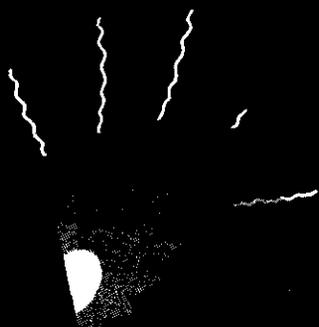


**ABOUT
GEOTHERMAL
ENERGY**

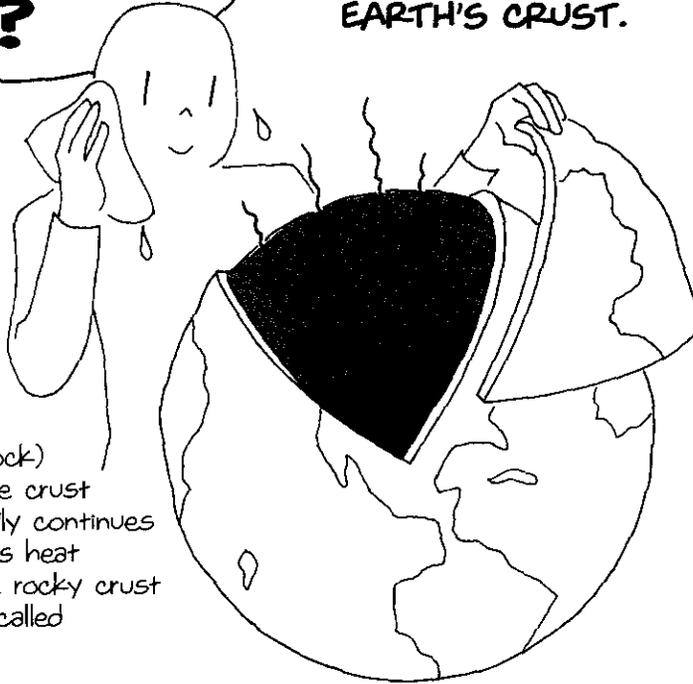


What is
**GEOTHERMAL
ENERGY**
?

It's **HEAT ENERGY**
that comes from
**BENEATH THE
EARTH'S CRUST.**

**THE YOUNG
EARTH** was a
fiery ball of liquid
and gas. As it
cooled, an outer
crust formed over
the liquid core.

MAGMA (molten rock)
was left between the crust
and core. As it slowly continues
to cool, the magma's heat
is transferred to the rocky crust
above. This heat is called
geothermal energy.

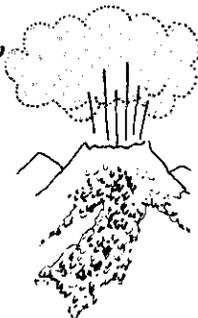


VISIBLE FORMS of geothermal energy include:

**HOT SPRINGS
OR NATURAL
STEAM,**
when hot water or
steam from within
the crust surfaces.



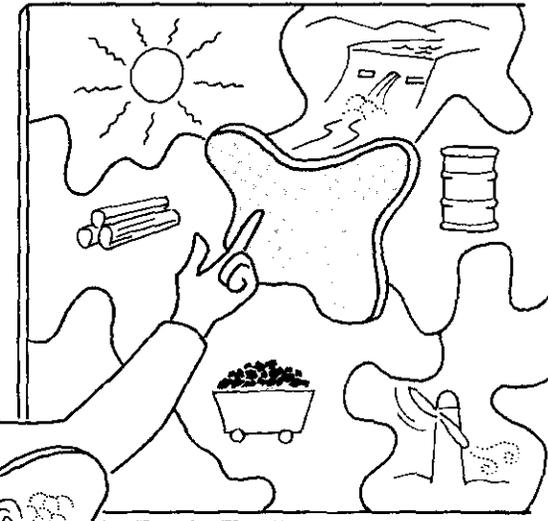
VOLCANOES,
when magma
itself surfaces
as lava.



So--

**GEOTHERMAL ENERGY
IS A GROWING
SOURCE OF ENERGY!**

✓ **UNDERSTAND
THE BENEFITS**
of geothermal energy.



✓ **SUPPORT
GEOTHERMAL
PROJECTS**
that can help expand the use
of geothermal energy.



Geothermal
energy is energy
for today -- and
tomorrow!

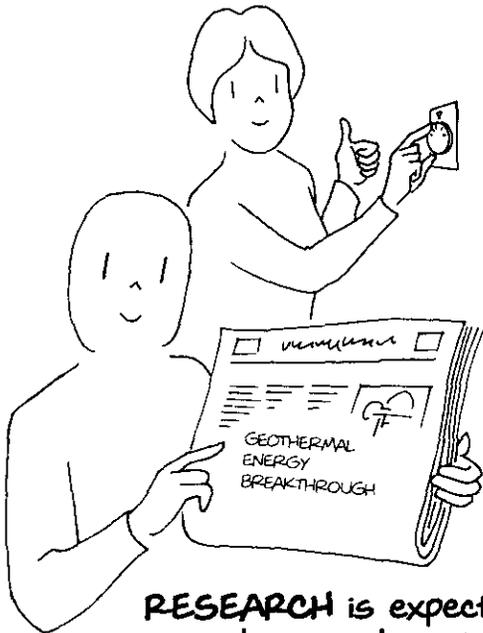
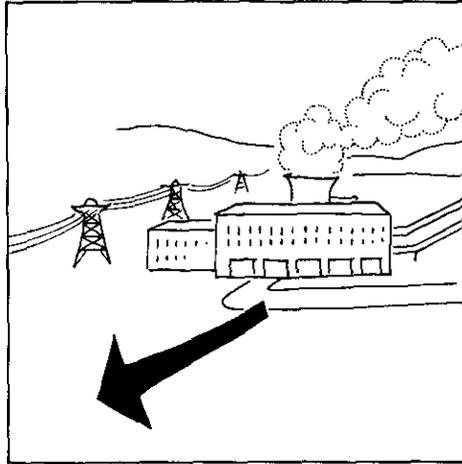


THE FUTURE

of geothermal energy looks bright.

THE BENEFITS ARE GREAT

- Geothermal energy can be used directly at low and moderate temperatures (for heating and many other purposes). And, it can be used indirectly at high temperatures (to produce electricity).
- It's a "clean," reliable source of energy that can help save vital fossil fuels.
- Local communities can benefit economically from the use of geothermal energy.

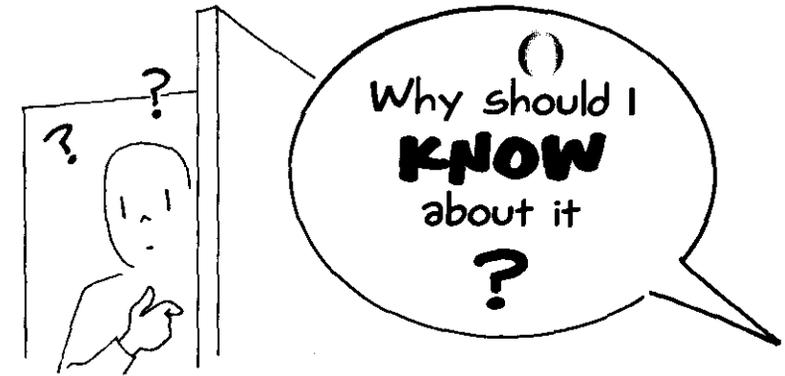


RESEARCH is expected to lead to new procedures and systems that expand the use of geothermal energy.

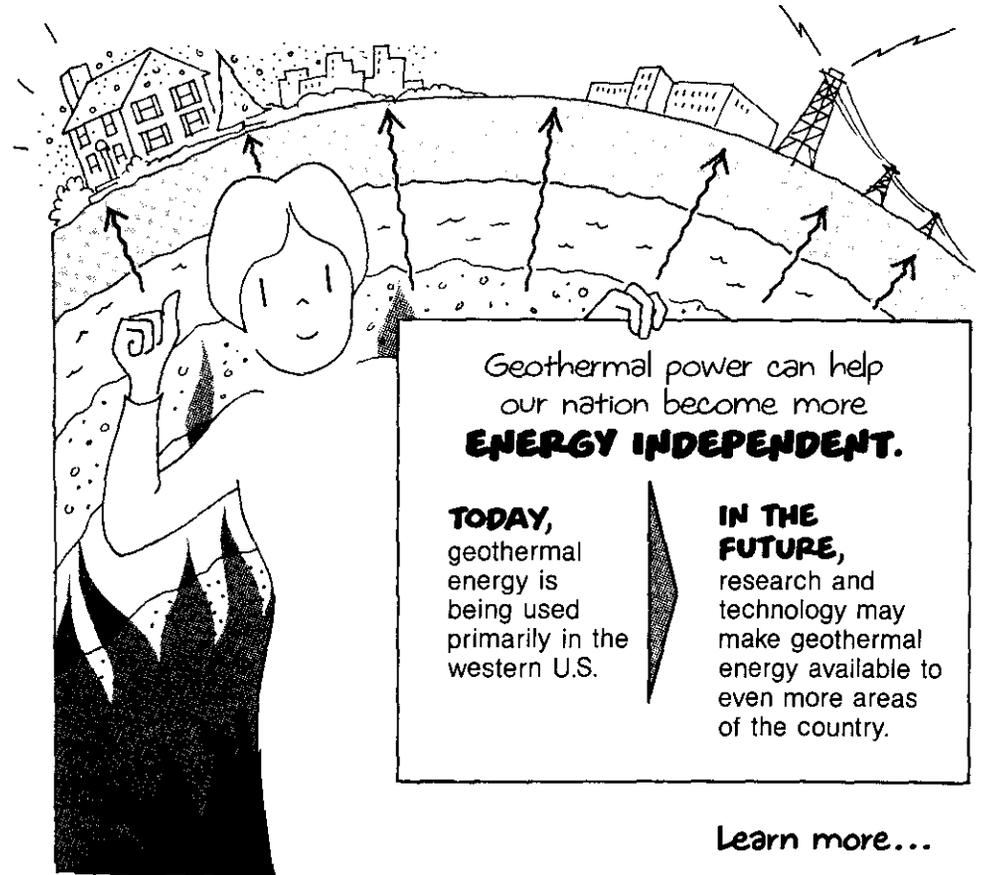
SOME CHALLENGES DO EXIST

For example:

- Improved technology is needed to make some types of geothermal energy more economical.
- Careful management of geothermal resources is essential to ensure they're not quickly depleted.



Because this vast source of energy can be put to use to help meet our energy needs.



Geothermal power can help our nation become more **ENERGY INDEPENDENT.**

TODAY, geothermal energy is being used primarily in the western U.S.

IN THE FUTURE, research and technology may make geothermal energy available to even more areas of the country.

Learn more...

Geothermal power --

AT HOME AND AROUND THE WORLD

Many countries are using or exploring geothermal energy. They include:

ITALY

The Italians were the first to see the potential for using geothermal energy to generate electricity. They built a generator at Lardarello in 1904, in a geothermal area that is still producing today.

ICELAND

The most extensive use of geothermal heating in the world is on the volcanic island, Iceland. Most of the island's homes and businesses are heated geothermally. Geothermal energy is also used to generate electricity, and it's used in industry, too.

A LIMITED AREA IS AFFECTED

A geothermal operation takes place in a confined area. Also, there's no need for mining or transportation of fuel or wastes over long distances.



IT SAVES FOSSIL FUELS

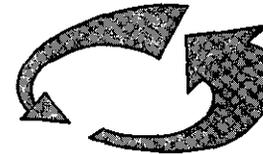
For example, the use of geothermal energy saves millions of barrels of oil each year! This means:

- less dependence on foreign sources for fuel
- fossil fuels can be saved for other purposes, such as fuel for transportation.



IT'S "RENEWABLE"

Unlike fossil fuels, geothermal resources can replenish themselves over time, and with careful management.



IT'S A RELIABLE SOURCE OF ENERGY

Geothermal energy sources aren't affected by changing weather conditions that affect other renewable energy sources, such as solar and wind power.



GEOTHERMAL ENERGY RESOURCES

are most prominent along the "Ring of Fire." This is where several sections (plates) of the earth's crust meet. It's where most of the world's volcanoes are located, and most earthquakes occur.

BENEFITS OF GEOTHERMAL ENERGY

Geothermal energy offers some important advantages. For example:

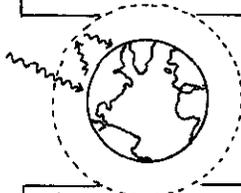
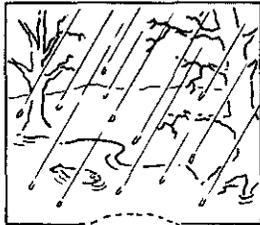
THERE'S LITTLE POLLUTION

That's because there's no burning of fossil fuels at geothermal electric plants.

HOWEVER, PLANTS THAT DO BURN FOSSIL FUELS

produce large amounts of carbon dioxide and other pollutants that have been linked to problems such as:

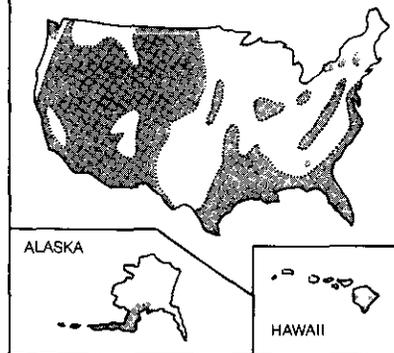
- ACID RAIN, which may harm fish and other forms of life in rivers, lakes and streams. It may also damage forests and crops, and erode statues, paint and building materials.
- THE GREENHOUSE EFFECT, which may lead to a dramatic warming of the earth's surface temperature. Such a warming could affect plant life, climate, water resources and more.
- POOR AIR QUALITY, which affects us all, but can be especially harmful to people with heart and lung problems.



THE UNITED STATES

- "The Geysers" in Northern California is the largest geothermal electrical power complex in the world. Other plants are located in Utah, Hawaii, Nevada and Southern California (where the use of geothermal energy is rapidly growing).
- Boise, Idaho, is one of the leaders in geothermal heating. The city began using geothermal energy to heat homes in the 1890s. Klamath Falls, Oregon is another city that uses geothermal heat to warm homes, businesses, a hospital and a college.
- Research and development on other geothermal projects are in progress.

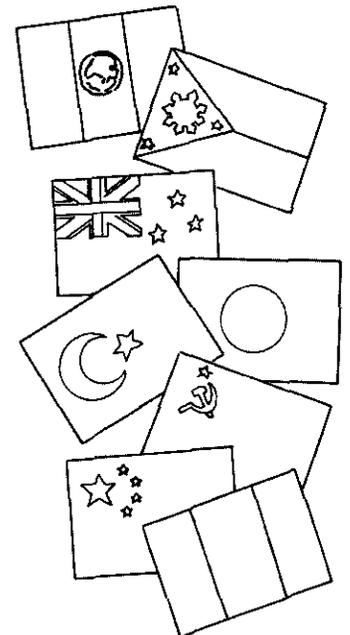
AREAS OF GEOTHERMAL ENERGY POTENTIAL



OTHER COUNTRIES

For example:

- Mexico
- the Philippines
- New Zealand
- Japan
- Turkey
- the Soviet Union
- China
- France.

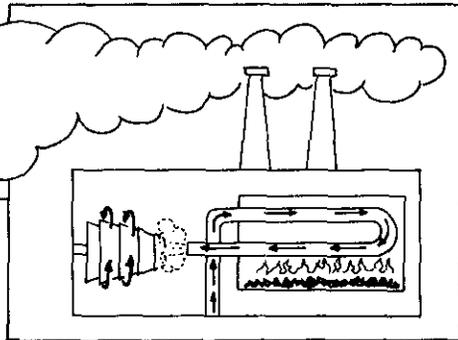


GEOTHERMAL ENERGY IS USED IN 2 WAYS

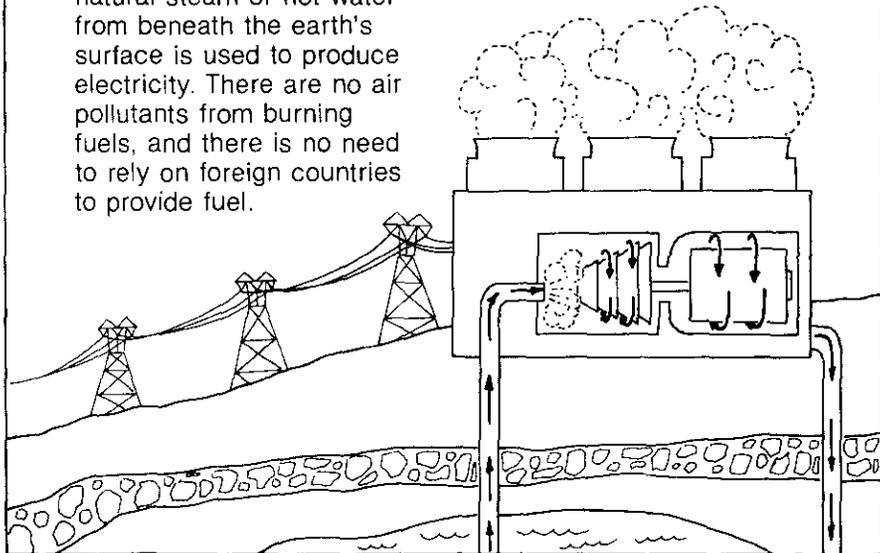
AT HIGH TEMPERATURES,

it can be used to generate electricity.

IN MOST ELECTRIC PLANTS, a fuel (coal, oil or natural gas) is burned to heat water until it turns to steam. This steam is then used to turn a turbine and make electricity.



IN GEOTHERMAL PLANTS, natural steam or hot water from beneath the earth's surface is used to produce electricity. There are no air pollutants from burning fuels, and there is no need to rely on foreign countries to provide fuel.



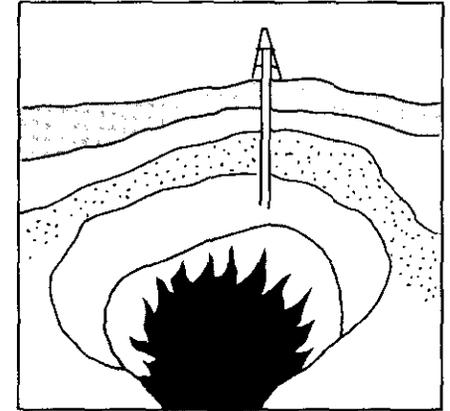
Geothermal power plants are an extremely reliable source of electricity.

④ MAGMA

Magma is very hot molten rock found below the earth's crust.

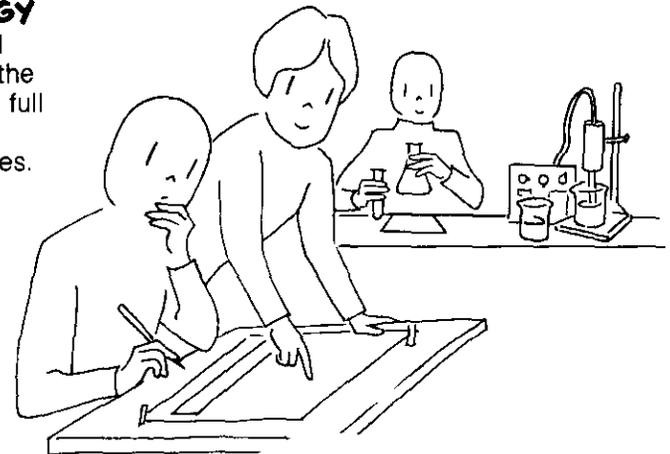
IN CERTAIN LOCATIONS

in the western continental U.S., Alaska and Hawaii, it may be possible to extract heat from the magma.



IMPROVED TECHNOLOGY

and continued research are the keys to taking full advantage of these resources.

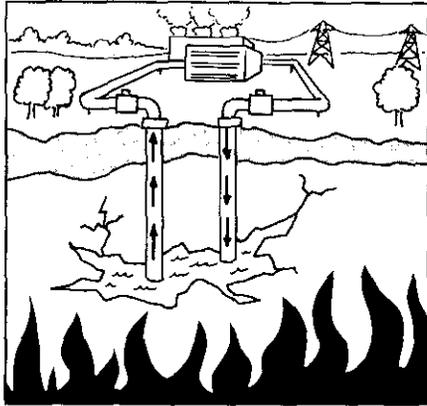


② HOT DRY ROCK GEOTHERMAL

In some areas, magma is close enough to the earth's surface to heat rock containing little or no water.

HOT DRY ROCK AREAS ARE THE MOST ABUNDANT

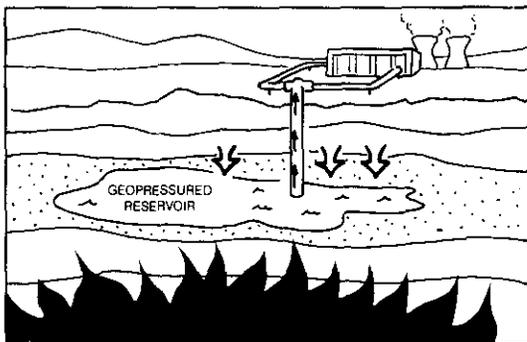
and widely distributed source of geothermal energy. However, more research is needed to determine if these areas can become an economical source of energy.



③ GEOPRESSURED RESERVOIRS

These contain a mixture of water and methane (natural gas). Geopressured reservoirs are found in sandstone that's sandwiched between layers of rock.

IN THE U.S., some of the largest geopressured reservoirs are found along the Gulf Coast of Texas and Louisiana.

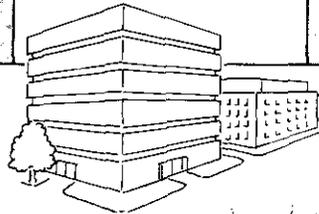


AT LOW AND MODERATE TEMPERATURES

(less than 350°F), it can be used for:

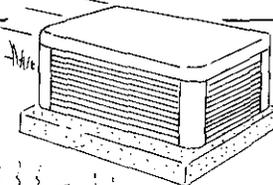
HEATING

Geothermal energy can be used to heat a single structure (space heating) or several buildings in the same area (district heating).



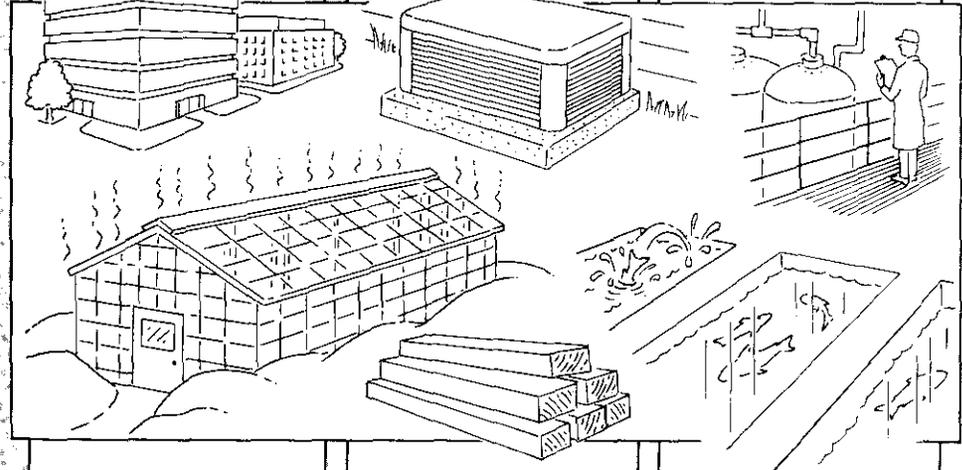
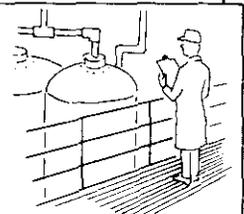
HEAT PUMPS

Heat pumps can be used for space heating and cooling. Pumps that use geothermal energy are much more efficient than air-source heat pumps.



FOOD PROCESSING

Preheating, cooking and drying foods, and sterilizing utensils and equipment are only a few ways to use geothermal energy in this field.



GREENHOUSES AND SOIL WARMING

Geothermal heat can extend the growing season in cooler climates.

PREPARING WOOD PRODUCTS

Geothermal energy can heat kilns to dry wood for lumber, paper, etc.

RAISING FISH

Waters warmed by geothermal heat can expand the areas where fish farming is profitable.

There are 4 BASIC KINDS OF GEOTHERMAL ENERGY.



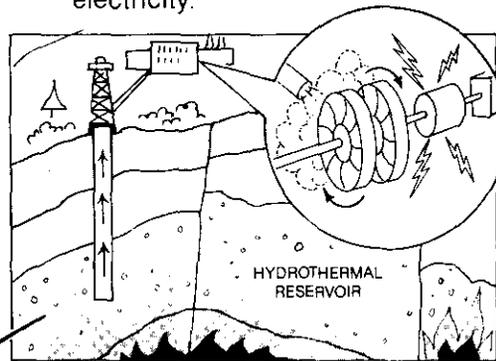
1 HYDROTHERMAL ENERGY

is being used today to produce electricity and for direct heating.

Reservoirs of hot water and/or steam are trapped in fractured rock or sediment in the earth's crust. There are 2 kinds of hydrothermal wells:

DRY STEAM ("hot steam") WELLS

To release the steam from the reservoir, a deep hole is drilled and a pipe is inserted. After solid particles are filtered out, the steam is used to turn the blades of a turbine and generate electricity.

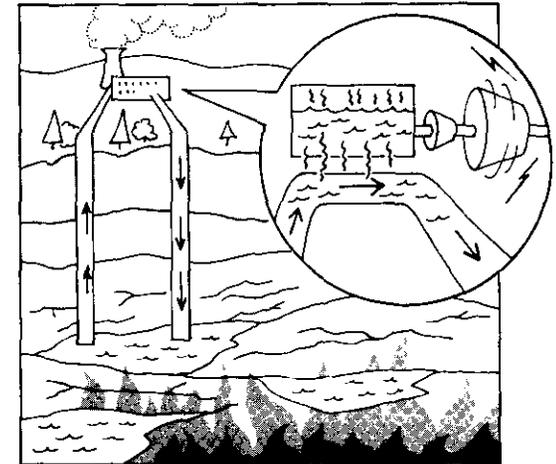


- Dry steam is the most widely used source of geothermal energy for electrical generation. However, the number of potential dry steam sites is very limited.
- It's the type of power harnessed at The Geysers in California and at Lardarello, Italy.

HOT WATER WELLS

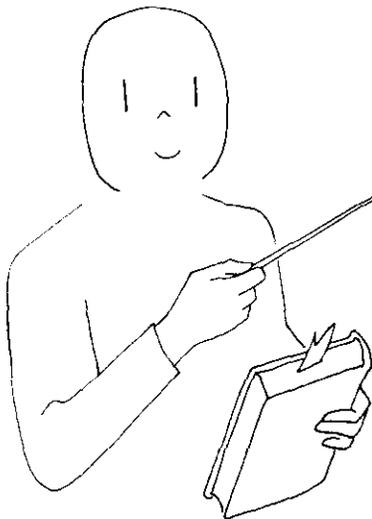
The water and steam found in these wells can be used to make electricity in 1 of 2 ways:

- 1 THE STEAM IS SEPARATED FROM THE WATER in a special vessel and is then used to drive a turbine. The water that remains is usually injected back into the earth. (This is known as the "flash" method.)
- 2 THE HOT WATER IS USED TO HEAT ANOTHER LIQUID that has a lower boiling point. The liquid turns into a gas, which is used to turn a turbine. The original hot water is returned to the earth. (This is called the "binary cycle" method.)



Hot water wells are a growing source of geothermal energy. They are in use today in Southern California, Nevada and along the Pacific Rim.

Learn about other types of geothermal energy being developed for possible future use . . .





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