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THE SIZE EFFECT FOR DISTRICT SPACE HEATING IN BOISE, IDAHO

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ABSTRACT

Heating portions of the city of Boise with geothermal water seems attractive, because the 170°F resource was confirmed with drilling in the summer of 1976 to be within 1-1/2 miles of the downtown business district. However, the capital cost of installing pipelines to transport the hot water under the city streets is so large a capital investment that nearly full-capacity utilization is necessary to recover the investment. Furthermore, enhancing the annual utilization factor on the pipelines to the maximum is necessary in the moderate temperature climate. A doubling of the utilization factor is possible by using fossil fuel to peak the system on the few cold days. The geothermal system so that fossil must peak for about 6% of the heating needs during the season appears to give the optimum return on investment.

The further confirmation of a 170°F geothermal resource within 1-1/2 miles of the downtown business district of Boise has spurred hopes that a major district heating system could be established using geothermal energy. One suggestion was to approach the project in small increments, gradually, over many years, eventually having a significant portion of the city on geothermal heat. The State of Idaho appeared to be an obvious candidate for first such use, in 10 of its office buildings, with a design basis heat load of 50,000,000 Btu/hr. The total annual heat usage of these is 90 x 10^6 Btu, for a present day natural gas fuel bill of $300,000/year.

During the summer of 1976, two test wells were drilled in an attempt to confirm if an adequate resource could be found. Both wells proved successful, tapping a 170°F resource at about the 900 ft depth. The wells are 1,000 ft apart on the surface, are presently fully cased and are now being tested. Preliminary indications are that the two wells, when pumped, should deliver a combined total of at least 1500 gallons/minute. Since the wellhead temperature has been measured at 165°F, the inlet temperature to the heat exchanger should be about 160°F, and the discharge 120°F. With \( p = 61 \text{ lb/ft}^3 \) and \( 8.2 \text{ lb/gal} \), the required flow rate is 2550 gallons/minute.

The estimated capital cost for supplying this water to the buildings, disposing of the cooled water by reinjection wells, and making the necessary additions of pipes and heat exchangers to the various buildings is approximately $3,000,000, as summarized in Table I.

About 13% of the above costs are in the building heating and ventilating system modifications. But nearly 60% of the capital investment is in the pipelines to carry the fluid to the buildings and away from them to the disposal wells. Alternative methods of disposal have been proposed, such as seepage pits or discharge directly into the Boise River after being cooled in spray ponds. These methods may eventually prove acceptable since the water meets drinking tolerance except for fluorine, which is several times recommended tolerances. Either of these alternative schemes may save $100,000 to $200,000, but the major discharge cost would be in the pipelines to these discharge areas.

Yet another consideration should be presented for lowering the unit capital costs. The base utilization factor of a heating system in Boise is low. With only 5800 degree-F days per year of heating, the annual utilization factor is only 21%, when designed to the -10°F nominal low winter temperature. It is no wonder the geothermal system finds it difficult to compete. Who would dream of operating a capital intensive nuclear power plant, for instance, on only a 21% load factor? On the other hand, utilities routinely use gas turbine peaking units, low capital cost, high fuel cost, at load factors within the 10% range. Is there a way of analogous operation of a geothermal heating system?

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TABLE I

Summary of Capital Costs for 2500 gpm
Geothermal Heating System for Boise

A. PRODUCTION SITE $300,000
Five wells
1000 to 1500 ft deep
Pumps, etc.

B. DISTRIBUTION SYSTEM TO BUILDINGS 850,000
2-1/2 miles, all concrete asbestos, insulated with urethane and buried 6 ft below grade, at $65/ft in streets
plus grade crossings, river crossings

C. DISCHARGE SYSTEM 590,000
5 wells, 1500 ft deep
pumps, controls
Pipelines to wells

D. BUILDING MODIFICATIONS 280,000
Piping and heat exchangers
Engineering services $1,136,000
at 25% plus contingency at 25%

Total cost of 10-building system $3,156,000

The clue can be found in Figure 1, which is a histogram plot of annual temperature frequency distribution in Boise. It is apparent that by designing to -10°F design basis heat load, the system is poorly utilized. Whereas, if the design basis were in the range of 20° to 30°F, the system would be effectively utilized during most of the heating season months. Below the design temperature, the deficiency would be taken up with a fossil heating system. Presently, these systems exist in all the buildings of the test study.

CONCLUSIONS

Fossil peaking is a virtual necessity to make district geothermal heating competitive with conventional fuels in a moderate climate condition in the contiguous 48 states. Furthermore, it makes economic sense to use fossil peaking at low capital cost, in order to get the best utilization factor out of the high capital cost geothermal system. Such considerations do, however, impose a burden of size, making the most attractive systems those that gross over a million dollars in annual revenues, based on today's (1977) competing fossil fuel prices.

The annual energy use of fossil fuel for peaking is generally only 5 to 10% of the current annual use, i.e., a 10 to 20 fold reduction in consumption and air pollution. Of course, such a geothermal system will become even more attractive if (as expected) fossil fuel prices will rise substantially more than the cost of other goods and services in the future.