District Heating & Cooling

Volume 79 Number 3 First Quarter 1994

District Heating and Cooling in the Pacific Rim: A Growth Industry

Featuring

Seattle and Indianapolis Celebrate 100 Years

Improving Efficiencies with Heat Exchanger Applications

San Bernardino Taps Earth's Natural Resources

District Energy Linked to Canadian Infrastructure Plans

and more. . .

San Bernardino Capitalizes on Natural Heat

Kevin Fisher and Brett Bailey, City of San Bernardino, California, Water Department

According to the U.S. Geological Survey, approximately 60 percent of the known and proven geothermal resources in the United States are in California. The largest direct-use geothermal district heating system in the United States is in San Bernardino, California, where it is managed by the City of San Bernardino Municipal Water Department (SBMWD).

Tapping Geothermal History

The City of San Bernardino lies above several faults which form an artesian water bearing area know as the Bunker Hill Basin. The Bunker Hill Basin falls between the San Andreas fault zone on the northeast and the San Jacinto Fault Zone on the southwest. This area is also crossed by several minor northeast-trending faults. Nearly several hundred reported wells have been drilled into the Bunker Hill Basin, demonstrating elevated water temperatures. The Bunker Hill Basin has been identified as having a geothermal resource temperature ranging from less than 100 degrees F to maximum of 195 degrees F.

San Bernardino has a moderate climate with approximately 2,000 heating degree days. This heating load is characterized by uniformity extending from September through May with minor peaks in December, January and February. Even with this low heating load, the residents of San Bernardino have been enjoying this geothermal resource for at least 100 years. What is now the Inland Center Mall, used to be the Urbita Hot Springs, a place where residents could enjoy relaxing in geothermal water. Steam caves located under the old hotel (now the Campus Crusade for Christ) still exist.

The San Bernardino City Hall uses geothermal district heating.
Courtesy of City of San Bernardino Water Department.

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In 1984, the Board of Water Commissioners for the San Bernardino Municipal Water Department (SBMWD) were faced with the decision of buying a $300,000 boiler for the anaerobic digesters at the San Bernardino Regional Waste Water Treatment Facility. One of the water commissioners, Harold Willis, remembered that a warm-water well existed less than one-half mile from the waste water facility. Drilled by the Meeks and Daley Water Company, the well was being utilized for agricultural purposes only. Commissioner Willis requested the SBMWD staff investigate the feasibility of utilizing the nearby well to heat the digester in lieu of purchasing a new boiler.

SBMWD applied for a grant from the U.S. Department of Energy (DOE) to pay for the feasibility study. The results of the feasibility study led to the construction of the geothermal digester heating project. SBMWD purchased the Meeks and Daley #66 Geothermal Well for $40,000 and installed approximately 2,000 feet of 8-inch diameter pre-insulated pipeline. The cost of the original project was $300,000 paid for by a grant from the California Energy Commission (CEC). The project was successful and economical. With the success of this demonstration project the Board of Water Commissioners directed the SBMWD staff to investigate the feasibility of constructing and operating a large municipal geothermal district heating system.

Nearing a Decade of Operation

In 1985, SBMWD was successful in obtaining a $2.75 million grant/loan from the CEC to develop and construct a munici-

pal geothermal district heating system. The system began construction in 1985 and presently the geothermal heating district serves 37 buildings through a 15-mile distribution system. The distribution system is fed by two 950-foot-deep geothermal production wells that are each capable of producing 5,000 gallons-per-minute of 132 degrees F fluid.

Facilities served by the district heating system include several public and private office buildings, a hotel and large residence facility, a jail and other industrial complexes. Many of these facilities are retrofitted with heat exchangers which allow the geothermal energy to heat both domestic water and the space heating systems. Some of the facilities use the geothermal fluid directly without the use of heat exchangers. Large laundries and other cleaning processes effectively use the geothermal fluid (water) and the water's heat directly.

The geothermal heating district distribution system utilizes two forms of piping. The original backbone system was constructed using epoxy-lined, pre-insulated asbestos cement pipe with an asbestos cement casing pipe. The southern extension of the geothermal heating district uses a pre-insulated ductile-iron pipe with a PVC casing pipe. Laws dealing with the use of asbestos cement pipe and its low availability required SBMWD to switch to ductile-iron products.

Marketing Geothermal Energy

A Btu meter is used at each service connection. The current pricing structure sets the cost of the geothermal heat at 75 percent of the cost of delivered natural gas. The delivered price of natural gas includes all taxes and standby/service charges. For customers using the fluid directly, the cost of the fluid is set at half the rate of potable cold water and the heat content of the fluid is set at 75 percent of the price of delivered natural gas. This price has not changed since the system's conception.

Individual and specialized contracts have been signed with customers who use the geothermal fluid efficiently. For purposes of clarification, the most efficient application is an application that totally uses the temperature difference between groundwater temperature (64 degrees F) and the geothermal temperature at the service connection point. These contracts feature long-term pricing, lower geothermal rates and lower direct-use rates. Advantages to SBMWD in these varied cases range from lower pumping costs (less pumping cost per therm of energy sold), offsetting the use of expensive potable water in processes that do not require valuable potable water, and new businesses that in turn bring jobs into the area and also expand the City of San Bernardino's tax base.

A typical geothermal plate-and-frame heat exchanger in a San Bernardino building.
Courtesy of City of San Bernardino Water Department.

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There are several reasons beyond the aggressive pricing of the geothermal fluid that would cause a customer to utilize the hot water resource. The City of San Bernardino is blessed with high-quality geothermal fluid. Being only one grain in hardness, (17 parts per million) as $CaCO_3$, and nearly meeting all of the potable maximum contaminate levels (MCL) for domestic drinking water, the geothermal fluid can be disposed of on the surface without costly treatment or re-injection into the geothermal aquifer. The high-quality water is environmentally acceptable and therefore attractive to potential customers with problems meeting local discharge and sewer pretreatment guidelines.

For example, the geothermal fluid can be utilized in laundry processes without the need of softening or heating. On the surface these savings do not seem excessive. However, AHSL, an industrial laundry that was connected a year ago and uses approximately 9 million gallons per month of geothermal fluid, considers this to be a substantial savings. Now that the brine from the softening process no longer needs to be hauled away, the laundry experiences a savings of $50,000 per year. The total savings reported by the laundry through geothermal energy was $354,000 for the first year of system operation. Through the use of geothermal energy the laundry also meets air-quality guidelines, since a second boiler is no longer required.

SBMWD also works very closely with the City of San Bernardino Economic Development Department (EDD). For example, EDD may have a client that is considering moving to the City of San Bernardino. If the customer has a need for low-temperature water within a particular process, SBMWD staff are requested to evaluate the potential facility for the consumption of geothermal energy. The clients are also given an informational brochure and video that further explains many of the geothermal concepts and pricing structures necessary to fully understand the potential savings available to potential geothermal customers.

Special funding has been utilized in several of the geothermal retrofits. Community Block Development Grants have been utilized for a portion of the infrastructure required to serve some of the community buildings and swimming pools. Low-interest loans from the CEC, managed by SBMWD, have been granted on a few occasions. Free or low-cost service connections have been offered to attract potentially efficient/large geothermal customers.

Developing a Safe Growth Strategy

The staff of the San Bernardino Municipal Water Department make every reasonable effort to ensure that the current customers are satisfied with the geothermal savings as well as the performance of the heating district. SBMWD has 24-hour on-

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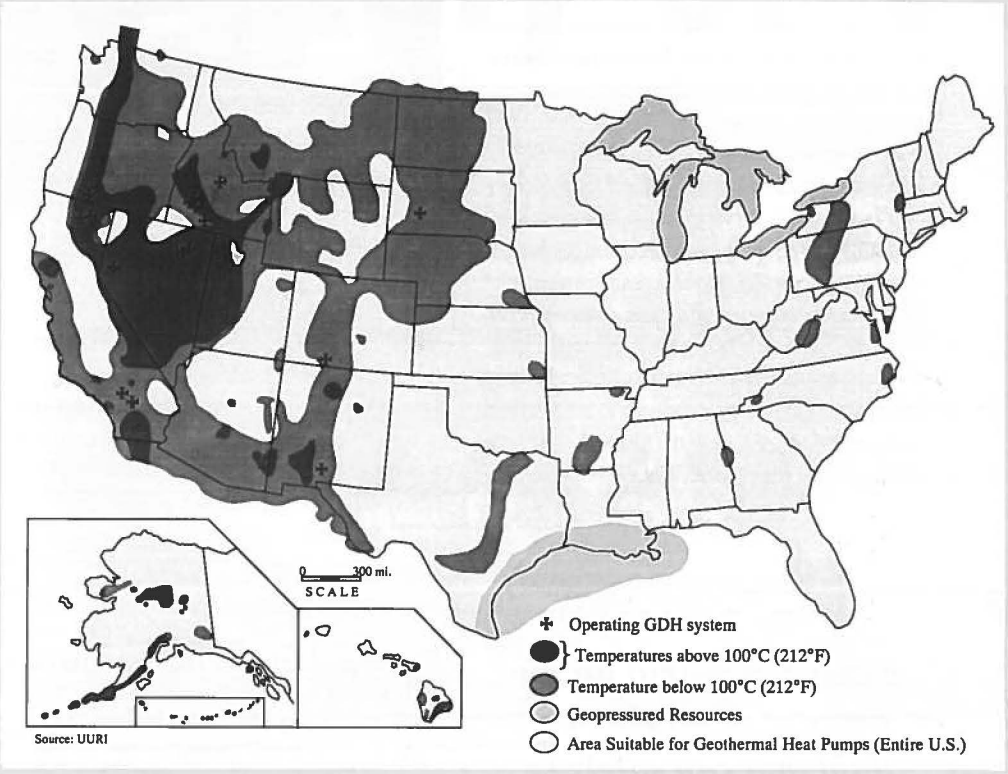
Geothermal Program has Western Focus

Kevin Rafferty, Research Associate, Geo-Heat Center at Oregon Institute of Technology



Geothermal resources in the United States exist primarily in the western half of the country.
Courtesy of University of Utah Research Institute (UURI).

Geothermal resources exist due to the generation of heat deep within the earth. In other words, geothermal energy is the earth's internal heat. The temperature within the earth increases with increasing depth, with molten rock at temperatures between 1300 degrees F and 2200 degrees F thought to exist 60 miles beneath the earth's surface. Under normal conditions, this heat arrives near or at the surface of the earth in a low-temperature, diffuse state. Certain geologic conditions such as faults, however, can result in a higher concentration of heat giving rise to the presence of hot water or steam.

Geothermal energy is currently consumed using two processes—electric power generation (indirect use) and direct use. Geothermal energy can be converted into electricity through the use of a generator or other mechanical devices. The process of direct use involves the moving of geothermal energy from its source in the form of steam or hot water through pipelines to another location where the heat and/or fluid is then consumed directly.

All of the 20 or so district heating systems currently operating in the western United States (see figure) take advantage of this hot water resource. As indicated by the figure, the extent of geothermal resources suggests a great potential for further development. One of the principal barriers to development has been a lack of adequate information about the location and quality of geothermal resources. To address this problem, the U.S. Department of Energy has embarked on a project to gather all available information on geothermal resources into a single database.

The project entitled "Low-Temperature Resources Assessment" is scheduled for completion in June 1994. Prime contractors, under the direction of Marshall Reed at U.S. DOE, are the Oregon Institute of Technology Geo-Heat Center, University of Utah Research Institute and the Idaho Water Resources Research Institute. Results of the work will include a database and map for each of the 10 western states that will enable developers to locate and evaluate all known geothermal resources in the region. Initial results are promising. The current inventory includes over 10,000 resource entries — more than twice as many as the last inventory completed in 1983. The information should assist in promoting more active development of this under utilized resource.

The U.S. DOE contributes further to stimulation of geothermal district heating as well as other applications, through a grant for geothermal services with the Geo-Heat Center. Under the program, the Center provides information, technical assistance and research for geothermal developers and the general public. Individuals and organizations within the district heating and cooling industry are welcome to take advantage of these services.

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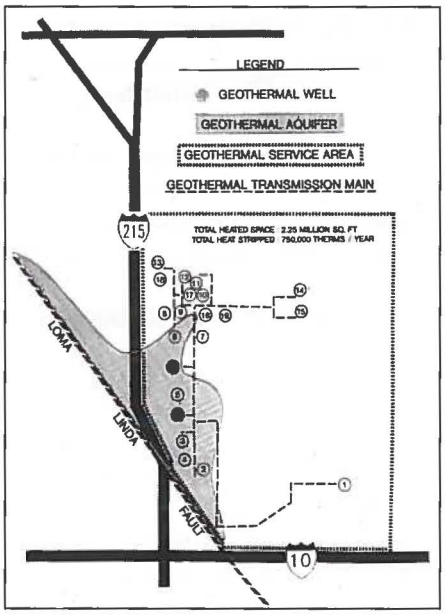

The geothermal district heating system in San Bernardino, California, taps the Bunker Hill Basin that borders the Loma Linda Fault.
Courtesy of City of San Bernardino Water Department.

Keyed Index of Geothermal Users

1. Automated Health System Laundry*
2. Regional Water Reclamation Facility
3. Blood Bank of Riverside & San Bernardino Counties
4. City of San Bernardino Animal Shelter*
5. National Orange Show Fairgrounds
6. San Bernardino City Hall Annex
7. San Bernardino County Retirement Board
8. Radisson Hotel & Convention Center
9. San Bernardino City Hall
10. California Department of Transportation
11. San Bernardino County Superblock
12. San Bernardino Sun Newspaper
13. Feldheym Library
14. Center for Individuals with Disabilities
15. San Bernardino County Sheriff's Complex
16. State of California General Services Building
17. California State Court of Appeals
18. St. Bernardine's Retirement Center
19. Baker's Restaurant

* = *indicates direct user*

San Bernardino Capitalizes on Natural Heat

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call geothermal technicians who have been trained to assist each customer with questions or mechanical problems. Customers have called, written letters, and on one occasion, shown up at a Water Board meeting for the sole purpose of thanking the managers for such well-trained and amiable employees. SBMWD doesn't draw the line at the service connection and tell the customers that is were the service stops. The geothermal staff members are prepared and equipped to go into the buildings and assist customers in replacing pumps, adjusting controls, fixing leaks, and educating their customers on their particular geothermal retrofitted systems. It is department policy to visit each customer that they haven't heard from for a while just to make sure that all is well.

. . . the Bunker Hill Basin has a limit on the amount of geothermal fluid that can safely be drawn without suffering temperature degradation.

The future growth of the San Bernardino Municipal Geothermal District Heating System is dependent on two items. First, the Water Department has an Environmental Protection Agency (EPA) permit to dump a maximum of 4 million gallons of geothermal water per day. This will ultimately place a ceiling on the size of the district. SBMWD has been marketing and recruiting facilities that can utilize low temperature cascaded geothermal fluid from its existing customers. Car washes and agriculture and aqua culture, such as rose growing and fish farming, are examples of the types of business that can utilize this low-grade heat.

Second, the geothermal aquifer must be responsibly produced. As with all resources, the Bunker Hill Basin has a limit on the amount of geothermal fluid that can safely be drawn without suffering temperature degradation. This limit is as yet unknown. However, current geological data suggests that the heating district could be nearing the safe production ceiling. SBMWD has applied for a grant from the CEC to further investigate and model the geothermal aquifer. The future growth of the district heating system will greatly depend on the results of this aquifer study. Current production tests have led SBMWD staff to believe that the aquifer can safely produce another 20 to 30 percent without suffering any temperature degradation within the aquifer. The staff is making an effort to improve customer efficiency in obtaining the highest temperature strip possible and is selecting only efficient uses for future growth.

The geothermal transmission main is PVC-covered, pre-insulated ductile iron.
Courtesy of City of San Bernardino Water Department.

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