GEOTHERMAL DIRECT HEAT UTILIZATION ASSISTANCE

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KEY WORDS

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PROJECT BACKGROUND AND STATUS

The Geo-Heat Center located at the Oregon Institute of Technology (OIT) conducts research and provides assistance to users to stimulate utilization of the large direct-heat resource base in the United States. These users are typically small businesses, various types of local industries, communities and individuals. They rarely have the technical expertise to determine the feasibility of a proposed application or to solve problems related to the operation of a geothermal heating system. Additionally, consultants for such systems often also require technical assistance. Technical information on project designs, technology advances and new products are made available through a dedicated library and quarterly Bulletin. A handbook, Geothermal Direct Use Engineering and Design Guidebook, has been developed by Center staff and others to aid developers and engineers in the design of geothermal projects.

Geothermal direct heat utilization assistance started in 1990; however, the technical assistance program was initiated in 1979. This program is a continuing effort to provide assistance to developers of low-temperature geothermal resources. Since 1990, the thermal capacity of direct heat projects increased by 678 MWt representing an annual energy utilization of 2,747 TJ/yr, including heat pumps (Lienau, 1994). This growth is the result of 18 direct heat projects in five states and the equivalent of 72,700 3-ton geothermal heat pumps. The Geo-Heat Center provided technical assistance to 14 of the 18 projects and to 78 commercial geothermal heat pump projects.

PROJECT OBJECTIVES

The objectives of this project are to conduct direct-heat applied research and development and to provide assistance to stimulate utilization of the nation's large low-to moderate-temperature (<90° to 150°C) geothermal resource base.

Technical Objectives

- Provide technical assistance to developers of geothermal direct use projects for space heating, geothermal heat pumps, greenhouses, aquaculture and industrial applications.

Technical Objectives (continued)

- Perform appropriate R&D to reduce the cost of installing and operating direct use projects.
- Publish information and educational materials and maintain a library to aid researchers and developers of geothermal direct use projects.

The success of this project will mean more rapid penetration of geothermal direct use into the energy sector.

Expected Outcomes

- Energy savings and reduced emissions of airborne pollutants and greenhouse gases due to more geothermal direct-heat projects on-line. For example, a 457 m, 82°C geothermal well producing 3 MWt (500 gpm) saves 28 TJ/yr of energy and reduces SO_2 by 0.1 kg, NOx by 0.6 kg and CO_2 by 687 kg per hour compared to a natural gas boiler plant.
- Determine the cost of geothermal supplied heat in a similar fashion to that used for conventionally fueled sources. For the example above, the geothermal unit cost is $1.86/10^6$ Btu and for natural gas $6.14/10^6$ Btu with a simple payback of 1.2 years.
- Transferring the lessons learned in the Klamath Falls marketing program to some of the other district heating systems which have not achieved similar levels of customer saturation.
- Increased awareness of geothermal direct-heat developments and opportunities by publication of Bulletins on geothermal projects, technical papers, software, tours, and other educational materials.

APPROACH

The Geo-Heat Center's approach is to provide technical assistance to prospective geothermal users on resource data, preliminary engineering design, analysis of operational problems and technical information. The program is designed to introduce the potential user and engineering consultant to geothermal direct-heat applications. The presence of a proven and reliable source of technical advice to the consultant is critical in promoting their initial involvement with an unfamiliar resource. The Oregon Institute of Technology provides a cost share of 14.3% on the project. Further, the Geo-Heat Center publishes educational materials to aid engineers in the design of direct use projects.

RESEARCH RESULTS

Technical Assistance Program

The Geo-Heat Center provides assistance to those actively involved in geothermal development. Geothermal projects are allocated a limited number of man-hours for analysis (usually eight hours/project unless prior approval for additional hours are received from DOE). Engineering and economic assistance has been provided to a broad range of clients, from homeowners interested in geothermal space heating and municipalities engaged in geothermal district heating projects, to industrial concerns adapting geothermal resources to meet process energy needs. During FY 1995, the program handled 326 requests for technical and development assistance on geothermal direct use projects and for various types of technical information.

The program's R&D accomplishments included: (1) developing a spreadsheet for the cost evaluation of geothermal supplied heat in a similar fashion to that used for conventionally fueled sources, and (2) marketing program for cities with geothermal district heating systems.

Geothermal Cost Evaluation

In order to be seriously considered as an alternative in any project, an energy source must be easily characterized in terms of cost, both capital and unit energy cost. Historically, this has been a difficult hurdle for geothermal energy. Its costs vary with the depth and character of the resource, number of production and injection wells, and a host of other parameters. As a result, even in cases where developers are interested in using geothermal, identifying its costs has been a cumbersome process. To address this problem, a spreadsheet has been developed which allows potential users to quickly evaluate the capital cost and unit energy cost of accessing a geothermal resource (Rafferty, 1995).

Using resource, financing and operating inputs, the spreadsheet calculates the capital cost for production well(s), well pump(s), well head equipment, injection well(s), and connecting pipelines. These capital costs are used along with the quantity of annual energy to be supplied and financing information to produce a unit cost of energy. Unit costs for operation (maintenance and electricity) are added to arrive at a total unit cost in $ per million Btu for geothermal heat. To put this value into perspective, similar costs for an equivalent sized gas boiler plant are also calculated. These values can then be compared to determine the relative economic merit of geothermal for any specific set of circumstances. This information is particularly useful at the conceptual stage of a project when decisions as to fuel source are typically made by the developers.

Consider a local economic development agency in an area of known geothermal resources as a general example of the use of the spreadsheet. The economic development agency may wish to determine the relative economic merit of geothermal use for a new industrial development as a function of required well depth. Output from the spreadsheet can be used to develop the curve illustrated in Figure 1. This graph assumed a 3 MWt load at two different load factors: 20% representing greenhouse or multi-building district heating, and 30% representing an industrial process load. Even for this relatively small load, conditions are favorable (simple payback less than 5 years) for geothermal for all applications up to a well depth of 762 m without injection and for higher load factor (30%) with injection. For lower load factor (20%) applications, a well depth of up to 425 m with injection provides simple payback for less than 5 years.

Marketing Geothermal District Heating Systems

In the early 1980s, several geothermal district heating systems were installed with DOE sponsorship. Several of these were installed in small towns (Klamath Falls, OR; Susanville, CA; Pagosa Springs, CO; and Elko, NV) which lacked the infrastructure to market the energy. For a variety of reasons, a large portion of the capacity of these systems remains unsubscribed (Rafferty, 1994).

As a result of this situation, a marketing strategy for the systems was developed. The strategy is designed to address the following issues:

- Rates,
- Customer retrofit costs,
- Financing,
- System reliability, and
- Manpower requirements.

One of the issues with which the strategy had to deal with competition with low natural gas rates. When the geothermal systems were first installed, the plan was to equip each customer with an energy meter with the billing based upon geothermal at a percentage of natural gas. The savings for the customer resulted from two considerations: (1) the cost difference between natural gas and geothermal, and (2) the efficiency losses in the gas furnace. The new strategy eliminates the use of energy meters in favor of a flat-rate billing approach. The flat rate is based upon historic fuel bills for the building. This data is weather normalized using a computer spreadsheet developed especially for this purpose. The flat rate is simple, it is negotiable (usually about 50% of the gas bill), reduces cost (no energy meter) and can be a guaranteed value for a period of the contract.

To reduce retrofit costs, the new marketing plan eliminates the requirement for a customer heat exchanger. New customers are connected directly into the distribution loop water used as the building heating medium. For a customer with a 235 kW load, the elimination of the heat exchanger and associated components would reduce retrofit costs by 25%.

Some of the states operate tax credit and loan programs for renewable energy projects. For example, Oregon offers two programs which have been used in the marketing plan. The program offers business a 35% tax credit on costs associated with connecting to the geothermal district heating system and the Small Energy Loan Program.

Issues on the reliability of the geothermal district heating system operation were discussed at public meetings and with potential customers. This approach has generally proven to be an effective strategy.

Finally, most of the municipalities lack the manpower to do an effective marketing of the systems. The Geo-Heat Center has provided initial retrofit estimates and developed a life-cycle cost analysis for customer evaluation along with the fuel use weather normalization. Municipal engineering departments have been provided directions on how to evaluate buildings for inclusion in the district heating system. For example, the City of Susanville has decided to use this marketing approach and assistance has been provided to Boise on evaluating buildings.

FUTURE PLANS

The Geo-Heat Center will continue to act as a clearinghouse to provide project technical assistance and information on geothermal direct use projects.

R&D activities for FY-96 will include economics of moderate density geothermal district heating systems, strategies for greenhouses and continuation of the geothermal district heating marketing strategy.

The Bulletin will be distributed quarterly, new software will be developed that will enhance the ability of design engineers on geothermal direct use projects, and information about geothermal projects and other related developments will be gathered and distributed.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

The following is the number of requests for geothermal direct heat technical assistance during Fiscal Year 1995 from individuals, companies and municipalities:

Type of Interest	Number of Requests
Space and District Heating	45
Geothermal Heat Pumps	78
Greenhouses	19
Aquaculture	17
Industrial	6
Resource/well	63
Equipment	40
Other	58
Total	326

Technology transfer activities included: publication of the GHC Quarterly Bulletin (v.16, n.1-4), which includes technical articles and a geothermal progress section. A Geothermal Library of

5,164 volumes was computerized with the same software as used by the Geothermal Resources Council to enable compatibility through the GRC's on-line access system. A total of 1,091 publications were requested during the fiscal year, 15 technical papers were prepared, 15 presentations were given at conferences, 7 tours of local geothermal facilities were conducted, and 13 geothermal progress monitor reports were prepared.

REFERENCES

Lienau, P., J. Lund, K. Rafferty and G. Culver, 1994. Reference Book on Geothermal Direct Use: Prepared for USDOE Geothermal Division, Geo-Heat Center, P. 52.

Rafferty, K., 1995. A spreadsheet for Geothermal Direct Use Cost Evaluation: Prepared for USDOE Geothermal Division, Geo-Heat Center, p. 27.

Rafferty, K., 1994. Marketing the Klamath Falls Geothermal District Heating System: 85th Annual Conference for the IDHCA.

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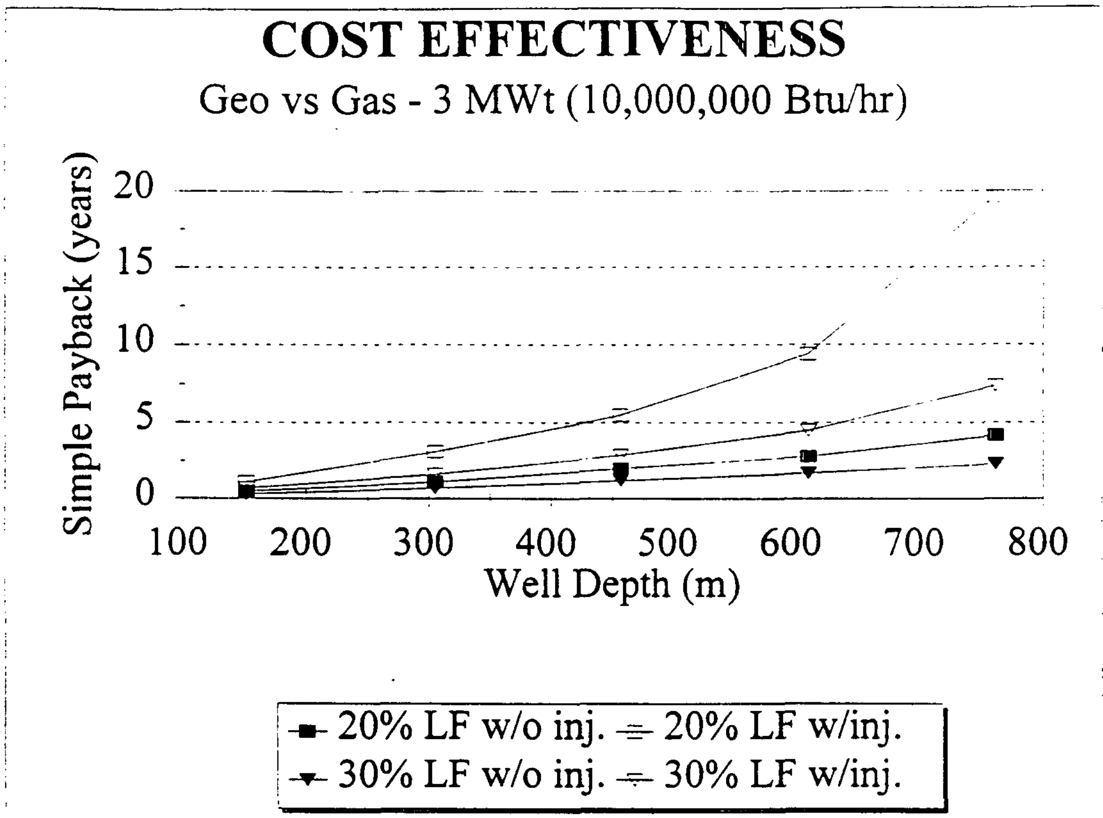

Figure 1. Cost effectiveness of a 3-MWt geothermal system vs. a gas-fired boiler plant.