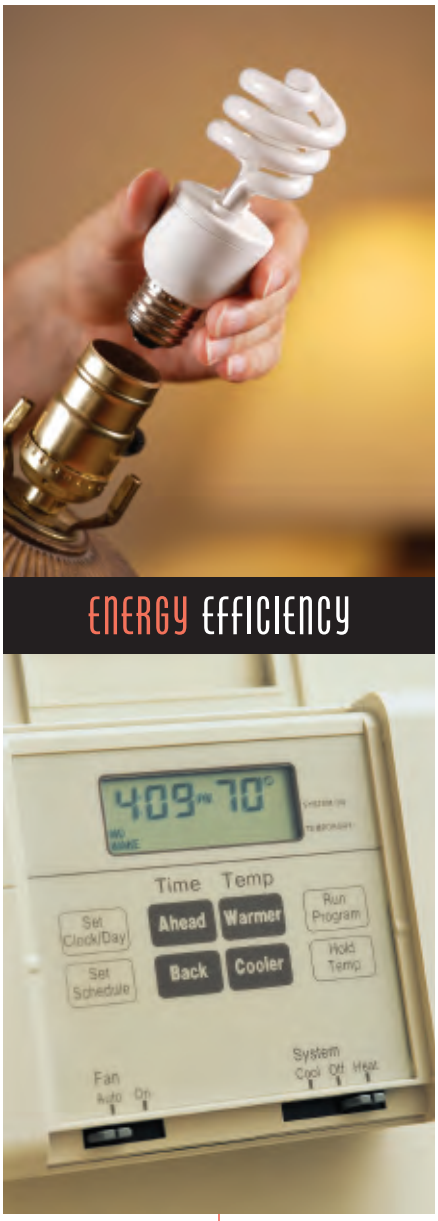
There is probably not one solution to the problems we face supplying energy. Rather the key is likely to find a mix of new technologies and practices that will help us have enough energy for the future.

Technology

Efficiency

Increasing *energy efficiency*—that is, using less energy to do more—is an important part of our energy future.

The appliances we use every day eat up a lot of electricity, but they can be—and many have been—designed to consume less. Since 1980, appliances have improved in energy efficiency by 30 to 90%. Today, products that meet strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the Department of Energy earn the Energy Star label. These products have advanced technologies that use 10 to 50% less energy than standard models. Energy Star products include big appliances such as refrigerators, clothes washers, dishwashers, and air conditioners, as well as table lamps and windows.



Other improvements in technology include:

- Smarter thermostats that can cut heating and air-conditioning costs up to 33%. Using a microcomputer, these thermostats allow you to divide the day into periods and to program each period with a specific temperature. For example, at 6 a.m., a half hour before you get up on a cold day, the thermostat can increase the heat to a comfortable temperature. When everyone leaves the house at 8 a.m., the thermostat goes back down. Then at 5 p.m., just before people come home, the heat comes back on, until 10 p.m. when everyone goes to bed.
- Compact fluorescent light bulbs (CFLs) that can last up to 10,000 hours—10 times longer than a standard light bulb. To get the same light, the CFL needs to be just one-fourth the wattage of the standard incandescent bulb, thus using 75% less electricity. These bulbs can replace standard bulbs in table lamps, desk lamps, and ceiling or wall fixtures. They are particularly efficient in lights that will be left on for 3 to 4 hours at a time. CFLs also produce less "waste heat," thus reducing air-conditioning in warmer weather.

Entire buildings can be made more energy efficient by using these improved technologies and by installing:

- solar roof panels
- skylights
- light sensors that naturally reduce lighting
- separate climate control zones
- low-emission windows that allow in maximum light but minimum heat

The U.S. Green Building Council has established a system to rate the environmental and economic impact of buildings. This Leadership in Energy and Environmental Design (LEED) Green Building Rating System certifies buildings as Silver, Gold, or Platinum. The rating is based on the number of points achieved in areas such as energy efficiency, water savings, content of building materials, and indoor environmental quality. In southern California, LEED certified buildings include the Audubon Center, The Getty Center, the Los Angeles Convention Center, and Metropolitan Water District's Diamond Valley Lake Visitor Center. What other LEED certified buildings can you find?

Continued....

CHECK THIS OUT:
Go online to www.fypower.com for more energy conservation tips.

Solar and Other Renewables

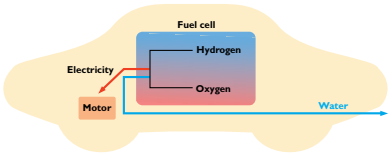
Such renewable energy sources as solar, wind, biomass, and geothermal represent only a small part of our current energy supply, but we may need to depend on them much more in the future. By law, California utilities are required by 2020 to have 33% of the electricity they produce come from renewable resources. Using renewable sources provides several benefits:

- They are *sustainable*—meaning they will never run out.
- They add fewer pollutants to our air or water.
- They can reduce our dependence on energy from other countries.

Advances are being made particularly in solar technology. Soon we may have solar cells placed in window panes or glass roofs, turning buildings into micro-power plants!

Fuel Cells

Fuel cell technology is often thought of as "space-age" technology because fuel cells have been successfully used in spacecraft to provide electricity. Now the technology can be used to power vehicles, homes, and businesses.



In a fuel cell, no fuel is burned; instead, hydrogen and oxygen are combined to produce electricity. And the only emissions are heat and pure water vapor!

Unfortunately, the hydrogen needed for the fuel cell is very expensive, and it must be stored at high pressure and at an extremely low temperature. But fuel cell systems can include a "fuel reformer," which chemically changes another fuel—such as natural gas, methanol, even gasoline—to hydrogen to power the fuel cell. This process emits some pollutants but much less than using the original fuel.

CONSERVATION

FUEL CELLS

Fuel cells are being used in some experimental vehicles. They are being designed for use in electric power plants as well as for buildings—hospitals, hotels, manufacturing plants, shopping centers. Eventually, small systems may be used in homes with natural gas supplying the fuel.

Conservation

Even with improved energy efficiency, each of us is still using more energy than we did in the past.

Not only do we have more "things" that use energy—at home and in businesses—but also many of our appliances continue to use energy even when they have been turned off. TVs, DVD players, audio systems, electric toothbrushes, cable boxes, computers—all are "energy vampires," draining electricity while they are just waiting to be used. This "standby power" can add up to almost 10% of residential use and can cost $100 per year per household.

How can you conserve energy?

REMEMBER:
Go to surveys.bewaterwise.com to complete your Water and Energy Surveys.

To reduce the amount of energy we use, we all need to conserve energy—that is, use it wisely and not waste it. Turning off lights, lowering the water heater temperature, weather stripping around windows and doors, along with other conservation practices, can all help reduce our demand for energy. We'll save money, protect the environment, and increase our supply for the future.

ENERGY MATH

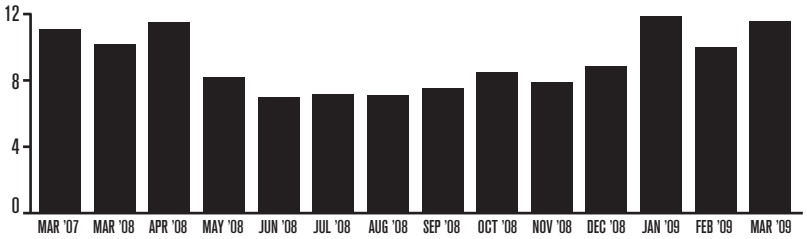
Look at the sample electricity bill below to answer the following questions.

CITY ELECTRIC COMPANY

Current meter read – March 26		24245
Previous meter read – February 25		23908
Total electricity used this month in kWh		**337**

Your daily average electricity usage (kWh)

2 years ago: 11.18 Last year: 10.20 This year: 11.62



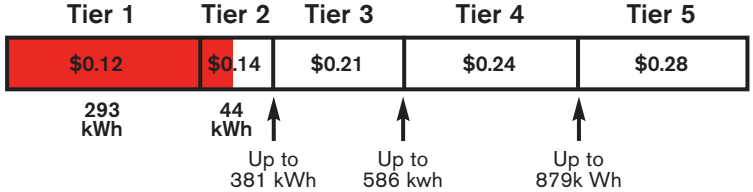
Details of new charges

Your rate: DOMESTIC

Billing period: February 25, 2009 to March 26, 2009 (29 days)

Delivery charges		
Basic charge	29 days x $0.02900	$ 0.84
Energy – Winter		
Tier 1 (within baseline)	293 kWh x $0.06399	$18.75
Tier 2 (up to 30%)	44 kWh x $0.06909	$ 3.04
DWR bond charge	337 kWh x $0.00491	$ 1.65
Generation charges		
DWR		
Energy – Winter	130 kWh x $0.06508	$ 8.46
SCE		
Energy – Winter		
Tier 1 (within baseline)	163 kWh x $0.03530	$ 5.77
Tier 2 (up to 30%)	44 kWh x $0.06218	$ 2.74
Subtotal of new charges		$41.25
State tax	337 kWh x $0.00022	$ 0.07
Your new charges		**$41.32**

Average cost per kilowatt hour



1. How many kilowatt hours (kWh) did this customer use this month? _____*kWh*
2. What is the total cost for electricity this month? *$*_____
3. Use the chart at the bottom of the bill to fill in the blanks.

   _____ Number of kWh used in Tier 1

   x _____ Average cost per kWh in Tier 1

   = ☐ **Cost for Tier 1 Usage**

   _____ Number of kWh used in Tier 2

   x _____ Average cost per kWh in Tier 2

   = ☐ **Cost for Tier 2 Usage**
4. If 50 fewer kWh were used, approximately how much would the bill be? *$*_____
5. If 50 more kWh were used, approximately how much would the bill be? *$*_____
6. According to this bill, has this customer's daily average electricity usage increased or decreased from the last year? _____
7. Why does the average amount of energy used change from month to month?
8. Use your "Personal Energy Use Log" and the average cost per kWh on this electricity bill, to figure the cost of all the electricity you used in one day. *$*_____
9. Use the figures on page 21 and the cost per kWh on this electricity bill to figure the monthly (30 days) operating costs of the electrical appliances listed below.

Stereo: 2 hours a day

*$*_____ *per month*

Television: 3 hours a day

*$*_____ *per month*

Computer: 4 hours a day

*$*_____ *per month*

Refrigerator: 24 hours a day

*$*_____ *per month*

What's Your HOME Conservation Plan?

Why do we need to conserve water?

Why do we need to conserve energy?

From the results of your HOME Water and Energy Survey, plan ways that you and your family can better conserve water and energy.

Think about:

- **behaviors** or habits that could be improved *(for example, running the clothes washer when it isn't full or leaving the computer on when you are not home)*
- new **technologies** *(for example, repairing sprinkler heads or replacing incandescent bulbs with CFLs).*

When you make your choices for ways to improve, consider:

- how much the improvement will cost—in money, time, effort
- whether your specific family members will be able to follow through on the action.

PRESENT YOUR PLAN TO YOUR FAMILY

Water Conservation Plan

Energy Conservation Plan

What's Your SCHOOL Conservation Plan?

From the results of your SCHOOL Water and Energy Survey, choose one or two possible water conservation improvements and one or two possible energy conservation improvements. Then plan how to get these changes done.

Think about:
- what tasks need to be done
- who needs to be contacted
- how funds will be provided if necessary.

Water Conservation Improvement

1.

2.

Tasks to Accomplish Improvement

Energy Conservation Improvement

1.

2.

Tasks to Accomplish Improvement

Choose what improvements you want to work on and implement your plan!

A Water and Energy Efficient Home

Go online to www.mwdh2o.com/education/conservationhouse to find out how water and energy are being conserved in and around this house.

With improved technology and non-wasteful practices that conserve water and conserve energy, you can help

- protect the environment,
- stretch our supply of water and energy,
- and save money.

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA