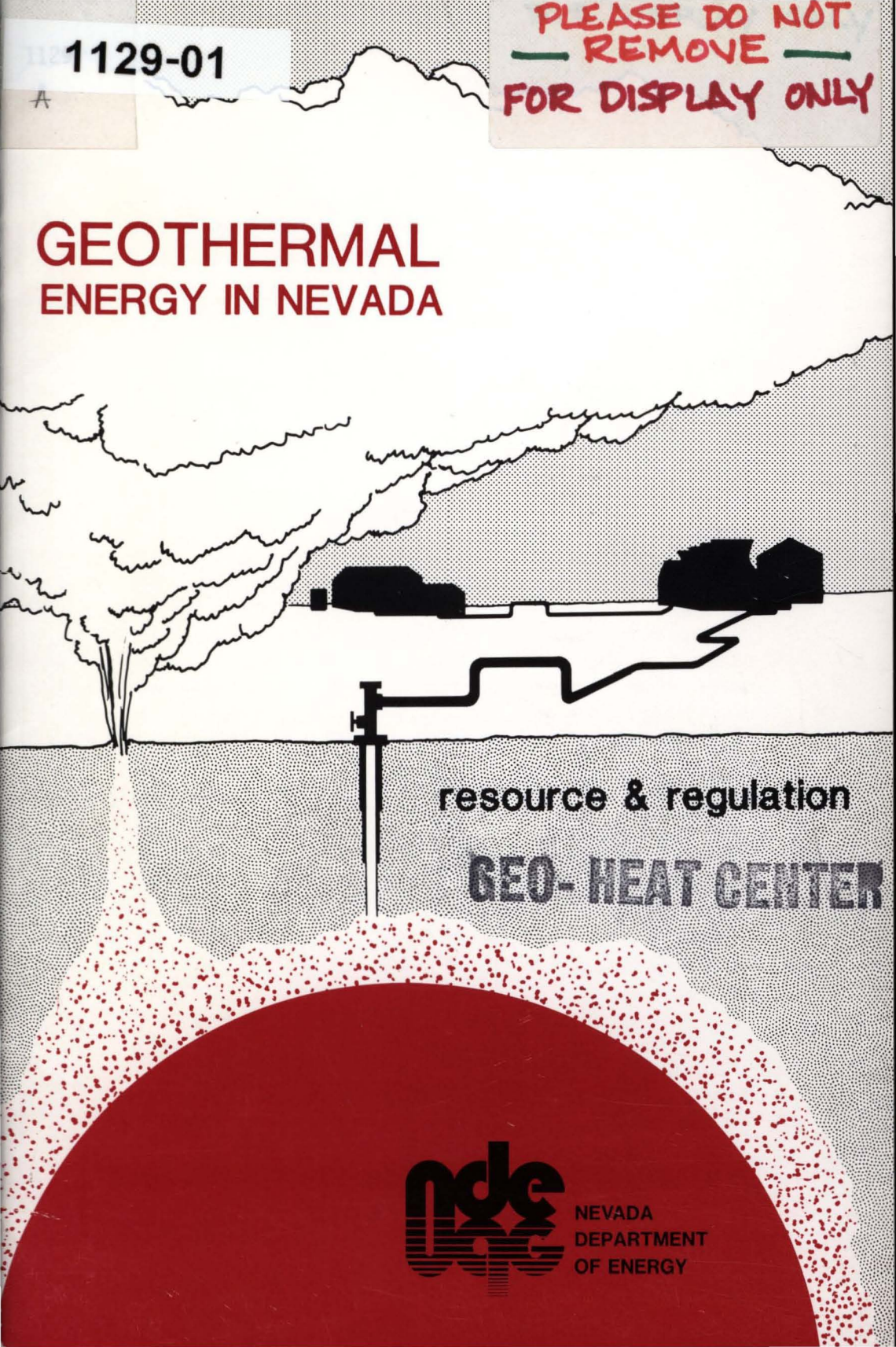
GEOTHERMAL
ENERGY IN NEVADA



resource & regulation

GEO-HEAT CENTER

NEVADA DEPARTMENT OF ENERGY

DISCLAIMER

Nevada and the rest of the nation have reached a disturbing paradox. Our demand for energy is increasing, while at the same time, our non-renewable sources of energy are decreasing. Therefore, we must now look to other sources of energy, such as geothermal, to supplement our dwindling fossil fuels.

The utilization of geothermal energy in Nevada has great potential. Not only is the resource widespread throughout the state, its quality is sufficient to support the needs of many different types of uses such as residential space heating, aquaculture, and various manufacturing and industrial processes. In several areas, it is even of sufficient quality to generate electricity.

This brochure was prepared to help you understand what geothermal energy actually is, how it can be used, and the potential for its development in our state. Your local, state, and federal officials can answer many of the questions you might have and refer you to other sources of information. To those who are considering utilizing a particular geothermal resource, a reputable consulting firm can be an invaluable aid.

Former Nevada Senator Alan Bible has described geothermal energy as a "sleeping giant." Through the efforts of private citizens, industry and government, it is now time to awaken this giant.

NOEL A. CLARK
Director of the Nevada Department of Energy

GEOTHERMAL ENERGY—THE RESOURCE

Geothermal energy is the natural heat of the earth. Geothermal heat is the result of processes occurring deep in the earth's interior. Nevada is very fortunate because much of the state is located where this energy is found near, or even actually on, the land surface.

There are four distinct types of geothermal energy systems, two of which are found in Nevada. Each is the result of a different set of geological conditions.

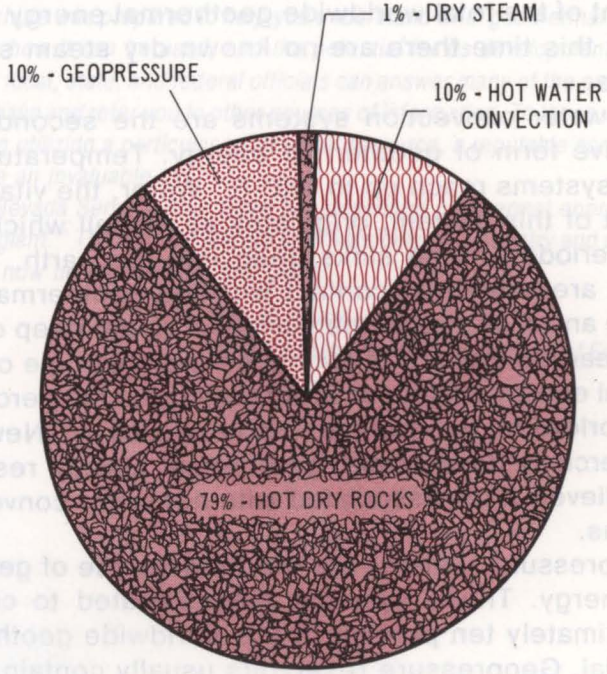
The most obvious type of geothermal energy system consists of dry steam. The subsurface temperatures are so great that water cannot exist in its liquid form. This type of system is the easiest to put to use and is the most potentially productive, with existing technology and equipment. Unfortunately, it is the rarest form of geothermal energy and probably accounts for less than one percent of the total worldwide geothermal energy potential. At this time there are no known dry steam sites in Nevada.

Hot water convection systems are the second most attractive form of geothermal energy. Temperatures in these systems reach up to 400° F. Water, the vital component of this system, originates as rainfall which over long periods of time sinks deep into the earth. These waters are heated by contact with the geothermal heat source and then rise to the surface through deep cracks in the earth's crust. It is estimated that this type of geothermal energy system accounts for about ten percent of the worldwide geothermal resource. All of Nevada's commercially developable geothermal energy reserves are believed to be associated with hot water convection systems.

Geopressure systems are the third source of geothermal energy. These systems are estimated to contain approximately ten percent of the worldwide geothermal potential. Geopressure reservoirs usually contain water between 300° F. and 400° F. which is trapped under very

thick layers of sediments. This causes the reservoir to be under very great pressure. Geopressure systems are found most frequently around the Gulf of Mexico and have been found in several deep basins in the western part of the United States. No geopressure systems have been located in Nevada.

The largest of all geothermal energy systems, which accounts for about 79 percent of the total worldwide geothermal potential, is the hot-dry rock system. Unfortunately, this geothermal energy system is the most difficult to tap with existing technology. There are two major problems in developing this type of resource: it is usually found at very great depths; and there is no fluid medium present to transfer the energy from the rock to the surface where it can be put to use. As a result, hot-dry rock systems are not expected to supply significant quantities of commercial energy in Nevada during this century.

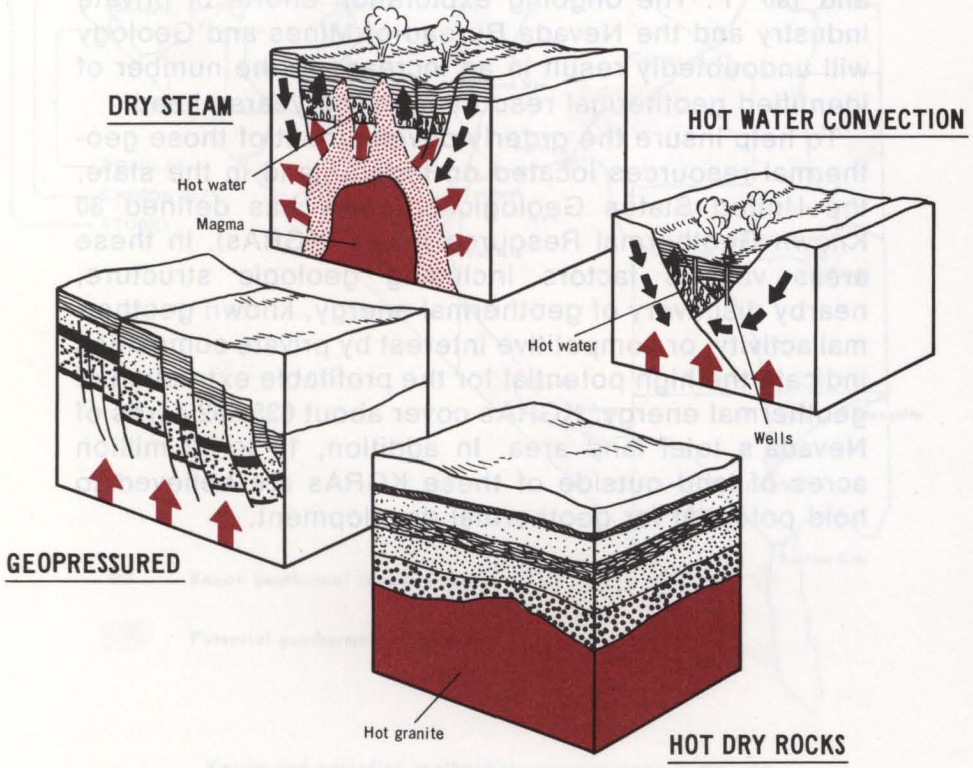


Worldwide percentage of geothermal energy systems.

GEOTHERMAL ENERGY—NEVADA'S RESOURCE

Nevada is located in a geologic area called the Basin and Range Province. This province is characterized by a large series of parallel north-south trending faults and a thin continental crust. Energy, resulting from the high heat flow through the thin continental crust, is transferred to the earth's surface by fluids migrating up portions of those faults that extend to depths of several thousand feet. Where these faults cut the land surface, the geothermal water can flow out as hot springs. Many

Geothermal Energy Systems

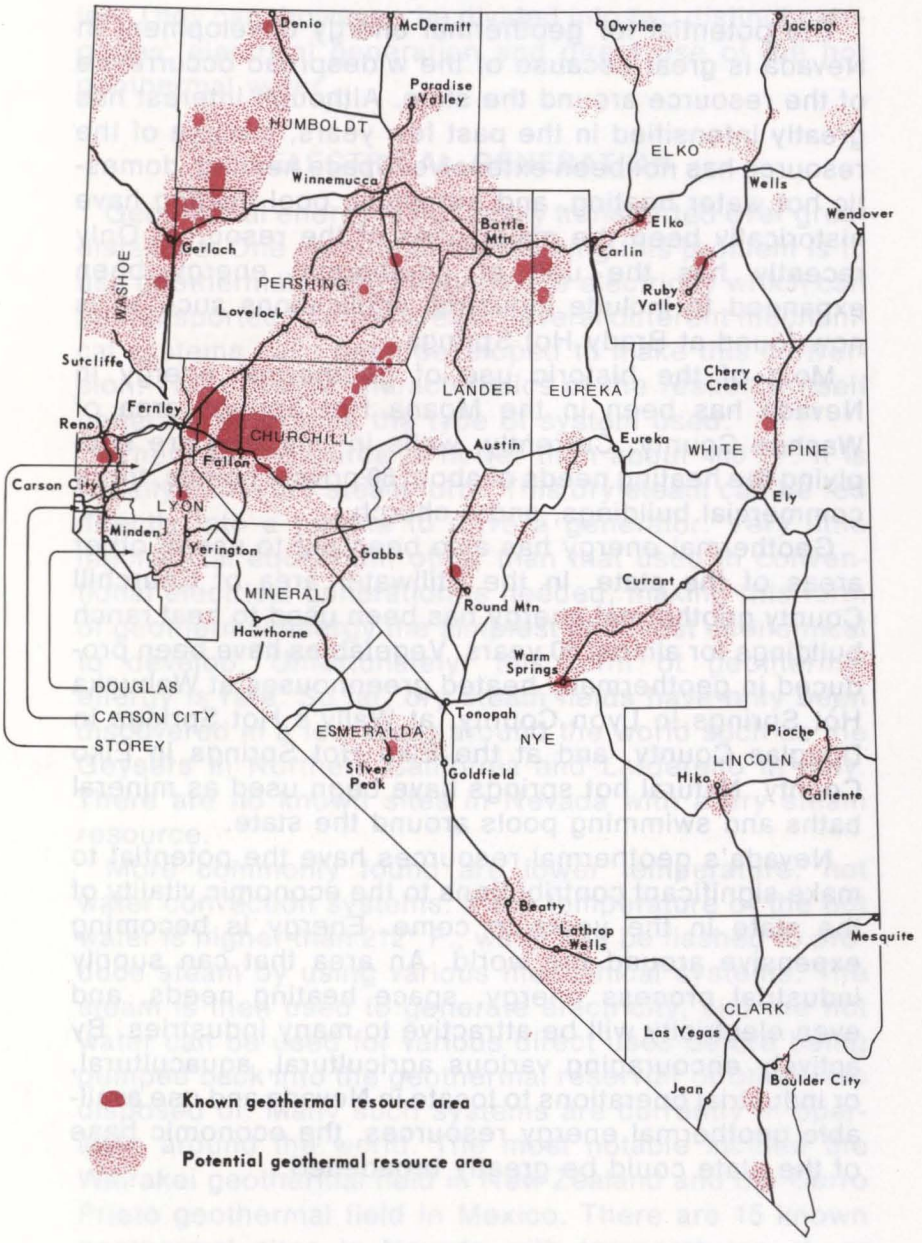


of these faults, however, are buried beneath layers of sediments. Finding this geothermal resource is one of the goals of modern exploration geology.

As a result of these geological conditions the most commonly encountered type of geothermal energy system in Nevada is hot water convection. These systems are found in virtually every part of the state. The resource is, however, somewhat more abundant and higher in temperature in northern Nevada.

To date, more than 300 hot springs and hot wells have been located at various places around the state. Twenty-one of these sites have temperatures greater than 300° F., and a few, such as Dixie Valley, Humboldt House, Steamboat, Brady Hot Springs, and Desert Peak, may have temperatures in excess of 400° F. Ninety-four of the sites have temperatures between 190° F. and 300° F., and more than 175 sites have temperatures between 70° F. and 190° F. The ongoing exploration efforts of private industry and the Nevada Bureau of Mines and Geology will undoubtedly result in an increase in the number of identified geothermal resources in the years ahead.

To help insure the orderly development of those geothermal resources located on federal land in the state, the United States Geological Survey has defined 30 Known Geothermal Resource Areas (KGRAs). In these areas various factors including geologic structure, nearby discovery of geothermal energy, known geothermal activity, or competitive interest by private companies indicate the high potential for the profitable extraction of geothermal energy. KGRAs cover about 635,462 acres of Nevada's total land area. In addition, 10 to 12 million acres of land outside of these KGRAs are believed to hold potential for geothermal development.



Known and potential geothermal resource areas in Nevada.

GEOTHERMAL ENERGY—THE POTENTIAL

The potential for geothermal energy development in Nevada is great because of the widespread occurrence of the resource around the state. Although interest has greatly intensified in the past few years, the use of the resource has not been extensive. Space heating, domestic hot water heating, and swimming pool heating have historically been the major uses of the resource. Only recently has the use of geothermal energy been expanded to include industrial applications such as is now found at Brady Hot Springs.

Most of the historic use of geothermal energy in Nevada has been in the Moana Hot Springs area of Washoe County. Currently, wells in this area are supplying the heating needs of about 60 private homes, three commercial buildings, and a church.

Geothermal energy has also been put to use in other areas of the state. In the Stillwater area of Churchill County geothermal energy has been used to heat ranch buildings for almost 60 years. Vegetables have been produced in geothermally heated greenhouses at Wabuska Hot Springs in Lyon County, at Wally's Hot Springs in Douglas County, and at the Elko Hot Springs in Elko County. Natural hot springs have been used as mineral baths and swimming pools around the state.

Nevada's geothermal resources have the potential to make significant contributions to the economic vitality of the state in the years to come. Energy is becoming expensive around the world. An area that can supply industrial process energy, space heating needs, and even electricity will be attractive to many industries. By actively encouraging various agricultural, aquacultural, or industrial operations to locate in Nevada and use available geothermal energy resources, the economic base of the state could be greatly broadened.

GEOTHERMAL ENERGY—THE USES

The potential uses of geothermal energy are quite varied. They can, however, be divided into two distinct categories: electrical generation and direct use of the hot geothermal water.

ELECTRICAL GENERATION

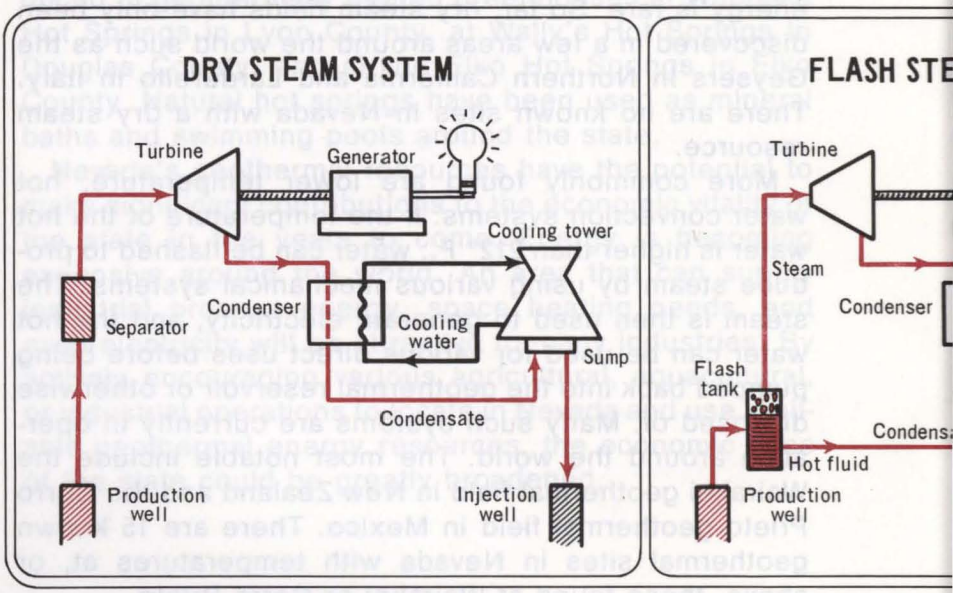
Geothermal energy is not easily transported over great distances. One method of overcoming this problem is to use geothermal energy to generate electricity which can be transported to other areas. Several different mechanical systems have been developed to make this conversion. The physical characteristics of the resource itself generally determine the type of system used.

Where the resource is hotter than about 400° F. it is usually in the dry steam form. This dry steam can be fed directly into a turbine to drive a generator. Very little mechanical equipment other than that used in conventional electrical generation is needed, making this form of geothermal energy the simplest and most economical to develop. Unfortunately, this form of geothermal energy is rare. So far, dry steam fields have only been discovered in a few areas around the world such as the Geysers in Northern California and Larderello in Italy. There are no known sites in Nevada with a dry steam resource.

More commonly found are lower temperature, hot water convection systems. If the temperature of the hot water is higher than 212° F., water can be flashed to produce steam by using various mechanical systems. The steam is then used to generate electricity, and the hot water can be used for various direct uses before being pumped back into the geothermal reservoir or otherwise disposed of. Many such systems are currently in operation around the world. The most notable include the Wairakei geothermal field in New Zealand and the Cerro Prieto geothermal field in Mexico. There are 15 known geothermal sites in Nevada with temperatures at, or above, those found at Wairakei or Cerro Prieto.

Recent experiments have shown that geothermal resources with temperatures between 150° F. and 300° F. can be used to generate electricity. To use this lower temperature resource, a binary type of powerplant must be used. In a binary powerplant, the hot geothermal water is used to boil and vaporize a secondary fluid such as freon or isobutane. The vapor from this process is then directed through a turbine to generate electricity. Several hundred sites with temperatures in this range have been located in Nevada. This type of electrical generation system is being tested in several areas which were previously thought to be unsuitable for electrical generation because of low resource temperatures. Pilot plants are currently in operation in the Imperial Valley of California and in the Raft River area of Idaho.

Various estimates have been made as to the amount of electricity that can be produced by Nevada's geothermal resources. These estimates range from a low of 1,000 megawatts of highly probable capacity to a high of 10,000 megawatts of potential capacity. The development of even 1,000 megawatts could have a significant impact on the future of the state.



Electrical gen

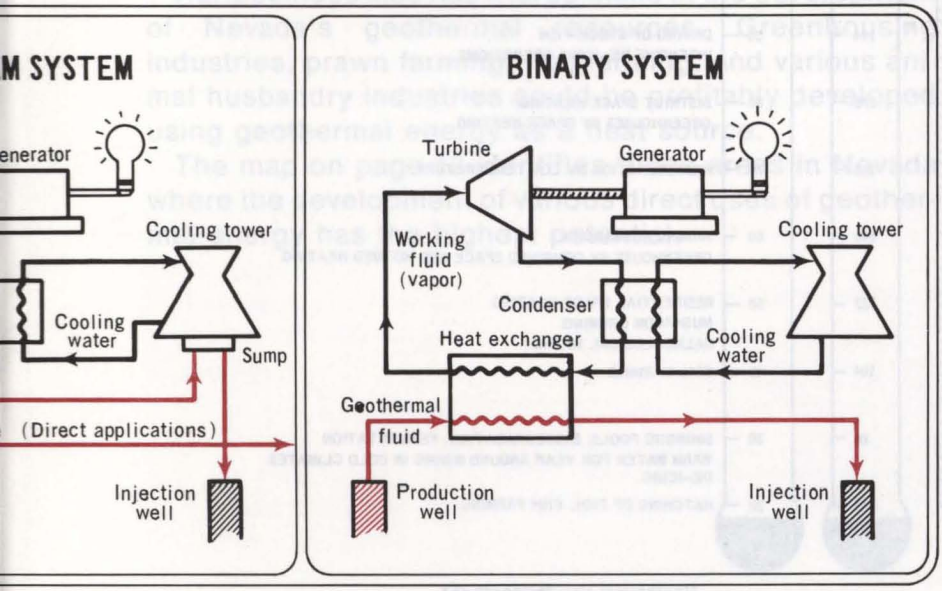
DIRECT USES

Hot springs have been known since ancient times when they were used for hot baths and health resorts. Hot spas remain the focus of many large resorts around the world.

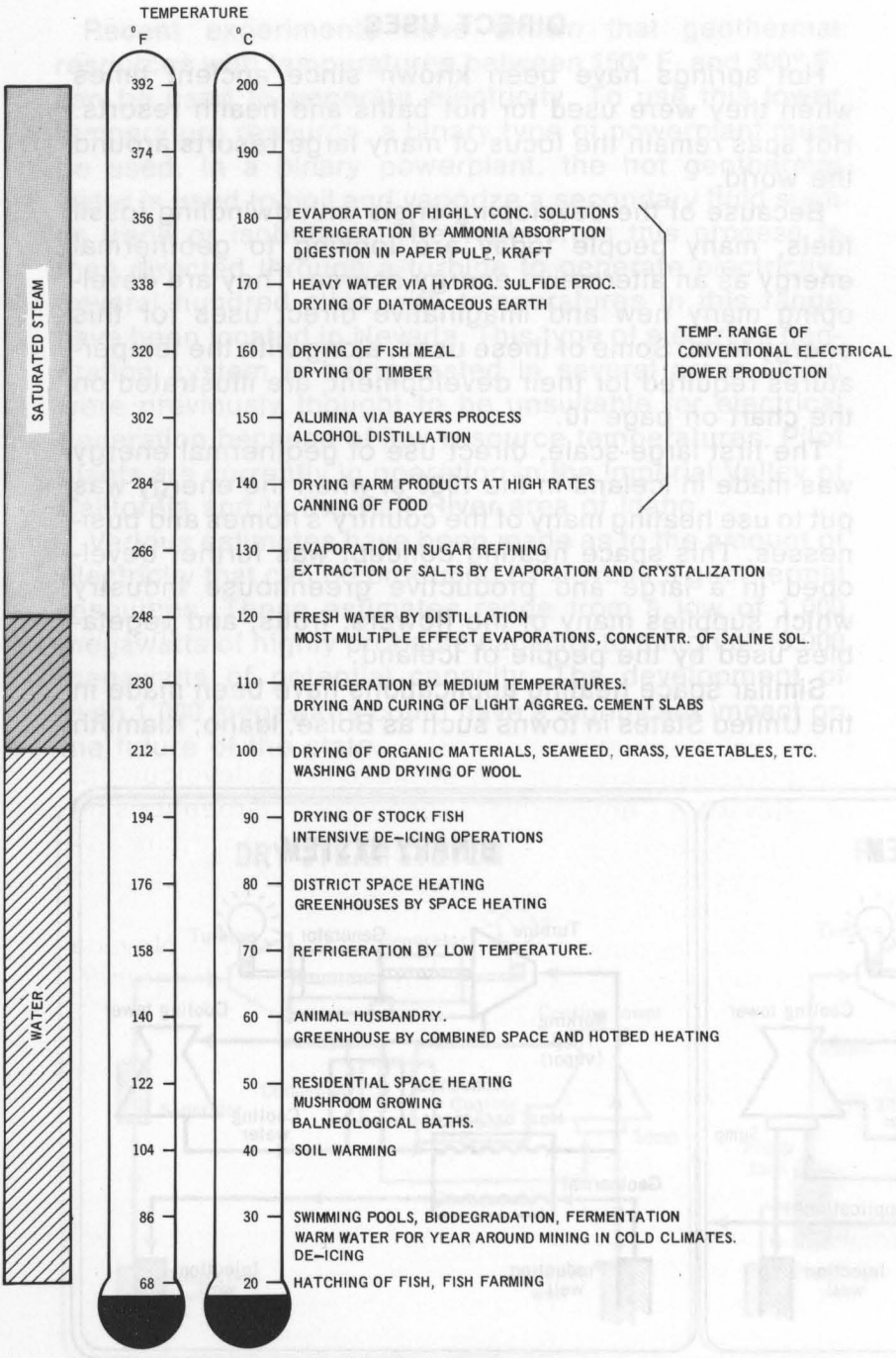
Because of the developing crisis with dwindling fossil fuels, many people today are looking to geothermal energy as an alternative energy source. They are developing many new and imaginative direct uses for this energy form. Some of these uses, along with the temperatures required for their development, are illustrated on the chart on page 10.

The first large-scale, direct use of geothermal energy was made in Iceland in the 1930's, when the energy was put to use heating many of the country's homes and businesses. This space heating concept was further developed in a large and productive greenhouse industry which supplies many of the flowers, fruits, and vegetables used by the people of Iceland.

Similar space heating applications have been made in the United States in towns such as Boise, Idaho; Klamath



ation systems.



Geothermal use temperatures.

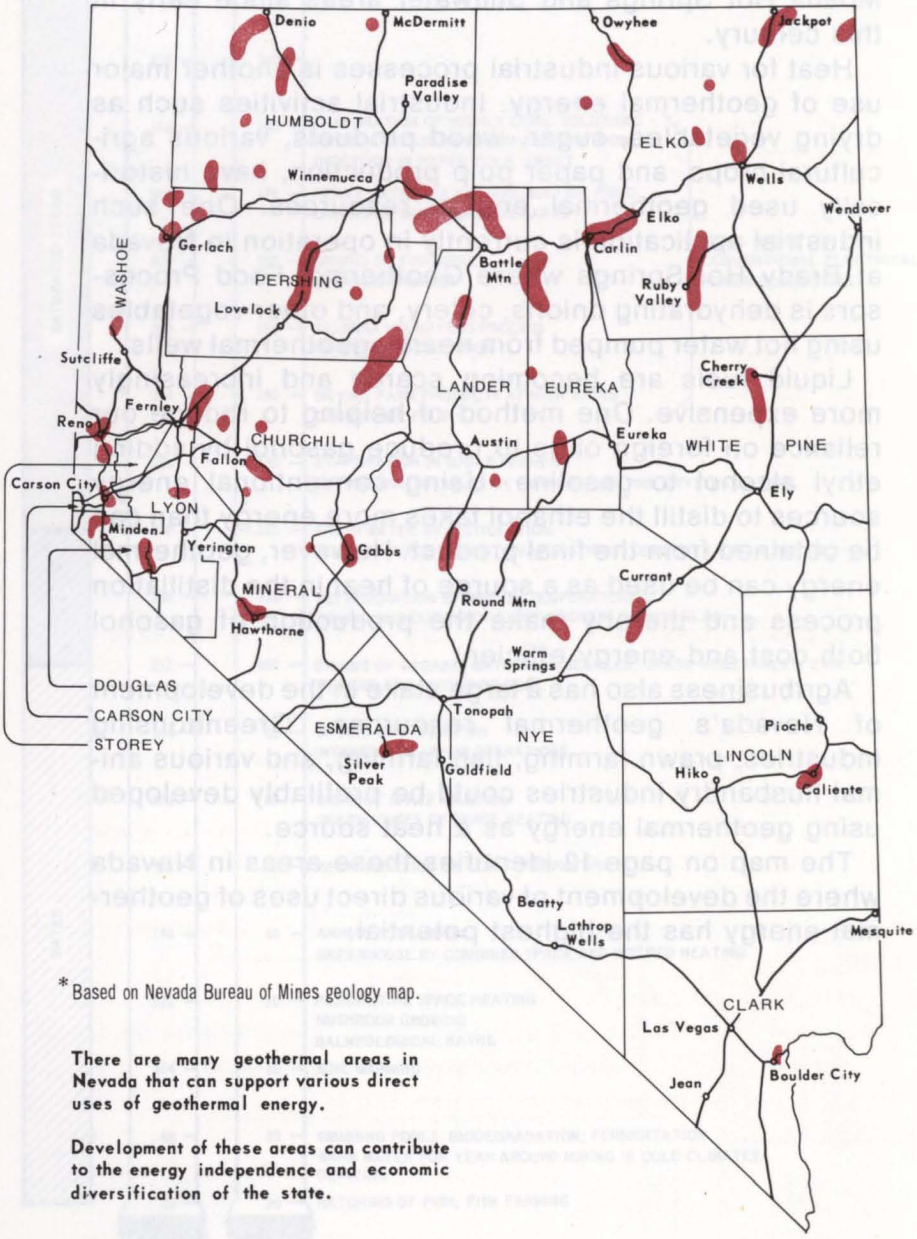
Falls, Oregon; and Susanville, California. In Nevada, geothermal energy has been used to heat homes in the Moana Hot Springs and Stillwater areas since early in this century.

Heat for various industrial processes is another major use of geothermal energy. Industrial activities such as drying vegetables, sugar, wood products, various agricultural crops, and paper pulp production, have historically used geothermal energy resources. One such industrial application is currently in operation in Nevada at Brady Hot Springs where Geothermal Food Processors is dehydrating onions, celery, and other vegetables using hot water pumped from nearby geothermal wells.

Liquid fuels are becoming scarce and increasingly more expensive. One method of helping to reduce our reliance on foreign oil is to produce gasohol by adding ethyl alcohol to gasoline. Using conventional energy sources to distill the ethanol takes more energy than can be obtained from the final product. However, geothermal energy can be used as a source of heat in the distillation process and thereby make the production of gasohol both cost and energy efficient.

Agribusiness also has a large stake in the development of Nevada's geothermal resources. Greenhousing industries, prawn farming, fish farming, and various animal husbandry industries could be profitably developed using geothermal energy as a heat source.

The map on page 12 identifies those areas in Nevada where the development of various direct uses of geothermal energy has the highest potential.

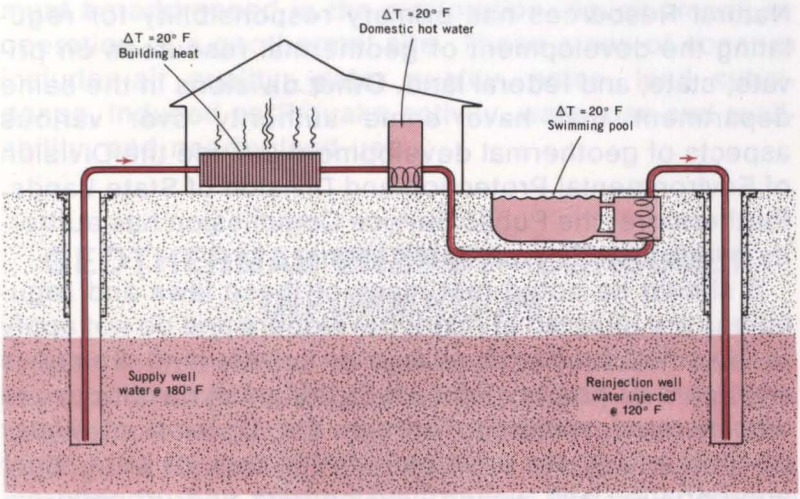


* Based on Nevada Bureau of Mines geology map.

There are many geothermal areas in Nevada that can support various direct uses of geothermal energy.

Development of these areas can contribute to the energy independence and economic diversification of the state.

Geothermal resources of Nevada and their potential for direct utilization.*



Cascading geothermal energy use system.

GEOTHERMAL ENERGY—REGULATION

Development of Nevada's geothermal resources is based on the interplay of several different factors including the size of the development, the land ownership pattern in the state, and the resultant mixture of federal, state, and local laws governing its development. Major developers on public lands are required to comply with 47 federal laws, seven federal executive orders, 32 chapters of the Nevada Revised Statutes, and miscellaneous local ordinances.

The primary federal laws are the Geothermal Steam Act and the National Environmental Policy Act of 1969. Responsibility for administering these laws is held by the Bureau of Land Management and the United States Geological Survey. Potential developers of geothermal energy resources on public land should contact these agencies for more detailed information.

Though a variety of state agencies have regulatory authority over geothermal development, the Division of

Water Resources in the Department of Conservation and Natural Resources has primary responsibility for regulating the development of geothermal resources on private, state, and federal land. Other divisions in the same department that have some authority over various aspects of geothermal development include the Division of Environmental Protection and Division of State Lands. Furthermore, the Public Service Commission has authority over all utility-type applications.

It should be noted that many of these laws and regulations are directed at major developers and do not apply to the small, private developer on private land. The laws which are of primary interest to the small developer are administered primarily through the Division of Water Resources and are principally in the area of water right appropriation and well-drilling permits and procedures. All prospective developers should contact that agency early in the development process to insure that the resource is developed in a lawful manner.

In addition to federal and state regulation of geothermal development, there may also be local ordinances applicable to the development. The developer is encouraged to contact the local governing bodies before any project is attempted.

If additional information is needed concerning governmental regulation of geothermal energy development, the *Geothermal Handbook for Nevada* is available by writing or calling the Nevada Department of Energy.

GEOTHERMAL ENERGY— ENVIRONMENTAL CONCERNS

The development of geothermal resources may result in some changes to the environment. These changes, however, are not as significant as changes that occur with the development and use of fossil energy resources.

Associated with the development of geothermal

energy are several areas of environmental concern that must be addressed in the exploration, development, or operation of a geothermal site. These areas of concern include: air quality, water quality, noise, land subsidence, induced earthquake activity, water use and availability, and nearby land use.

GEOTHERMAL ENERGY—CONSUMER INFORMATION

Specific information concerning the location, temperature, characteristics, depths, and quality of Nevada's geothermal resources may be obtained by either contacting the Nevada Bureau of Mines and Geology, or by referring to their publication *Thermal Waters of Nevada* which is available in most state libraries. Limited technical assistance and other services are available to the developer of geothermal resources in Nevada through the Nevada Department of Energy. Interested individuals are encouraged to contact the Department for more information about the types of assistance available.

If you are considering developing a geothermal resource the following three steps should be taken:

1. Evaluate the temperature, capacity, and chemical characteristics of the geothermal resource to determine whether it is capable of supplying the needs of the proposed application.
2. Insure that any system which is developed to use the resource is properly designed, installed, and operated. Systems must be designed to adequately supply the needs of the proposed use and withstand the higher temperatures and the unique chemical composition of the geothermal resource.
3. Comply with all federal, state, and local regulations regarding exploration, development, and use of geothermal resources.

Because of the site specific character of geothermal resources it is wise to engage the services of a reputable

consulting firm that has had experience in assessing geothermal reservoirs and in designing operational geothermal systems.

SPECIAL NOTE

Because Nevada's State Legislature recognizes the value of converting private residences to use geothermal energy as a source of domestic heat, it has exempted, by law, the added value of such development from local property taxes. For more information on this exemption, contact your local tax assessor's office or the Nevada Department of Taxation.

In addition, certain geothermal uses can also qualify for federal income tax credits.

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GEOTHERMAL ENERGY—ADDITIONAL INFORMATION

Additional information on the occurrence, character, or development of Nevada's geothermal resources may be obtained by writing, calling, or visiting any of the following:

Nevada Department of Energy
400 West King Street
Carson City, Nevada 89710
(702) 885-5157

Nevada Department of Conservation and Natural Resources—Division of Water Resources
201 South Fall Street
Carson City, Nevada 89710
(702) 885-4380

Nevada Bureau of Mines and Geology
University of Nevada-Reno
Reno, Nevada 89557
(702) 784-6691

U.S. Bureau of Land Management
Room 3008, Federal Building
300 Booth Street
Reno, Nevada 89509
(702) 784-5748

U.S. Geological Survey
District Geothermal Office
4600 Kietzke Lane
Reno, Nevada 89502
(702) 784-5676

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