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LOW- TO MODERATE-TEMPERATURE DIRECT-USE GEOTHERMAL PROJECTS IN NORTHEASTERN CALIFORNIA

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ABSTRACT

Direct-use geothermal projects are in progress in northeastern California at Wendel in Lassen County, Greenville in Plumas County, Big Bend in Shasta County and at Cedarville and Fort Bidwell in Modoc County. These low- to moderate-temperature projects range from space heating to hybrid geothermal-biomass electrical power generation. Space heating systems at both Indian Valley Hospital in Greenville and at Fort Bidwell Indian Reservation became operational in 1983. Other projects are in various stages of development and design. These projects illustrate the extent to which geothermal resources may be utilized to replace demands on conventional power supplies.

INTRODUCTION

A number of small communities in northeastern California are supporting the evaluation and development of geothermal resources as alternate energy supplies. The locations of these projects are shown on Figure 1. The following sections present the various communities and specific projects, together with the characteristics of the individual resources and the status of resource development and facility system design.

WENDEL, LASSEN COUNTY

Geoproducts Corporation spudded their second well (WEN-2) in the Wendel-Amedee KGRA on April 10, 1984. The drilling and testing of their initial discovery well (WEN-1) was outlined by Juncal and others (1982). Results of a 500-point soil mercury survey, reinterpretation of geophysical data, structural modeling, and analysis of a variety of remote sensing formats were used in siting of this second well approximately one mile from WEN-1. The well was completed to 5050 ft on May 12 and initial well testing has demonstrated good production. WEN-2 is the second step in a field development program which will supply fluid for hybrid geothermal-biomass electrical generation.

An important development in the conversion of WEN-1 from an exploratory to a production well has been the granting by the Lahontan Regional Water Quality Control Board of a permit to discharge 800 gpm of geothermal fluid to the surface. The generally good water quality of WEN-1 along with its beneficial use in helping to maintain waterfowl habitat supported the dicision to grant only the second surface disposal permit for geothermal effluent in the State of California. It is anticipated that WEN-2 will have water of similar quality.

GREENVILLE, PLUMAS COUNTY

To date, two low-temperature geothermal projects have been undertaken in the town of Greenville. A direct-use project is planned for the Greenville School System. A projected 800 to 1000 ft well was spudded in March 1984 at the Greenville High School. If an adequate resource is tapped by the well, plans call for retrofit of the existing space/water heating systems at both the High School and the adjacent Elementary School.

A second direct-use project has been successfully completed at Indian Valley Hospital. The exploration and drilling program began in late 1982. Imagery analysis and field reconnaissance located a previously unmapped fault which served as the primary drilling target. The fault zone was intersected by the well on the hospital grounds. Subsequent 7-day pump testing confirmed that the well in this shallow reservoir is capable of producing 300 to 500 gpm (capacity 1.5 to 3 gpm/ft drawdown) of 116°F water from fractured metavolcanic rocks of Devonian age (Sierra Buttes Formation).

As part of the heating system implementation at the hospital, a surface discharge permit was obtained for 80 gpm of geothermal water. This permit was granted by the Central Valley Regional Water Quality Control Board and represents both an environmentally sound and technically cost-effective means of disposal.

The heating load at the Indian Valley Hospital consists of a single story hospital/nursing care facility, an out-patient clinic, and office building. Electric resistance equipment provided all space heating requirements, and the domestic hot water system is both electric and propane.

The objectives of the engineering design were to use the 116°F geothermal fluid to displace reliance on electric and propane heating, to use minimum flow requirements so as not to interfere

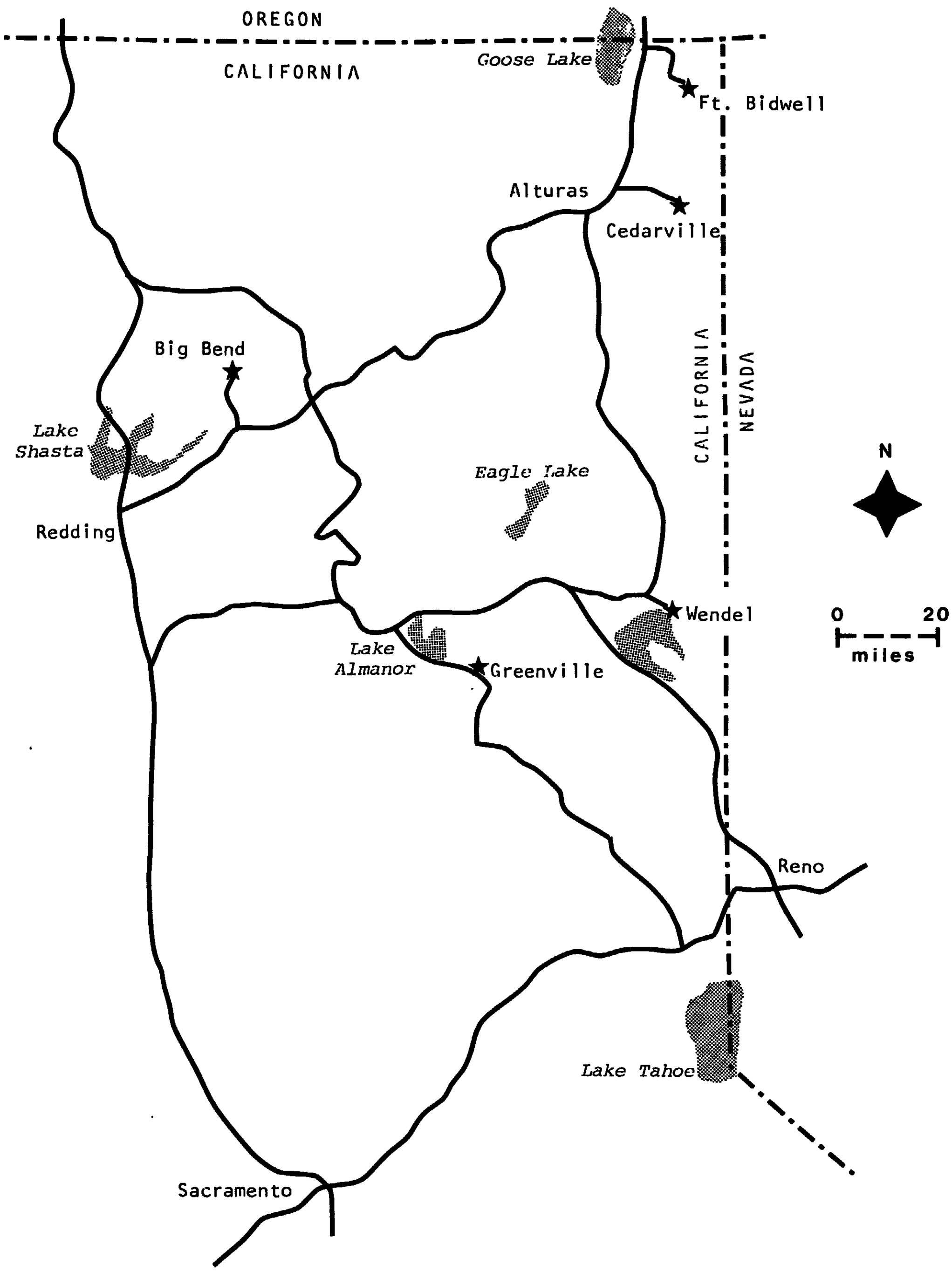

Figure 1. Index map of northeastern California showing location of project sites of Wendel, Greenville, Cedarville, Big Bend, and Fort Bidwell where low- to moderate-temperature geothermal resources are being developed and used for alternate energy systems.

with a nearby spa well and to provide options for heating expanded hospital and related facilities.

The design selected and installed is based on the use of two McQuay Templifier heat pumps, one to provide a 140°F hot water loop for space heating and the other to provide a 180°F hot water loop for domestic hot water heating. Hot water is conveyed to six air handling units in the hospital and hot water coils in the office building and clinic. A package heat pump unit was installed to provide both heating and cooling in the surgery and emergency care areas.

Load demands are precisely matched to fluid flow from the well by the use of a variable speed motor controller and a temperature sensor located in the discharge stream of the heat pumps. All space and hot water heating demands are met by an average 50 gpm flow from the well.

The heating system became fully operational on January 5, 1984. It is expected that net electric energy savings attributable to the system will amount to approximately 280,000 kwh per month which has been supplied by PG&E.

CEDARVILLE, MODOC COUNTY

An exploration program conducted in the Cedarville area of Surprise Valley has culminated in a cooperative effort between the local school district and two private well owners to utilize geothermal water for space/water heating at the local High School and Elementary School and possibly other community and private buildings. Exploration entailed geophysical and imagery analysis, valley-wide water chemistry analysis, a soil mercury survey, reconnaissance field mapping, and extensive temperature logging in all accessible wells.

Drilling and pump testing has been completed on two wells, 1100 and 1800 ft deep, which produce approximately 130°F water from fractured basalt in the hanging wall of the range front fault. Extensive calcite veining has sealed the system from above.

A feasibility study on heating the two schools has been completed and includes preliminary engineering design. System construction may be undertaken in summer 1984, pending a grant from the California Energy Commission.

BIG BEND, SHASTA COUNTY

At the Indian Springs School in the town of Big Bend, resource exploration was completed and a space/water heating system designed. The school is located approximately 4000 ft southeast of the 180°F Big Bend Hot Springs which discharge along the banks and beneath the channel of the Pit River. The Hot Springs effluent is of very poor quality with 1914 ppm total dissolved solids (TDS), 1 ppm arsenic and 32 ppm boron. A steeply dipping fault trending N45W was located by imagery analysis and field reconnaissance and traced into the area of the school. This structure is marked by hydrothermal alteration and extensive calcite veining along its trace; there are at least five separate springs over a distance of approximately one mile.

Drilling, offset from the trace of the fault on the school property, encountered a section of Jurassic pyroclastics, argillites and volcanic conglomerates. Production in the rock is from primary porosity within several conglomerate layers.

Pump testing of the well produced 123°F water and indicated a capacity of 2 gpm/ft drawdown at a discharge rate of 280 gpm. Analysis of Horner plots from the test revealed a boundary, probably a fault though possibly a pinch-out, which affects the drawdown curve. The fluid produced by the well is of excellent quality (better than the present cold water source), meeting all Title 22 requirements with a TDS content of 223 ppm. An application for surface disposal is pending.

The heating system at the Indian Springs School consists of a classroom/office building and attached auditorium and swimming pool completely heated with electric resistance equipment. Adjacent facilities which are also part of the project include the superintendent home and a staff duplex heated by propane and electric resistance wall units. Domestic hot water is also heated by electric resistance equipment.

The preliminary engineering design is based on direct use of the exceptionally clean geothermal fluids in low silhouette fan coil units and in the domestic hot water systems and the swimming pool. The pool change-over rate and/or chlorination schedule will ensure compliance with State health codes. Fluid will be conveyed to the facilities in a 4-inch pre-insulated main from the well and supplied by a 7.5 hp submersible pump. The system is expected to displace a net reliance on electric energy, supplied by PG&E, of approximately 500,000 kwh annually. Final engineering design will begin in July, and the system is expected to be operational by December 31, 1984.

FORT BIDWELL, MODOC COUNTY

A number of geothermal projects are planned on the Fort Bidwell Indian Reservation in northern Surprise Valley. A highly transmissive geothermal well drilled in 1981 is capable of producing approximately 150 gpm of sustained artesian flow, determined by a 40-day constant head test. However, it immediately diminished the adjacent "Hot Springs" when allowed to flow (the "Hot Springs" are actually an artesian well drilled in the 1920's(?) which produces from corroded casing). Due to the desire to find a shallow resource without depleting the community-used hot spring, a second well was sited and drilled in 1983. The siting was based on imagery analysis, available temperature gradient logs, soil mercury profiling, and field mapping.

To date, the well has been drilled to 700 ft and, through a novel completion is able to produce

150 to 200 gpm (artesian) of 85°F water and 400 to 450 gpm (artesian) of 97°F water from the same well. This was accomplished by bringing the second casing back to the surface and cementing it only about 50 ft up from the shoe. This allows an artesian zone to be produced through the annular space between the second string and the hole wall (competent basalt) and the first casing string. The second artesian zone is then produced through the second casing. Potentially, this could be done again if another production zone is reached. The water quality from the two zones is excellent and the water will be used for irrigation (85°F zone) and aquaculture (97°F zone). The earlier thermal well (116°F) is presently being used for space heating.

The heating load at the Fort Bidwell Indian Reservation consists of three load centers. Nearest the well (approximately 500 ft) are five apartment units, an adjoining medical clinic and adjacent staff house; all heated with electric resistance equipment. About 1000 ft from the well is the tribal community center, with a propane central fired unit. About 1500 ft from the well is a new gymnasium with electric resistance unit heaters. All domestic water heating is by electric resistance heaters.

The objective of the engineering design effort was to displace current heating sources with the minimum possible fluid flow from the well so as not to adversely affect thermal spring flows and to preserve system expansion options. The system design was based, therefore, on the use of package heat pump units in each of the load centers with 115°F geothermal fluid brought to the units off a 4-inch uninsulated PVC main. Freon coils were inserted into existing equipment in the apartments, staff house, clinic, and community center, while new unit heaters with freon coils were installed in the gym. Fluid flow requirements for the entire system are provided by a 30 gpm artesian flow from the well. In each of the load centers, plumbing was provided for using the clean geothermal fluid directly in the domestic hot water systems, pending final EPA approval for such use. A 5 hp centrifugal booster pump and a 200 gallon insulated storage capacity is provided in the pump house for when the domestic hot water system can be used.

The heating system became operational on December 22, 1983. When fully utilized the system will displace about 300,000 kwh annually. The total cost of the system was approximately $140,000.

ACKNOWLEDGEMENTS

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REFERENCE

Juncal, R.W., Gertsch, W.D., and Johnson, K.R., 1982, WEN-1: First successful well in the Wendel-Amedee KGRA: Geothermal Resources Council, Transactions, v. 6, p. 281-284.