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GEOTHERMAL ENERGY FOR COLLEGE CAMPUS
SPACE HEATING AND AGRICULTURAL DEMONSTRATION

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ABSTRACT

Recognizing the economic value and conservation benefits of a renewable energy source, the College of Southern Idaho has taken steps to tap a known geothermal aquifer below its campus. In 1978, a well was drilled on campus which can provide 100°F water.

Using the 100°F water as a heat source, electric heat pumps can significantly reduce space heating costs by replacing the existing electric boilers. In addition, the geothermal resource can be used directly for preheating domestic hot water; swimming pool heating; and secondary uses such as greenhouses, warm water fish ponds, tree nurseries, alternative energy demonstration projects, and others. A new campus building is now being designed to use the 100°F water directly in space heating coils without any temperature boosting.

Additional wells can be drilled to provide sufficient energy for present and future campus facilities. Relatively low-cost additions to an initial distribution system can provide extremely low-cost heating for future campus facilities which will be designed to directly utilize the geothermal resource.

INTRODUCTION

The College of Southern Idaho is located in the City of Twin Falls which is approximately 1 mile south of the Snake River Canyon in southcentral Idaho.

At present, the CSI campus facilities include nine major buildings, all of which are heated by electric power. The majority of energy consumption on the campus is used for space heating and domestic hot water heating in these buildings. Individual electric hot water boilers and ducted air supply systems heat most of the major campus buildings. Hot water at 160°F circulates from the boilers to heating coils located in the air handling units. Hot water for domestic use is supplied by separate electric water heaters in each building.

GEOLOGY AND HOT WATER SOURCE

A geologic study of the area shows that the underlying structure is very uniform over an area of at least 100 square miles. This structure consists of alternating layers of basalt, rhyolite, and similar igneous extrusive layers extending to an unknown depth. These kinds of rock are often quite porous and are potentially good aquifers.

All wells drilled to a depth of 1,200 feet in the area have encountered hot water. This hot water is artesian, with the suspected intake area being located approximately 20 miles to the south in the South Hills. It is believed this water comes up through a fault from deeper layers that extend under the whole Twin Falls area.

Drilling of a deep well at CSI was started in late summer 1978 and is now complete. A 20-inch hole was drilled to 365 feet; a 12-inch hole was drilled from that point down to 1,760 feet, with a further reduction to an 8-inch pilot hole to a depth of 2,220 feet. A temperature of 101°F was reached at 1,185 feet, with no significant increase in temperature at greater depths. The well, which is artesian, can produce 850 gallons per minute at 100°F with a residual pressure of approximately 10 pounds per square inch at the well head.

POTENTIAL RETROFIT SYSTEMS

Because the water quality is exceptionally good, future buildings on the campus can be designed to make direct use of the 100°F water by large capacity heating coils and air handlers in the space heating systems (see Figure 1). However, the systems in existing buildings would require a retrofit to utilize the relatively low temperature resource.

Three retrofit schemes appear to be technically and economically viable:

Heat Pump in Series With Hot Water Boiler

In the existing electric hot water boilers/air handling systems, heat pumps can be installed in series with the boilers (see Figure 2). The return water from the heating coils would enter the heat pumps at approximately 140°F. The heat pumps would take the energy from the natural hot water and boost the closed-loop heating water temperature to 160°F. From the heat pumps, the closed-loop heating water would circulate through the existing boilers. The boilers, which would serve only as emergency standby, would not operate as long as the heat pumps were in operation. Using the 100°F natural hot water, the heat pump systems can supply all of the required space heating.

A heat pump in retrofit systems has many advantages. The heat pump principle permits use of the existing heating coils, system controls, pumps, and the boilers (as standby) with few modifications. The closed heating water loops need only slight
modifications to permit installation of the heat pumps in the existing systems. This retrofit approach allows placement of the heat pumps in the existing mechanical rooms and requires no building modifications.

An obvious disadvantage of this approach is that electrical energy is still necessary, although much less is required. A second disadvantage is that initial capital cost of the equipment is high.
Domestic Hot Water Generation

Natural hot water can be used to preheat the cold domestic water supplied to existing hot water generators which produce hot water for showers, residence halls, laundry facilities, cafeterias, and other uses. The natural hot water is of good quality, but the fluoride concentration (approximately 12 parts per million) is higher than drinking standards allow. For this reason, the natural hot water use must be indirect.

A plate heat exchanger can be installed in series with the hot water generator (see Figure 3). In this system, the cold makeup water flows through the heat exchanger as domestic hot water is used up. Heat is transferred from the 100°F natural hot water to the 40°F to 50°F makeup water to raise it to approximately 95°F. The hot water generator then receives the hot return water and 95°F preheated makeup water and heats the mixture to 140°F.

100°F Natural Hot Water Duct Heaters

In buildings equipped with electric duct heaters, natural hot water coils can be installed upstream of the electric heaters (see Figure 4). The system would operate similarly to a return air preheat system: Natural hot water coils would preheat the air and a three-way valve would decrease flow of hot water as the exit air temperature from the coil is satisfied.

There are no major disadvantages to this type of installation if the mechanical room and building layouts allow access to the ductwork. However, this is a supplemental system which would only reduce the electric power input to the electric duct heaters.

ELECTRIC ENERGY COSTS

The campus energy costs for 1979 were $111,240 for 5.6 million kWh. The demand and facility charges accounted for about half of the costs. Effective March 1980, the rates increased 26 percent, which will be reflected in the 1980 total. It is estimated that rates will increase at 15 to 20 percent per year, based on current trends.

POTENTIAL COST SAVINGS

The present metering system on the CSI campus does not permit separation of the energy costs for each campus facility; nor is it possible to separate heating costs from total energy costs. Based on the estimated heating loads in the major campus buildings, space heating and domestic hot water heating for the buildings proposed for retrofit to natural hot water account for the major share of total demand and energy consumption on the campus.

Natural hot water could provide as much as 50 percent of the total energy requirements, and could represent a decrease in demand as high as 50 percent during the heating season. In electric energy costs, the total annual savings could be in the range of 40 to 50 percent. Recent electrical energy costs have increased dramatically, rising more rapidly than inflation in general. This trend is expected to continue, further enhancing cost savings from a geothermal energy system.
SUMMARY
A campus-wide retrofit to natural hot water would provide at least seven important benefits:

1. Electric power demand would be substantially reduced, resulting in reduced demand charges.

2. Electric energy consumption would be substantially reduced, resulting in reduced energy costs.

3. A campus-wide natural hot water system could accommodate future campus facilities—providing virtually all of the space heating by the direct-use method. This could be accomplished with minor extensions to the distribution system. Electric space heating would not be required.

4. Relatively low-cost additions to the natural hot water system would provide essentially free space heating to future buildings which could be designed to utilize the natural hot water directly without temperature boosting.

5. Secondary uses could be developed at little cost, starting with an in-place system of wells and piping.

6. As a demonstration project, valuable experience with low temperature natural hot water systems would benefit future users. The project has the potential to demonstrate to the entire community of Twin Falls that the resource is technically and economically viable. The result could be that other large energy-consuming facilities in the community would plan to make use of the natural hot water.

7. The electric energy saved would result in an overall reduction in energy consumption in the community that will stretch existing reserves and delay the necessity of constructing additional electric generation facilities.

BIBLIOGRAPHY