NOTICE CONCERNING COPYRIGHT RESTRICTIONS

This document may contain copyrighted materials. These materials have been made available for use in research, teaching, and private study, but may not be used for any commercial purpose. Users may not otherwise copy, reproduce, retransmit, distribute, publish, commercially exploit or otherwise transfer any material.

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specific conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.

Syd Willard

California Energy Commission Sacramento, CA 95825

ABSTRACT

Interest in California in the use of geothermal energy for direct heat applications has increased since 1976, as a result of expanded federal interest and support, and the increasing costs of conventional energy sources. California has abundant geothermal resources which have been primarily investigated for electricity generation potential, but with both industrial and developer interest on the rise, the prospect for increased levels of utilization of lower temperature geothermal resources is looking brighter. As the cost of conventional energy sources continues to escalate, the direct use option will continue to look promising, as an energy source capable of displacing conventional fossil fuels and electricity. However, forecasts for high levels of geothermal direct use must be tempered with resource assessment/confirmation activities and consideration of the economic, environmental, and political climates, before firm commitments are made.

INTRODUCTION

The use of geothermal energy in California for electricity generation is substantial. The Pacific Gas and Electric Company has 663 MW of capacity on-line, and plans to expand that capacity to over 900 MW by the end of 1980. Plans by PG&E, the Northern California Power Association, Sacramento Municipal Utility District, and the California Department of Water Resources call for a total of almost 1,700 MW at The Geysers by 1985. Development elsewhere in the State could add another 600 MW, in the same time period. It comes as no surprise, then, that geothermal energy usually is associated with the generation of electricity in California, since the bulk of the development to date has been oriented toward generation of electricity.

Despite the level of development of the State's geothermal resources for electricity generation, California lags behind other Western States in the use of geothermal energy for direct heat applications. Many reasons for this exist, including, California's mild climate, the remote nature of many of the State's hot water resources, the historical availability of economical fossil fuels and electricity, the reluctance of developers and utilities to invest in an energy source whose economics and long-term productivity are unproven, the lack of recognition and understanding of geothermal direct heat potentials, and the strong influence of the environmental preservationists. California geothermal direct heat utilization actually suffers as a result of the availability of other energy sources: solar, wind, biomass, and conventional energy sources such as oil, natural gas, and hydro-power. Before 1976, direct use of geothermal resources in California was the result of individual initiative--channeling hot water from a spring or artesian well to heat a pool or a house, provide year-round watering for stock, and to provide heat for several small greenhouse operations.

With the advent of the Department of Energy's Program Research and Development Announcement for Engineering and Economic Feasibility Studies for Direct Applications of Geothermal Energy, direct heat development began to generate some interest, albeit modest. Several generations of federally funded feasibility studies have now taken place, as well as two rounds of federally funded demonstration projects. It is now time to analyze the impact of direct utilization of geothermal resources in California, and the prognosis for the future.

CALIFORNIA'S GEOTHERMAL RESOURCES

The estimated geothermal potential of California is quite large, with only a small fraction of the potential confirmed by drilling and reservoir analysis. Hundreds of thermal springs and wells are scattered throughout the State, in 34 out of California's 58 counties. The California Division of Mines and Geology, through the Department of Energy's State-Coupled Resource Assessment Program, is cataloguing the various water well, oil, gas, and geothermal records in the State, in an effort to determine subsurface heat measurements, bottom hole temperatures, and anomalously warm water. However, there is not yet a comprehensive or firm estimate of the magnitude of the State's direct heat geothermal resources. Even the USGS Circular 790 essentially apologizes for the lack of resource data available:

"Current knowledge does not allow quantifying the recoverable energy for low temperature waters...The investigations that will eventually quantify and evaluate sources of low-temperature energy have barely begun in most of the promising areas of the country, and data currently available from these studies do not afford a basis for quantitive evaluation. This assessment...relies almost entirely on recent compilations of data by numerous individuals and agencies, [and] the assessment is not necessarily consistent in its approach. It is most certainly not complete".¹

It is no wonder that direct heat uses in the State are not widespread. It will take more wells and experience with long-term productivity before sufficient understanding and confidence is developed by the potential users. (Solar energy enthusiasts, on the other hand, do not have the same fears about nor the requirement to prove the long term productivity of their resource).

CALIFORNIA'S ENERGY PICTURE

The California Energy Commission projects that the annual growth in electricity demand will not exceed two percent per year (California Energy Commission, 1979). Inherent in this demand projection is increased reliance on conservation, efficiency improvements, and accelerated uses of indigenous resources such as solar, geothermal, wind and biomass energy, and cogeneration. Although continued use of conventional fuel sources is expected to be central to California's energy picture through the year 2000, the staff projects that the use of alternative resources should be dramatically accelerated. This definitely includes the use of geothermal energy for space heating and cooling of residential and commercial buildings, process heat requirements for industry, and agricultural applications. The Energy Commission's 1979 Biennial Report made demand projections for the various market sectors using a traditional conventional outlook, and a scenario based on increased uses of alternative resources (see Table 1).

A market survey performed for the Energy Commission by Science Applications, Inc. (SAI) estimated that 56 trillion Btu's of 1980 energy demand could be displaced by using geothermal resources for industrial and commercial applications (market potential). SAI (Larson, 1980) projected that the market penetration for the industrial and commercial sectors in California could be as follows:

Year	Industrial Sector (Trillion Btu's)	Commercial Sector (Trillion Btu's)	
1985	4.0	1.5	
1990	12.0	4.0	
1995	26.0	9.0	
2000	38.0	15.0	

Table 1. ENERGY CONSUMPTION IN 1978 AND 2000

Consumption (Trillion Btu)

	1978	2000	
Sector		Conventional Outlook	Alternative Resources
Residential*	836	995	908
Commercial*	464	609	571
Industrial*	1,067	1,435	1,168
Transportation	2,466	3,125	2,691
Agriculture*	93	102	100
Nonfuel Energy	160	380	380
TOTAL	5,086	6,646	5,818

(California Energy Commission, 1979)

¹USGS Cir. 790, 1978, p.86.

Although these projections are admittedly conservative, there are a number of actions that need to take place to even realize these comparatively modest levels of use:

- Resources must be confirmed and proven capable of long-term productivity.
- (2) Federal and State incentives must be implemented to provide low interest loans for direct heat projects, to provide tax credits and streamlined loan guarantees, and to support exploratory and confirmation drilling in areas likely to undergo development for direct utilization.
- (3) Developer exploratory interest for resources suitable for direct heat applications must be heightened.

DIRECT HEAT DEVELOPMENT IN CALIFORNIA

Until 1976, utilization of geothermal energy for direct heat applications in California was confined to isolated uses of thermal springs and artesian wells for heating individual buildings and pools, a few small greenhouses, and providing year-round ice-free water for stock. In 1976 the federal government embarked on a program to study the engineering and economic feasibility of direct applications of geothermal energy. The first PRDA (Program Research and Development Announcement) resulted in five studies specifically for California sites out of a total of 18 projects and another four studies had particular emphasis or relevance for California (see Table 2). The next generation of federally sponsored feasibility studies in 1977 resulted in only six awards, two which were in California.

Table 2. CALIFORNIA DIRECT HEAT ENGINEERING AND ECONOMIC

FEASIBILITY STUDIES

	Contractor	Location	Application
PRDA-1 (18 total)	Ben Holt Co. International	Mammoth Lakes Village Lake County	district heating agribusiness
	Engineering Co. Geonomics, Inc.	Lake County	agribusiness
	Westec Services, Inc.	El Centro	industrial processing
	City of Desert Hot Springs	Desert Hot Springs	agribusiness, space conditioning
	Aerojet Energy Conversion Co.	Generic Study	geothermal absorption refrig. for food processing industries
	TRW, Inc.	Generic Study focussed on Holly sugar factory in Brawley, CA	use of geothermal heat of sugar refining
	The Futures Group	Generic Study	use of geothermal heat for crop drying
	CLR Consortium	Northern CA & Nevada	<pre>controlled environment livestock . production system</pre>
PRDA -2 (6 total)	Aerojet Energy Conversion Co.	Susanville	district heating and agribusiness
	Westec Service, Inc.	El Centro	space heat & cool;agribusiness
PRDA -3 (11 total)	Westec Services, Inc.	Bishop	tungsten metal processing
(Burns & Roe	El Centro	corn milling

	Table 3. CALIFORNIA DIRECT HEAT DEMONSTRATION PROJECTS			
	Contractor	Location	Application	
PON-1	none			
PON-2	City of El Centro	El Centro	heating and cooling community center	
	Aquafarms International Inc.	Mecca	aquaculture	
	TRW, Inc.	Brawley	sugar beet processing	
	Geothermal Power Co.	Kelley Hot Springs	pork feed lot operation	
	City of Susanville	Susanville	district heating	
Cal.Energy Commission (1978-1979)	Ben Holt Co.	Mammoth Lakes Village	building heating and snow melting	

The federal government next initiated a modest program designed to support demonstration projects ("field experiments") for direct heat. The first PON solicitation (Program Opportunity Notice) in 1977 resulted in selection of eight projects---4 in South Dakota, 1 in Oregon, and one each in Texas and Utah. To some observors, the absence of California projects was conspicuous. The demonstration projects began in 1978, resulting in selection of 15 projects, with 5 in California; 2 each in Idaho, Utah and Nevada; and one each in Oregon, Texas, Montana, and Colorado (see Table 3).

In 1979, DOE requested additional feasibility studies and funded 11 projects, with 2 in California. A fourth generation of PRDAs is currently in the works, and it is hoped that these projects (after 35 previous feasibility analyses, and 22 demonstration projects in various stages of environmental review, resource confirmation, and construction) will focus on the critical question: When will (not can) geothermal resources be able to provide reliable and cost-effective energy for industrial, commercial, agricultural, and residential energy needs?

The federal government's program of feasibility studies and demonstration projects has been of tremendous help in providing a basis for technological and economic projections and comparisons. Federal tax and economic incentives are also resulting in more serious consideration being given to direct uses of geothermal energy. A basic problem remains, though, that despite the <u>techni-</u> <u>cal</u> feasibility of using geothermal direct heat applications, key decisionmakers, corporate planners, and commercial investors are not yet convinced of the reliability of the resource itself, and the price which can be projected per unit of geothermally-provided energy.

The Energy Commission has undertaken an independent approach to the commercialization of direct uses of geothermal energy, while closely coordinating efforts with the federal government and its contractors. In 1976-77 the Commission administered a technical assistance grant from the Economic Development Administration to study the economic use of low temperature geothermal resources in Lassen and Modoc Counties, California. The study identified five direct heat applications with particular promise for the region--greenhouse heating, kiln drying of lumber, onion dehydration, feedlots, and aquaculture. Each of these applications has been the subject of subsequent detailed federal scrutiny and support.

In 1977, the Energy Commission supported a pilot-scale project which provided actual geothermal heating for a hardware store, and snowmelting on an adjacent walkway. The heating system employed a fresh water closed loop system, using pre-existing production and injection wells at the Casa Diablo thermal area near Mammoth Lakes Village. The project resulted in 5 months of system operation, and confirmation of technical feasibility for a scaled-up version of district heating.

The Commission then performed a market survey to establish (estimate) the potential for direct uses of geothermal energy in California. The survey entailed administration of a questionnaire to California businesses and industries to determine their energy requirements and attitudes about direct utilization of geothermal energy. On-site interviews were conducted and valuable contacts were established. Finally, the Commission is following up the results of the market survey by undertaking a case study approach to the development of implementation planning guides for businesses industry. Contracts with the potential energy consumer will be developed, and the State will cooperate in the investigation of using geothermal energy for specific representative businesses and industries. Information gathered during these projects will be used to develop generic guides for the representative market sectors. These guides will be suitable for presentation to corporate policy makers, boards of directors, and energy managers, and will help provide a basis of information upon which to base decisions to use geothermal direct heat applications.

STATUS: BOOM OR BUST?

Even though California has perhaps over half of the Nation's geothermal resources, and ten percent of the Nation's population, the State is not the leader in the utilization of geothermal energy for direct heat applications. Progress is being made, and with the escalating price of oil and gas, and increased emphasis on energy independence, one should be able to expect a greater level of reliance on geothermal direct heat over the next two decades. Several critical issues, however, must be addressed before we break out of our cautious treadmill:

- 1. Confirmation of geothermal resources near regions of energy demand
- Acceptance of geothermal energy by the business community
- 3. Institution of strong Federal and State incentive provisions via low interest loans, tax credits, and government support
- Streamlining of environmental procedures, in order to encourage expanded use of this comparatively low-impact energy source
- Development of strong Federal, State, and local policies encouraging direct utilization of geothermal energy

REFERENCES

- California Energy Commission, 1979, Biennial report: Sacramento, California, 67 p.
- Larson, Tod C., 1980, Market survey for direct utilization of geothermal energy in California, draft final report: California Energy Commission, 57 p.
- Sammel, E.A., 1978, Occurrence of low-temperature geothermal waters in the United States, in Muffler, L.J.P., ed., Assessment of geothermal resources of the United States - 1978: USGS Cir. 790, p.86-131.
- U.S. Department of Energy, 1978, Engineering and economic studies for direct applications of geothermal energy: DOE Program Research and Development Announcement PRDA-03-79-ET-27004, 46 p.
- U.S. Department of Energy, 1980, Geothermal direct heat applications program summary: El Centro, California, 267 p.
 VTN-CSL Associates, 1977, Economic study of low
- VIN-CSL Associates, 1977, Economic study of low temperature geothermal energy in Lassen and Modoc Counties, California: California Energy Commission and California Division of Oil and Gas, 87 p.