Geothermal Energy— a Viable Energy Source for Health Facilities

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THIS NATION HAS A TREMENDOUS SOURCE of efficient, nonpolluting, and always available energy. It lies under every square inch of land; yet it is seldom mentioned and little used. This energy source is geothermal—literally meaning earth heat. Geothermal energy has been used in some areas of the world for centuries. Up to now it has been tapped primarily in areas where the heat of the earth draws attention to its existence through hot springs and geysers. However, our present-day ability to use this energy has expanded beyond the areas of warm springs or other natural phenomena. Geothermal wells are now drilled deliberately to tap this energy source. Indeed the potential for geothermal energy is much greater even than its existing uses portend. All 15 Western States have hot water resources (see map), and a Federal survey shows that 37 States have low-to-moderate-temperature resources (*1*). Within the next 20 years geothermal energy should supply 7 to 10 percent of our nation's domestic hot water and space-heating requirements. Therefore, the direct heat application of geothermal energy warrants serious investigation.

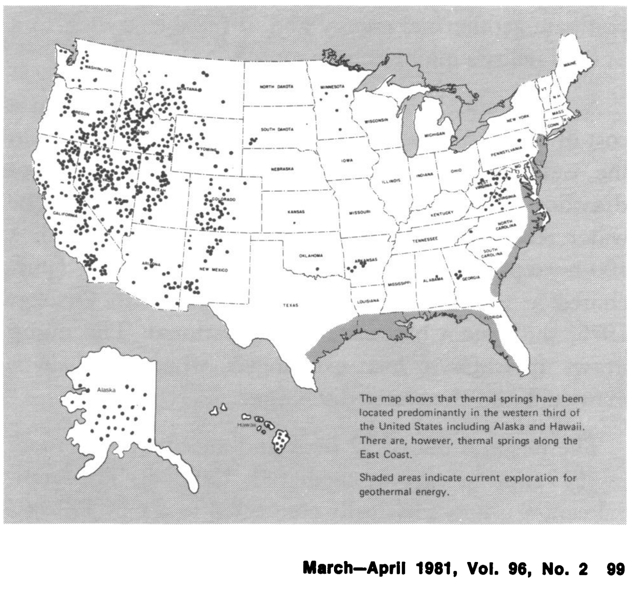
From the perspective of the health care system, geothermal energy resources are widespread, are currently available, and can be used for practically all activities requiring large quantities of heat at relatively low temperatures. At least six health facilities are either already using this low-cost, dependable energy source or are in the process of converting to its use. In this paper I will review the nature of geothermal energy, outline the advantages of this energy resource, and show why it is a particularly viable choice for health facilities.

One of the oldest uses of geothermal energy is for space heating. Geothermal energy has been directly used for this purpose and to heat water for bathing for centuries in different parts of the world. During the 13th century, hot springs were recreation sites, as well as the source of sulphur and other minerals used in trade. In the United States, geothermal space heating has been used successfully since the turn of the century in parts of Idaho and Oregon. The most significant developments in its application outside of the United States are in Iceland, New Zealand, the USSR, Japan, Italy, Mexico, El Salvador, and Hungary. Several other countries also use geothermal energy, but to a lesser degree.

In Iceland, about one half of the entire residential heating requirements of the nation are being met by geothermal energy sources; by 1982, 80 to 85 percent of the country's 226,339 residents will be kept warm with geothermal energy. The most dramatic example of direct application of this source is in Reykjavik, Iceland's capital, where about 97 percent of the residents are supplied heat from the geothermal municipal heating project. Lessons from Iceland, as well as from other countries that tap geothermal energy, show that conversion to a geothermal fuel system is a relatively simple process. The technology is available, has been tested, and is adaptable. These are important considerations for the managers of health facilities, who need to be assured that they are not breaking ground in a new and untried technology.

The most common heating systems in health facilities

Distribution of known geothermal springs



The map shows that thermal springs have been located predominantly in the western third of the United States including Alaska and Hawaii. There are, however, thermal springs along the East Coast.

Shaded areas indicate current exploration for geothermal energy.

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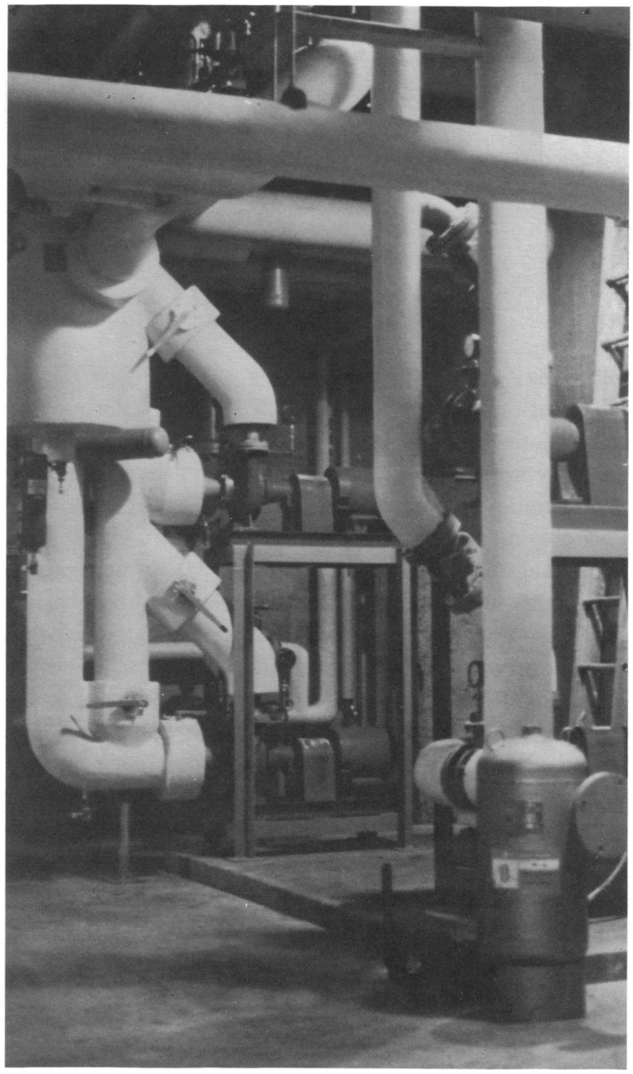
—warm or hot water and forced air—can be readily adapted to geothermal energy. These warm or hot water systems with radiators or convectors can be adapted either (*a*) by running the geothermal water in the equipment, provided it does not cause corrosion or scaling, or (*b*) by installing a heat-exchange system in which scaling and corrosion are controlled. Therefore, replacing the present furnace and fan with a surface-heat exchanger, and possibly with a somewhat larger fan, would complete the adaption from a forced air or hot water system to a geothermal system. For geothermal temperatures in the lower range, around 100°F, a heat pump may be necessary to provide temperatures that are high enough to allow a building's present air delivery system to be used. One of the advantages of conversion to geothermal energy is that all the equipment required to accomplish it is readily available "off the shelf." The actual cost associated with conversion varies from site to site and depends on the number, depths, and successes of well-drilling and the recovery and transportation costs. For example, one facility may be within 300 yards of a producing well that may only require 800 feet of drilling. For another facility, a mile from a resource, three wells may have to be drilled, each to a depth of 4,500 feet, before success is achieved. These examples demonstrate the factors of cost variance. The experience of the Merle West Medical Center, Klamath Falls, Oreg., is instructive.

Geothermal Energy Use in Klamath Falls

The community of Klamath Falls, Oreg., has been tapping geothermal sources since the turn of the century to heat approximately 100 of its buildings, including schools, homes, and businesses. In 1974, board members of the Merle West Medical Center, concerned with the soaring cost of fuel and the projected cost and uncertainty of future natural gas supplies, decided to investigate geothermal energy and, if feasible, switch to it as the facility's major energy source.

A 1,583-foot, 10-inch well was drilled and cased at a cost of $32,915. Tests showed that the water pressure in the well was 400 gallons per minute with a 15-foot drawdown from a static water level of 322 feet. The water temperature was 191° F. After a pump with a 100-horsepower, 500-gallon-per-minute capacity (purchased at a cost of $29,100) was installed in October 1976, the system became fully operational. The pump draws up water to heat exchangers, where the heat is extracted and the water discharged.

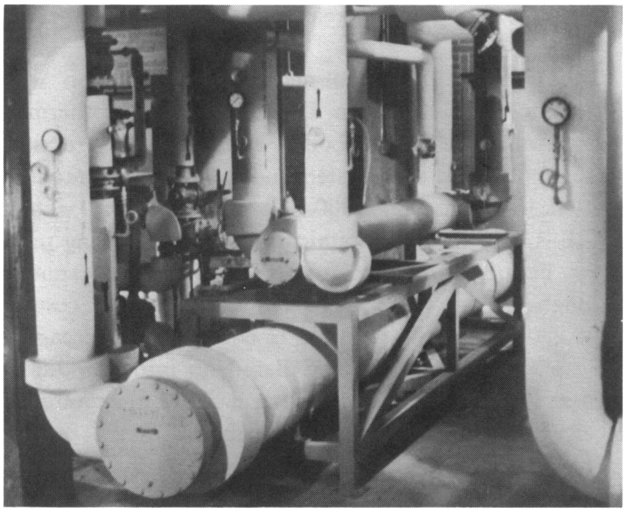
The hospital added 57 beds and an emergency room in 1977, and its current capacity is 150 beds. The medical center is now physically connected to a new 120-bed



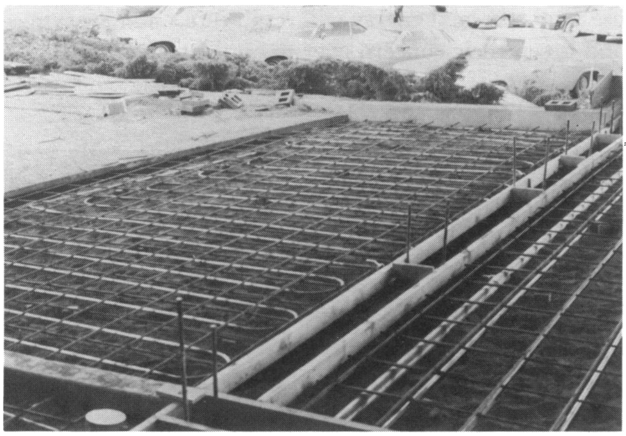
Space heating transfer pump at Merle West Medical Center, Klamath Falls, Oreg.

skilled and intermediate care nursing facility owned by Klamath County. Geothermal energy provides heating and air conditioning for the original facility, the 57-bed addition, the emergency room, and the 120-bed nursing facility, in other words, for 100 percent of the center's and the nursing facility's requirements for space heating and hot water. In addition, a system of pipes transports geothermal energy to keep outdoor areas free of ice and snow. Thus, the complex has an energy source that is readily available, constant in supply, and not subject to continuing price rises.

The cost for developing the heating and domestic hot water capabilities for the entire complex was about $357,500. The net cost for developing the heating for the hospital, including the new additions, was $250,000. The hospital board has estimated that within 5 years, savings from gas bills will cover the initial cost of devel-



Domestic hot water and snow melt exchanges at Merle West Medical Center, Klamath Falls, Oreg.



Snow melt system at Merle West Medical Center, Klamath Falls, Oreg.

oping the geothermal system. By avoiding increases in the hospital's fuel bill, conservatively estimated at 10 percent per year (5 percent increase in cost, plus 5 percent increase in consumption), it is calculated that Merle West will realize a cumulative net saving of more than $22 million in 40 years as a result of the geothermal system. The projected savings can contribute to reducing the cost and improving the quality of the care provided.

Other Hospitals Switching to Geothermal Energy

Five other hospitals that are currently switching to geothermal energy are St. Mary's Hospital, Pierre, S.D., Torbett-Hutchings-Smith Memorial Hospital, Marlin, Tex., Warm Springs State Hospital, Deer Lodge County, Mont., Navarro College and Hospital, Corsicana, Tex., and Carrie Tingley Hospital, Truth or Consequences, N. Mex.

St. Mary's Hospital. The 138-bed St. Mary's Hospital is part of an integral complex that includes an 86-bed nursing home, a licensed practical nursing school, and a convent along with the space the convent leases to a 36-client drug abuse treatment unit. In February 1978, the hospital received a cost-sharing geothermal demonstration grant from the Department of Energy. After receiving funding and the necessary approvals, the project got underway with the drilling of a well, which was completed in April 1979. The well was drilled to a depth of 2,174 feet. The temperature of the water right out of the well is 106° F. The water travels through heat exchangers to preheat fresh air and to heat water circulating through St. Mary's heating and air conditioning systems. This geothermal energy system was completed in October 1980 and is now operating successfully.

Although fuel oil is the present source of heat energy for St. Mary's, energy from the geothermal source is expected to reduce the hospital's future demand for fuel oil by 115,000 gallons per year. Based on a simple payback formula of initial cost divided by annual cost savings, the economics of the St. Mary's Hospital project are as follows:

Total cost of geothermal energy project	$718,000
Annual fuel oil savings (115,000 gal @ 95 cents per gal)	109,250
Projected annual operational and maintenance costs	
Added pumping cost	$840
Maintenance cost	10,000
Operational cost	20,000
Total annual costs	$30,840
Period required for payback	
Simple payback for overall project: $718,000 total project cost divided by ($109,250 annual fuel oil saving minus $30,840 annual operational and maintenance costs)	9.15 years
Payback to owner at 25 percent share of total cost: ($718,000 total project cost times .25) divided by ($109,250 annual fuel oil saving minus $30,840 annual operational and maintenance costs)	2.3 years

Torbett-Hutchings-Smith Memorial Hospital. The 130-bed Torbett-Hutchings-Smith Memorial Hospital started its geothermal conversion project in February 1979 by drilling a 3,855-foot-deep production well, which was completed and tested in July 1979. The temperature of the water right out of the well is 138° F. The geothermal heating system will supply heat to the hospital's domestic water system, as well as to the 130° F space-heating system and the outside-air preheating system. At present, the heat input to these systems is steam, which is provided by a low-pressure boiler fired by natural gas. The boiler system will remain in place as backup and as an auxiliary. The hospital staff anticipates that all construction and retrofitting, which will cost $558,000, will be completed by September 1981. Project costs are being shared with the Department of Energy's Division of Geothermal Energy. The hospital's share will be approximately $121,000. Calculations based on the current energy cost for the hospital and the estimated cost of the geothermal system indicate that the hospital's investment in the geothermal system will be paid for in less than 4 years.

Hospital officials estimate that geothermal heat will reduce the facility's current demand for natural gas by 85 percent. Only the laundry, kitchen, and incinerator facilities will continue to run on natural gas.

Warm Springs State Hospital. A 1,500-foot production well for the 980-bed Warm Springs State Hospital, for which drilling was completed in December 1979, is currently being tested. The temperature of the water right out of the well is expected to be 170° F. The plan is to meet the hospital's domestic hot water requirements and part of its space-heating needs by substituting geothermal energy for the natural gas upon which the facility is currently dependent. The hospital staff anticipates that all construction and retrofitting will be completed by the summer of 1981. The project's cost, $625,000, is being shared by the Department of Energy's Division of Geothermal Energy, the State of Montana, and the hospital. The payback period on the investment will be determined once the demonstration phase begins in the summer of 1981.

Navarro County Memorial Hospital. This 177-bed hospital completed the drilling of a second well in March 1980. The temperature of the water right out of well No. 1 is 125° F and out of well No. 2, 158° F. Currently, the contractor is studying both wells to determine which will be the most viable resource. Construction and retrofitting are scheduled to be completed by the spring of 1982.

This geothermal system is designed to serve both the Navarro College Student Union Building and the Navarro County Memorial Hospital. The cost for the entire project is $1,014,000, which will be shared with the Department of Energy. The student union's and the hospital's share of the cost will be $198,000. Since the project is still in its early phases, the payback period for the investment has not yet been determined.

Carrie Tingley Crippled Children's Hospital. This 76-bed hospital has been using geothermal energy for therapeutic purposes since it opened 41 years ago. A single production well, 212 feet deep, is located 1½ miles from the hospital. The temperature of the water right out of the well is 109° F; the hot water is transported to the hospital through a 41-year-old uninsulated line at 105° F.

In February 1980, the necessary construction was started to increase Carrie Tingley's use of geothermal energy for preheating its boiler water. The construction was completed and the system successfully went into operation in September 1980. To heat the city water, which is used in the hospital primarily for bathing purposes, heat is transferred from the geothermal resource through a heat exchanger. The total project cost is $102,270. The hospital staff is considering increasing the well's depth to 500 feet. Based on initial findings, project personnel believe that a well at the 500-feet level will produce a temperature of 150° F.

Truth or Consequences, N. Mex., is not located on a major natural gas line, but rather on a small gas spur line. A small gas spur line is susceptible to political decisions and radical price changes. Consequently, the decision of Carrie Tingley's managers to increase the use of geothermal energy will result in economic savings and lessen their concern over natural gas shortfalls.

Other Geothermal Projects

Other health facilities whose staffs are currently conducting feasibility studies on converting to geothermal energy are St. Luke's Hospital and Elks Rehabilitation Hospital in Boise, Idaho, and the Lassen Medical Hospital and County Health Center in Susanville, Calif. The staff of the Leo N. Levi National Arthritis Hospital in Hot Springs, Ark., is also currently investigating geothermal energy.

In addition to these health facilities, geothermal energy is, or will be, used for district heating systems in Boise, Idaho, Pagosa Springs, Colo., El Centro, Calif., Klamath Falls, Oreg., Reno, Nev., Susanville, Calif., and Monroe City, Idaho. In these areas, all buildings connected to the district heating system will benefit from the direct use of geothermal energy. (The term "district heating" is applicable wherever more than one facility can be heated by a single central heating system.) Geothermal district heating systems will reduce the dependence of these areas on fossil fuels and their susceptibility to continuing rising prices and supply shortages.

Costs and Other Considerations

Conversion from fossil to geothermal fuels is costly, as evidenced by the cited projects. The process includes exploration fees, drilling cost, pumps, piping, building modifications, and possibly heat exchangers, as well as some retraining of personnel. Since the majority of these expenses are accrued at the beginning of the activity, capital must be available before the project begins. Once this energy source is installed, however, the expense is fairly constant, with minimal maintenance costs, for example, for such items as pump parts. Facilities that are already using geothermal energy, such as the Merle West Medical Center and some schools and businesses, uniformly report that once installed and operational, geothermal systems are practically carefree.

The energy demands of health facilities have up to now been satisfied largely by oil, gas, and coal. According to a "1976 Survey of Hospitals' Use of Fuels" (*4*), 32 percent of the hospitals responding reported that they used only natural gas for heating space and water, 13 percent reported that they used only oil, and 1 percent reported that coal was the only fuel that they used. Forty-six percent of the responding hospitals reported a 100 percent dependency on fossil fuels for heating space and water. Fossil fuels have been dependable and available at reasonable prices in the past. However, the current U.S. production of crude oil is not sufficient to meet national consumption levels, and more than 40 percent of all oil consumed in the United States is being imported from foreign sources. This dependency on imported oil has subjected the nation to ever increasing oil prices, uncertainty about supply, and the whims of foreign governments. Moreover, the outlook in the coming decade is for a continued increase in energy prices and increasingly tight supples.

Other kinds of geothermal reservoirs in this country include (*a*) hot dry rocks, (*b*) pockets of hot water trapped in sand formations thousands of feet below the earth's surface, and (*c*) the molten magma of the earth's core. All three of these reservoirs are being investigated and analyzed for their potential contribution to our energy reserves. Current research in geothermal energy is directed toward achieving even more practical and cost-effective means of tapping it.

To encourage industry to invest in geothermal energy, the Federal Government established the Geothermal Loan Guarantee Program under the Geothermal Energy Research Development and Demonstration Act of 1974. This program's primary purpose is to accelerate development of commercial uses of geothermal energy in the private sector by minimizing financial risks to

Sources of Information on Geothermal Energy

Mr. William Holman
Geothermal Loan Guarantee Program
Department of Energy
San Francisco Operations
1333 Broadway
Oakland, Calif. 94612
Telephone: 415: 273-7151

Other Federal programs providing direct financial assistance for geothermal development and utilization:

U.S. Department of Commerce
Economic Development Administration
Office of Public Affairs
Room 7019
Washington, D.C. 20230
Telephone 202: 373-5113

Housing and Urban Development
The Action Grant Program
Mr. Anthony Carey
451 Seventh St., S.W.
Washington, D.C. 20410
Telephone 202: 755-6267

U.S. Department of Agriculture
Mr. B. B. Brown, Commercial Loan Officer
Business and Industrial Loan Guarantee Division
Farmers Home Administration
South Building
14th & Independence Ave.
Washington, D.C. 20500
Telephone 202: 447-3479

For those seeking general information on geothermal energy, such as site-specific availability or how to start a geothermal project, consultants at the Earth Science Laboratory gratuitously offer up to 100 hours of technical assistance:

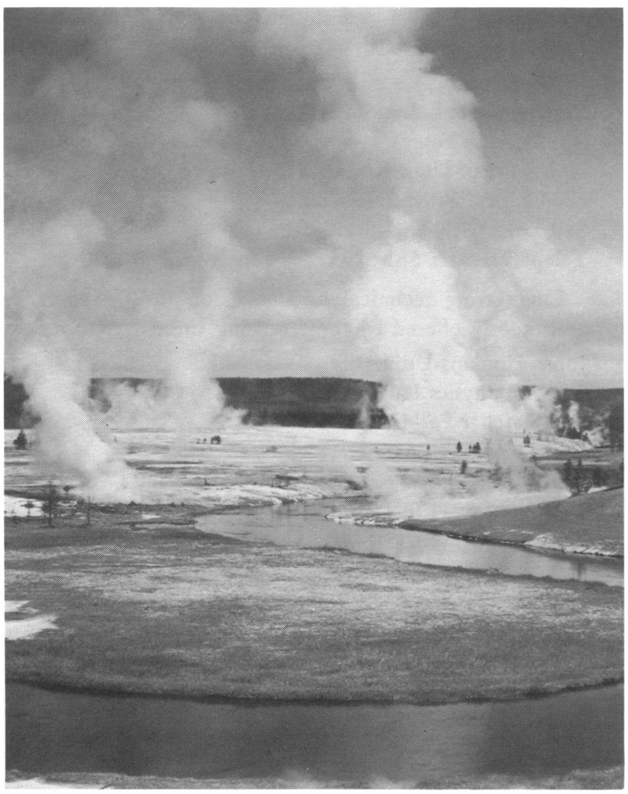
Earth Science Laboratory
Mr. Duncan Foley
University of Utah Research Institute
420 Chipeta Way, Suite 120
Salt Lake City, Utah 84108
Telephone 801: 581-5283

Engineering technical assistance, up to 100 hours, is gratuitously offered by the following three organizations:

Johns Hopkins University
Applied Physics Laboratory
Mr. Fletcher Paddison
Johns Hopkins Road
Laurel, Md. 20810
Telephone 301: 953-7100

Oregon Institute of Technology
Geo-Heat Utilization Center
Mr. John Lund
Klamath Falls, Oreg. 97601
Telephone 503: 882-6321

E G & G, Inc.
Mr. Ivar Engen
P.O. Box 1625
Idaho Falls, Idaho 83415
Telephone 208: 526-1836



Example of geothermal dry steam, the Midway Geyser Basin and the Firelake River, Yellowstone National Park

lending institutions. Health facilities are also eligible for this program. (For sources of information about this and other Federal programs and other help that is available for geothermal energy projects, see box.)

All of the geothermal examples I have described represent direct applications, that is, the heat from geothermal hot water heats space and domestic water. Currently, throughout the United States, there are 180 direct-heat application activities in 16 States, and 57 additional direct-heat projects are in the planning stage (*3*). The utilization of geothermal energy through direct application has proved for centuries to be a reliable and economical energy resource, as has the use of geothermal energy in the form of dry steam.

Use of dry steam to generate electricity dates back to 1904 in Italy. The major geothermal power plants in the United States are located in a natural steam field in northern California, known as the Geysers. At the geysers, steam is collected from a number of wells and then is filtered and passed through turbines that drive electric generators. The total electric capacity at the geysers is now about 500 megawatts, but the total potential geothermal capacity at this location is estimated at about 2,000 megawatts, a capacity sufficient to serve one-half of the present needs of the entire greater San Francisco metropolitan area. A program is underway to add about 100 megawatts per year for several years.

The managers of health facilities must now implement changes that will result in enhanced savings in energy. These managers, if they are to continue providing an affordable health system, must begin investigating all viable alternatives and the efficient use of all their resources. Energy is a resource that requires constant attention and assertive management.

The expenses of health facilities will continue to surge and will exceed income to such an extent that some facilities will no longer be financially functional. These facilities will then be faced with decisions as to whether they should merge or should completely close their doors. However, the severity of the choices may be lessened by educated decision making and proper planning. The time for learning and planning is now.

References

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2. Direct utilization of geothermal energy—a technical handbook. Special report No. 7. Geothermal Resource Council, Davis, Calif., 1979.
3. Peterson, E. A.: Geothermal district heating: projects and potential. International District Heating Association Proceedings, vol. 70, June 1979.
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