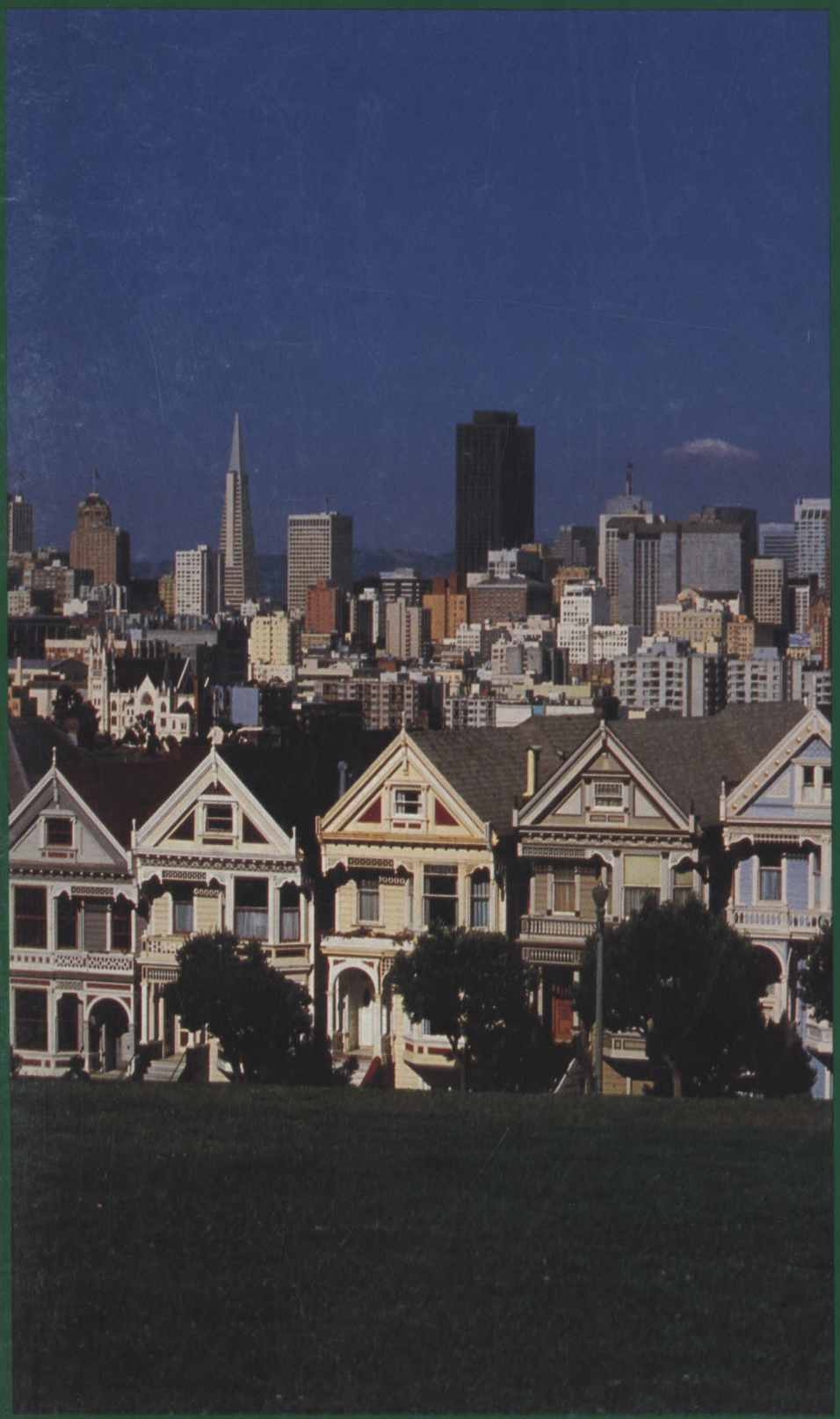
District Heating & Cooling

Volume 76 Number 3 First Quarter 1991



Northern California: District Heating and Cooling Growth Strong

Featuring

DHC has Strong Holds

Ninety-nine percent of the steam customers in downtown San Francisco are commercial operations.

Courtesy of San Francisco Convention & Visitors Bureau
photo by Craig Buchanan.

S T O R Y

in Northern California

Editor's Note: The 82nd Annual Conference of the International District Heating and Cooling Association will be held in San Francisco this June. Part of the conference will include tours of some of the area's flagship energy systems. This article offers the history of and insight into some of the district heating and cooling systems currently operating in Northern California.

The roots of district heating and cooling run deep in Northern California. Even in San Francisco, where summer's heat never gets too hot and winter's chills are seldom too cold, the desire to maintain a more consistent indoor temperature while addressing environmental issues has helped forge the popularity of district energy in this part of America's west coast.

From the system that has served San Francisco's heating needs since the early 1900s—to Sacramento's system, completed in 1969—to the new cogeneration system just starting to meet San Jose's electrical and hot and chilled water needs, district heating and cooling has a strong past of serving Northern California, headed to an even stronger future.

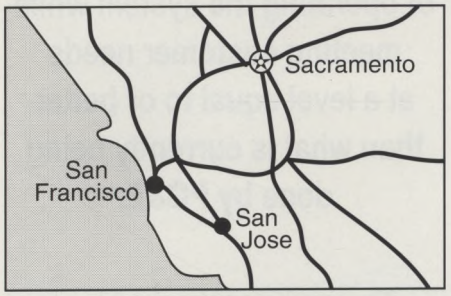
But inasmuch as these northern California cities are similar, they have their differences. In turn, each district heating and cooling system is different—designed to meet the specific needs of each individual city. Here's how northern California has found district heating and cooling (DHC) success.

San Francisco: Planning for DHC's Future

The San Francisco steam heating system has been part of San Francisco's energy picture since the early 1900s. In 1911 when Pacific Gas & Electric Co. (PG&E) entered the district heating business, there were already three electric companies utilizing exhaust heat from electric generation to supply steam to buildings in downtown San Francisco. In 1915, the three steam electric plants were purchased by Great Western Power Company, which in turn was acquired by PG&E in 1930.

Today, the existing system contains two natural gas-fired plants which provide steam to the distribution network. The system serves 205 customers through a network of 11.2 miles of mains that vary in size from 2 to 20 inches. Customers range from small cleaning establishments to large commercial office buildings to luxury hotels. Of the 205 customers served by the system, approximately 99 percent are commercial operations.

The steam for San Francisco's district heating system is produced at 125 pounds per square inch gauge (psig) and is distributed through 11.2 miles of mains, of which 1.8 miles are reduced to 10 psig.



District energy systems may be found in San Francisco, Sacramento and San Jose, California.

One of the two plants is baseloaded, operating 365 days per year; the smaller plant is used for peaking in the winter and for emergencies. The net output from both plants is approximately 385,000 pounds per hour. The peak sendout to the system occurred in the winter of 1974 when 330,000 pounds per hour was recorded. The most recent peak was 280,000 in the winter of 1988.

San Francisco: Between 1984 and 1989, many improvements were made which increased the operating efficiency, dependability and safety of the system. These improvements provided an increase in operating efficiency of over 10 percent.

In 1984, a separate department was formed to manage the district heating business. Previously, district steam operations had been handled by several different departments within PG&E. The new management was to focus on improving the operations and make recommendations for the future of the business.

Between 1984 and 1989, many improvements were made which increased the operating efficiency, dependability and safety of the system. These improvements provided an increase in operating efficiency of over 10 percent, an elimination of unscheduled outages (with the exception of the 1989 earthquake, detailed in a previous issue of District Heating and Cooling magazine) and an improved safety record.

The determining factors in selecting a buyer were not only price, but in having someone who was capable of operating the system while meeting customer needs at a level equal to or better than what is currently being done by PG&E. After all, these steam customers will continue to be PG&E electric customers. The intent is to have the transition to the new owner be undetectable to customers.

While the decision not to include district heating as part of PG&E's business has been made, it should be noted that it is still a valued energy option and as such, is a good business match for companies specializing in this area. The change of system ownership is expected to pave the way for even better steam district heating service for the City by the Bay in the coming years.

The Ritz Carlton is one of the newest customers to join San Francisco's steam system.

Courtesy of PG&E

Having made the improvements to the system, it was deemed necessary to apply to the California Public Utilities Commission for a general rate case to allow the system to earn a fully authorized rate of return. The previous rate case was completed ten years earlier.

The change to a central focused management structure also stopped the decrease in sales and customers and permitted a sales growth of over 36 percent between 1984 and 1989. Estimates for future sales show an additional increase of over 16 percent for the next three years.

During the course of system improvements, inquiries regarding the possible sale of the system were received. After extensive analysis and study, it was finally determined that PG&E's long-range plan would best be served by focusing on its core gas and electric business. The district heating portion of the overall business was less than one-tenth of one percent and took a disproportionate share of management time. To better serve the interests of the company and its customers, a decision was made to sell the steam district heating system.

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That transition is already taking place. The final Purchase and Sale Agreement between PG&E and Thermal Ventures is expected to be completed by mid-1991, with the necessary approvals taking an additional six to nine months. Meetings and other communications with customers have already been completed with no adverse reactions.

Sacramento: Energy Conservation Brings Added Savings

The central heating and cooling system for the State of California Central Plant Operations in Sacramento, designed by M. A. Nishkian & Company, was completed in 1969 to eliminate the need for individual chiller and boiler plants in 14 existing buildings and two new buildings, Twin Towers Office Buildings 8 and 9. The project consisted of building the central plant, utilizing the Raney method well and excavating 1-1/8 miles of underground tunneling.

The construction lasted approximately 2-1/2 years at a cost of $10.5 million. The original plant measured 160 feet x 140 feet and provided both steam and chilled water. Approximately 10,000 tons of cooling was supplied to meet the needs of 4.2 million gross square feet of office space. Since then, the addition of four new buildings has brought the total to 20 buildings and 5 million square feet.

In spite of a 20 percent increase of square footage baseload, energy conservation efforts in the central plant system (the central plant and 20 buildings) be-

tween 1972 and 1984 have resulted in natural gas energy savings of $17,696,206. This was a reduction of 62.2 percent. Electrical energy use in the system has been reduced 25.2 percent (38,339,795 accumulated kilowatt hours [kWh]), with a savings of $4,875,613 offset from the buildings and the central plant.

Sacramento: In spite of a 20 percent increase of square footage baseload, energy conservation efforts in the central plant system between 1972 and 1984 have resulted in natural gas energy savings of $17,696,206. This was a reduction of 62.2 percent.

In the past, energy use at the central plant had been reduced as much as 33.6 percent below the 1972 baseload. Present electrical use at the central plant, however, has increased 5.7 percent above the 1972 level. This is due to the 20 percent increase in square footage baseload and the additions of a 1,450-ton electric chiller and 2,400 gallon-per-minute deep well. The total system electrical usage now stands at 25.2 percent below the 1972 level.

Control Room

The central plant control room contains two energy management systems (EMS) and an independent manually operated console panel. The console system was installed in 1975 to facilitate the operation and control of energy use In the buildings connected to the central plant system. This system allows for manual operation of each building's fan system by use of the individual buildings' step controllers.

Two of the State buildings and the restored west wing of the State Capitol Building are operated by a Johnson EMS computer with the remaining buildings operated by a Honeywell EMS computer. Each computer features optimized start/stop capability which senses outside air and building zone temperatures in order to program the operation of the building's air-handling fans to meet the heating and cooling needs of the building efficiently. Another feature of each of the EMS computers is the supply air reset which measures interior and perimeter zone temperatures to adjust the hot deck temperatures according to the building's heating needs.

Monitoring by the EMS units consists of the on/off status of approximately 300 air-handling fans; supply air, return air, and hot and cold deck temperatures; and chilled- water and steam flow to the buildings. The Honeywell unit also monitors the absorption cooling systems, thermal storage ice machine and solar collector systems located in the Site 3 building. In addition, the Johnson unit is used by the state police for security system control.

Underground Tunnel System

Sacramento's 1-1/8 mile underground tunnel consists of the 24-inch chilled-water supply and return lines, 12-inch steam lines, 6-inch low-pressure and 2-inch high-pressure condensate return lines, and 3-inch pneumatic air lines to the 20 buildings connected to the central plant system. The tunnels are 10 feet by 10 feet and are 10 feet under the street at their shallowest point.

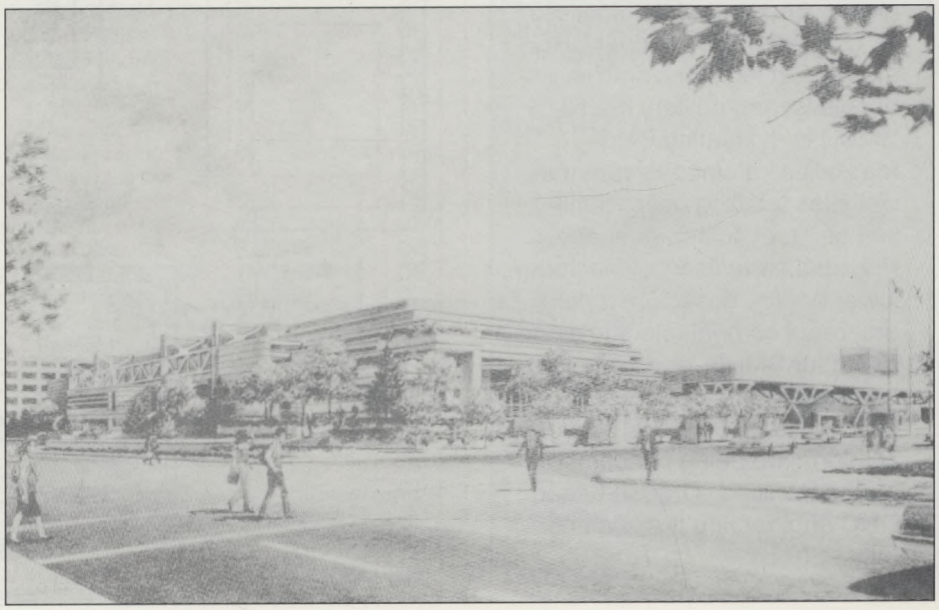
Chillers

The central plant provides 10,050 tons of cooling capacity through the use of five chillers.

1. York—one electric-driven, 1,450-ton, 4,160-volt, 1,252-horsepower (hp) motor, R-500 refrigerant.
   This is the smallest chiller at the plant and is used for low-load conditions.
2. Carrier—three solar gas-turbine-engine-driven, 2,100-ton, R-12 re frigerant. The gas turbine engines can burn natural gas or No. 2 diesel fuel The waste heat from the engines is recovered to create steam in the waste heat boilers.
3. Murray—one steam-turbine-driven, 2,750-ton, R-12 refrigerant.

Boilers

The central plant was designed to use two combustion- engineered vertical field erected boilers sized to produce 60,000



San Francisco's Moscone Convention Center is one of a growing number of convention centers using district energy across the country.

Courtesy of PG&E

pounds of steam per hour each (275 saturated) at continuous operation conditions and 80,000 pounds of steam per hour each. One boiler is continuously operated to meet the buildings' domestic hot-water needs and as back-up to the absorption chiller system located in the Site 3 building.

Waste Heat Boilers

The three Besler waste heat boilers produce 12,650 pounds of steam per hour by reclaiming the waste heat from the gas turbine combustion engines.

Heading into the Future with Fervor

There are future plans for major upgrades in the existing plant such as:

1. A new energy management system to replace the existing systems.
2. Convert gas turbine drives to variable speed electric drives.
3. All new instrumentation.
4. Upgrade the boilers.
5. Convert some large motors to variable speed.
6. Add a 25 megawatt (MW) cogeneration plant.
7. Add a 30,000-ton per day thermal energy storage system (TES).

Although the Sacramento district heating and cooling system has undergone numerous upgrades and changes in the past to remain effective in changing times, the planned upgrades will certainly help carry this city firmly into the future of steam district heating and chilled-water cooling.

The Sacramento Municipal Utility District (SMUD) is presently conducting studies to determine whether it should establish a DHC program as part of its demand-side management efforts. SMUD is the nation's third largest publicly owned utility, serving 50,000 commercial and 400,000 residential customers in one of the country's fastest growing regions. Because of the success of 12 existing institutional DHC systems at local universities, hospitals, and military bases, SMUD is evaluating DHC feasibilities at various commercial sites totalling over 15 million sq. ft. of customer space. Principal benefits would include lower energy costs for customers, reduced peak electric demand for SMUD, and improved environmental conditions for the community. SMUD's investigations are being conducted by the Portland, Oregon-based DHC engineering firm Criterion Inc.

San Jose: Cogeneration Brings New System, New Ideas

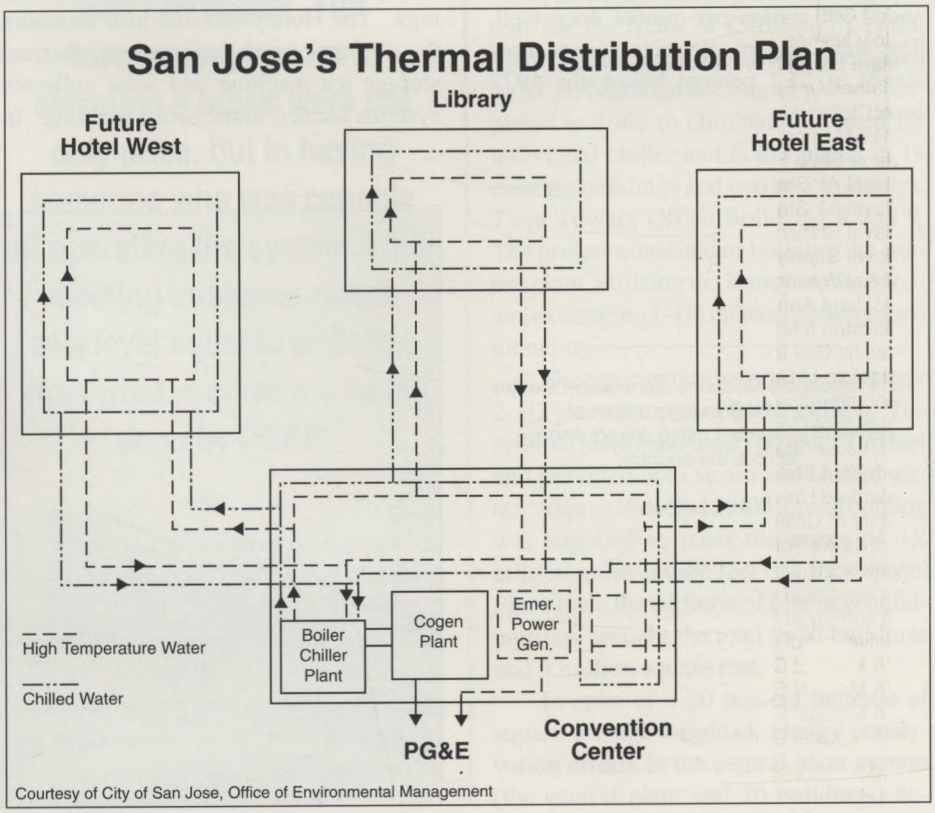
While San Francisco and Sacramento have more established district energy systems, the 1.5 megawatt (MW) cogeneration system serving San Jose's "superblock" is the City's first project in the area of district heating and cooling. The energy-reducing, cost-saving cogeneration system was designed as a marketing tool to attract private contractors to a newly developed entertainment and hospitality section of the city.

The system provides electricity, hot and chilled water to the 1.1 million-square-foot convention center and the 120,000 square-foot main library. The City will also provide hot and chilled water for space heating and cooling, pool heating and domestic hot water needs to a 350-room privately developed hotel currently under construction. Heat exchangers, serving as the point of transfer between the two energy systems, will be installed inside the hotel.

The City has agreed to provide the hotel with thermal energy at a price not to exceed the cost of operating an on-site heating and cooling system. The hotel will also be able to share the benefits of the City's cogeneration bulk gas rate.

Besides the obvious economic benefits, the new cogeneration system will also provide environmental advantages, assisting San Jose in its dedication to become a "sustainable community"—a plan adopted by San Jose's City Council in March 1990. A "sustainable community" is characterized by its ability to address and adjust to the constantly changing issues of safety, equity, jobs, quality of life and affordable housing.

San Jose has already received national recognition as a model sustainable city. The goal of San Jose's sustainable city program is to promote a secure future by conserving 10 percent of the projected energy use in all sectors (commercial/industrial, residential and municipal) by the year 2000 as a way to enhance the livability, economic strength and well-being of the city's residents and businesses.



Courtesy of City of San Jose, Office of Environmental Management

Reducing energy consumption through the use of cogeneration directly benefits the city and its residents by reducing environmental problems—particularly atmospheric emissions that contribute to acid rain and global warming.

The $2.5 million cogeneration system, which uses a natural-gas-fueled, reciprocating engine and topping-cycle cogeneration system—including a 310-ton absorption chiller—is expected to deliver a projected $612,900 annual energy savings. The City expects a payback period of just over four years on its investment.

As part of the cogeneration project, San Jose has a power purchase agreement with PG&E to sell the utility surplus electricity produced by the cogeneration unit during evening hours when it is not used by the main library and convention center. When the hotel comes on line, it will require 24-hour district heating and cooling operations. A utility power agreement (3.5 MW) with PG&E provides the City with full back-up, standby natural gas boilers and conventional electric chillers.

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The City chose cogeneration after successfully completing feasibility studies co-funded by the U.S. Departments of Energy and Housing and Urban Development, the California Energy Commission and Pacific Gas & Electric (PG&E).

Choosing the Correct DHC Path

The various advantages of district heating and cooling are apparent, even when examining the individual functions being utilized by three neighboring, but very different cities. From San Francisco's long-established entrance into district steam, to San Jose's new state-of-the-art cogeneration system, district heating and cooling has found a place, not only in the past, but also in the future of Northern California. As the technology grows in importance in terms of energy efficiency and environmental benefits, so will its popularity in this area and around the world. IDHCA

Greater Bay Area DHC Systems

Courtesy of Criterion Inc.

System Name	City	Type	Status	Installed Capacity Heating	Installed Capacity Cooling
California Medical Facility	Vacaville, CA		OP		
California State Prison, Folsom	Folsom, CA		OP		
California State University, Hayward	Hayward, CA	S & HW	OP		
California State University, Sacramento	Sacramento, CA	S & HW & CW	OP		3,500 Tons
City of Calistoga	Calistoga, CA	HW	DEV	1,980,000 BTU/HR	
Contra Costa Community College District	Martinez, CA	S or HW & CW	OP		
Correctional Training Facility	Soledad, CA		OP		
Deuel Vocational Institution	Tracy, CA	S & HW & CW	OP	150,000 LB-HR	300 Tons
Fort Ord	Monterey, CA	S	OP	56 MMBTU/HR	
Holy Names College	Oakland, CA		OP		
Mare Island Naval Shipyard	Vallejo, CA	S	OP	480.5 MMBTU/HR	
Mather Air Force Base	Sacramento, CA		OP		
McClellan Air Force Base	Sacramento, CA	S	OP		
Mills Memorial Hospital	San Mateo, CA		OP		
Napa State Hospital	Napa, CA	S & CW	OP		
Naval Air Station, Alameda	Alameda, CA	S	OP	606 MMBTU/HR	
Naval Air Station, Moffett Field	Moffett Field, CA	S	OP	68 MMBTU/HR	
Naval Station, Treasure Island	San Francisco, CA	S	OP	30.8 MMBTU/HR	
Naval Supply Center, Oakland	Oakland, CA	S	OP	37.7 MMBTU/HR	
Naval Weapons Station	Concord, CA	S	OP	53.5 MMBTU/HR	
Oakland Army Base	Oakland, CA	S	OP	58 MMBTU/HR	
Oakland International Airport	Oakland, CA	S or CW	OP	20,000 LB-HR	
Pacific Gas and Electric Company	San Francisco, CA	S	OP		
Presidio of San Francisco	San Francisco, CA	S	OP	82 MMBTU/HR	
Sacramento Army Depot	Sacramento, CA	S	OP	62 MMBTU/HR	
San Jose Convention Center, Super Block System	San Jose, CA	HW & CW	DEV		
San Jose State University	San Jose, CA	S & CW	OP	98,000 LB-HR	20,160 Tons
Sonoma State University	Rohnert Park, CA	HW & CW	OP	25 MMBTU/HR	2,400 Tons
Stanford University	Stanford, CA	S & CW	OP	320,000 LB-HR	8,000 Tons
State of California Central Plant Operations	Sacramento, CA	S & CW	OP	120,000 LB-HR	10,050 Tons
Travis Air Force Base	Fairfield, CA		OP		
University of California, Berkeley	Berkeley, CA	S	OP		
University of California, Davis	Davis, CA	S & CW	OP		
University of California, San Francisco	San Francisco, CA	S	OP		
University of California, Santa Cruz	Santa Cruz, CA	S	OP		
VA Medical Center, Martinez	Martinez, CA		OP		
VA Medical Center, Menlo Park	Menlo Park, CA	S	OP	59,500,000 LB/YR	
VA Medical Center, Palo Alto	Palo Alto, CA	S & CW	OP	139,900,000 LB/YR	
VA Medical Center, San Francisco	San Francisco, CA	S	OP	67,700,000 LB/YR	

KEY S - Steam CW - Chilled Water DEV - Under Development HW - Hot Water OP - Operational