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GEOTHERMAL ENERGY: OPPORTUNITIES FOR CALIFORNIA COMMERCE

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ABSTRACT

To accelerate the development of abundant low- to moderate-temperature geothermal resources, the California Energy Commission (CEC) has identified those resource areas and direct use applications with the greatest potential for successful commercial near-term (2-5 years) development. An economic development approach was used to identify these areas and end-uses. This approach focuses on enhancing a community's local economy by developing its geothermal resources to attract industries which need a low-cost reliable energy source.

Twenty-seven areas of the state met strict geologic and economic criteria and are considered priority areas for immediate development activities. Twenty end-use applications, such as district heating and agricultural processes (e.g. greenhouse heating), met economic and energy use criteria and can successfully convert to using geothermal energy.

The CEC has initiated geothermal market development activities to overcome the major impediments to accelerated development of small-scale electric and direct use applications. These activities include infield technical and economic assessment and financial assistance to private developers and local governments. These programs are explained in the context of the evolving geothermal market development effort.

INTRODUCTION

The Geysers' vapor-dominated resource, which supplies the largest geothermal electrical generation complex in the world, often overshadows the fact that a major portion of California's resource is water-dominated and best suited for direct use. This low- to moderate-temperature (50°-150°C or 120°-300°F) resource can be found in at least 46 of California's 58 counties.

Direct use applications have several significant advantages to electric applications including: a far greater and more readily available resource; a higher conversion efficiency (usually 80-90%); the use of simple, off-the-shelf, conversion technology; shorter development time; and, most importantly, less expensive exploration and development costs. With continually increasing energy costs, many developers and investors are taking a serious look at the benefits of direct use applications. Unfortunately, many others are unaware of these benefits or lack the experience to economically develop a resource.

To guide the California Energy Commission's effort to accelerate direct use development, an intensive, methodical and assertive effort has been initiated to identify those resource areas and end-use applications with the greatest potential for successful near-term (2-5 years) commercial development. Building on results from previous market studies, the effort is being directed at target communities that have exploitable resources, and at venture capitalists and industries which could benefit substantially from converting to geothermal energy.

AN ECONOMIC DEVELOPMENT APPROACH

Before presenting the methodology and results of the marketing effort, it is important to understand the basic philosophical approach to geothermal commercialization - economic development.

Developers of geothermal resources for electrical generation pay little attention to how the energy is ultimately used once its been transmitted to the grid. However, when the heat from a resource is to be used directly, the cost of pipelines requires that an end-user be located within an economic distance from the hot spring or well. For marketing and developing the low- to moderate-temperature resource for direct use applications, attracting end-users goes hand in hand with exploring and developing the resource itself. This, in turn, requires the community to offer conventional economic development incentives (e.g., labor base, community services, etc.) normally used to attract industry to a given site.

Further, to be cost effective, several end-users are required in order to reduce resource development and distribution costs. The hot water can be cascaded through multiple applications, either in a large single complex or in a group of individual end-users who are united in a "Geothermal Park of Commerce." For example, water

from one well can supply heat for large buildings in a downtown area, then be cascaded to food processors, then greenhouses and finally sold as irrigation water. A Geothermal Park of Commerce is similar to a conventional industrial park with one major exception: the offer of a lower-cost, reliable energy source. This lower cost energy is an important "carrot" for attracting industry. However, the benefit of lower energy costs usually has to be traded-off (at least in part) against increased transportation and/or other difficiencies (e.g., reduced labor base) that are associated with the rural sites where most geothermal resources are found. Hence, a full scale, local marketing effort is required to accomplish the successful development and utilization of a geothermal direct-use resource. Only through such an approach can the economic benefits accrue to the local community.

This strategy promotes geothermal development as a means to an end: economic development for a community or industry. If communities near a geothermal resource area can demonstrate the cost-effectiveness and reliability of the energy alternative and can offer conventional economic development incentives, they can attract industrial end-users (e.g., Susanville Park of Commerce). Industrial development leads to tax revenue, indirect benefits from employees and families moving to the community and decreased unemployment: these, in turn, stimulate the local economy. Successful businesses which use geothermal energy can achieve reduced energy costs and lead to adoption of the alternative by others in the industry and, therefore, improve the economic condition of the industry.

While many of the results of this effort are California-specific, this economic development approach and the methodology to determine and develop target resource areas and end-use applications can be replicated in other geothermal areas of the U.S. and elsewhere in the world.

PRIORITY GEOTHERMAL RESOURCE AREAS

California was divided into 5 broad geothermal regions according to general resource characteristics and proximity to major population and trade centers. Within these regions thirty-eight areas met or exceeded the minimum resource factors listed in Table 1. Three of these factors - temperature, well depth and amount of total dissolved solids in the geothermal fluids - determine at a very basic level of analysis whether a project will be economically feasible. For example, two independent studies evaluated the feasibility of constructing and operating a greenhouse complex using heat from geothermal wells (Lahontan, 1982). The economic cost effectiveness between a greenhouse complex at Wendel, near Susanville, using 200°F fluids with a TDS of 300 ppm from a 600 foot well and a greenhouse operation in Imperial County using 155°F fluids with a TDS of 25,000 ppm from a 2000 foot well is extreme. Considering the heating system costs alone, the Wendel project has an excellent return on investment compared with the unacceptably low return from the Imperial Valley project in Imperial Valley. Therefore, with few exceptions, the five resource criteria should be used as the absolute minimum standards necessary for most cost effective direct use projects.

Following this screening against resource criteria, the thirty-eight resource areas were then evaluated according to economic development factors (Table 1). These factors address the suitablity of the resource area for project development from a business perspective. As shown in Figure 1: Priority Resources for Direct Use Development, twenty-seven areas are rated Priority of I, II or III which qualified them for further marketing and development efforts. These areas, listed in Table 2 according to priority, should be used as a guide for government and industry in evaluating potential project sites, since some areas rated Priority IV (e.g. Lake County) may become more attractive if one or two major impediments are removed. Additonally, other areas not yet identified in this study could offer a good opportunity for future direct use project development.

PRIORITY END-USE APPLICATIONS

To identify potential applications, relevant market studies were reviewed and numerous state agencies, trade associations and industrial leaders were consulted. Twenty-nine general applications were determined to have potential for using low- to moderate-temperature geothermal fluids directly. These applications were then assessed against the economic and energy use criteria listed in Table 3. The applications having the highest potential for successful near-term commercial development, fell into three general categories: district heating, agricultural processes and small-scale electric systems.

Geothermal district heating systems have been successfully installed throughout the world. In the U.S., Boise (Idaho), Klamath Falls (Oregon), and most recently Susanville (California), space heat large sections of their communities with fluids ranging from 60-90°C (140-195°F). Bridgeport (California), south of Lake Tahoe, may be the next community to install a heating system. Included in the category of district heating, are "Parks of Commerce" where several end-users share the heated fluids for a variety of processes.

Agricutural is the most important industrial sector that can convert to direct use. Most geothermal resources have temperatures (50°-150°C or 120°-300°F) that match requirements of agri-industrial processes. Specifically, intensive, confined growing in greenhouses was determined to be the best application which could immediately use geothermal for space heating. Facing high interest rates and fierce foreign competition, the greenhouse industry, with over 3,000 acres under glass in California alone, is extremely

sensitive to further increases in heating costs which have escalated more than 400 percent in the last five years. Several operators have already moved their operations to take advantage of geothermal energy. In addition to greenhouse operations, food processing and methane generation were also identified as having significant potential for successful near-term development.

Small-scale electric systems, 'well-head generators' (ranging in size from 40 kW to 10 MW) are beginning to be sold throughout the western U.S., despite uncertainty regarding operational performance and system reliability. These systems can dramatically improve the cost-effectiveness of developing many moderate temperature (90-150°C or 200-300°F) resources in the state. By cascading the heat from the well-head generator to direct use applications, several district heating and agri-business complexes become economically feasible. However, lacking a commercial track record, these small-scale electric systems may require unique approaches to financing, design, warranty agreements and serious attention to reliable operation and maintenance.

IMPEDIMENTS TO DEVELOPMENT

Following the assessment and ranking of resource areas and end-use applications, the next step was to identify the major impediments preventing the widespread adoption of geothermal energy in these areas and by these end-users. CEC geothermal staff, in preparing for the fourth Biennial Report to the Legislature, identified four major impediments: resource risk, capital availability, lack of technical expertise and regulatory disincentives.

1. While up to 50 percent of the total costs of a direct use project can be spent for resource development, there is no guarantee the well will produce the necessary temperature, flow rate or water quality for the application. Well costs increase exponentially with depth, making resource confirmation and development the major expense and greatest risk of a geothermal venture.

2. Given high interest rates and generally poor economic conditions, the lack of capital availability (at reasonable cost) for direct use projects are significantly slowing adoption of this technology. Direct use geothermal projects require large amounts of capital to develop the resource and delivery systems. The cost of financing must be added to the conventional project construction costs, and is the single largest annual expense.

3. Although geothermal resources occur in 46 of California's 58 counties, and are readily available, the following factors contribute to retarding rapid market development: a) the general public has little knowledge regarding possible low-temperature geothermal applications and the attendant problems are often greatly exaggerated; b) developments will not be seriously considered until they are proven feasible from both an engineering and an economic basis; and c) legal, institutional and environmental constraints peculiar to direct use development are beyond the experience of many communities and potential users.

4. Excessive regulations significantly impede development as most regulatory agencies continue to incorrectly perceive direct use development as a high risk venture with the same impacts as large-scale electric development at the Geysers or Imperial Valley. To achieve a maximum reasonable increase in use, regulatory agencies should recognize that, in most cases, direct use projects employ water well technology to drill to shallow depths and result in an environmentally benign development.

MARKET DEVELOPMENT

Successful commercial development of priority resource areas and end-use applications requires an intensive, cooperative effort between business and government that is aimed directly at mitigating the four major impediments.

Candidate projects at priority areas which employ priority applications, have been defined and analyzed as a continuation of the market development contract. Potential agricultural complexes have been identified at Wendel and East Mesa. The former includes small-scale electric and greenhouse operations and the latter includes animal feed production, swine raising and food processing. Heating districts cascaded from a small-scale electric system have been examined for Calipatria and Bridgeport. This market assessment effort confirmed that responsible businessmen are seriously considering this form of alternative energy. Their participation is expected to be paced only by the general economy and high cost of money. These businessmen are financially committed to their own businesses. Most expect that a community, private developer or cooperative district energy group will develop and supply the geothermal energy in a manner similar to other utilities (e.g., water and sewer).

To develop a market infrastructure and stimulate new projects, the CEC staff presents the results of the market study to communities near high priority resource areas. Emphasis is on explaining the geothermal development as a method of attracting industry and encouraging the area's economic growth. For industries rated as high priority end-use applications, contacts have been established with leaders in the industry, and information packets addressing the benefits of direct use for the specific industry can be furnished. Presentation at trade association meetings and articles for trade journals are also

being implemented to communicate the benefits to the entire industry.

The CEC offers technical assistance for geothermal direct use and small-scale electric projects, through a contract with the Oregon Institute of Technology (OIT). In-field technical support services are offered to resource owners, developers and potential end-users. Such services include on-site investigations and consultation, and preliminary assessment of a project's engineering and economic feasibility. The assistance determines initial feasibility and can assist the developer in obtaining financial support by reducing investment risk.

Federal lease revenues dispursed to certain counties and to the CEC, provide funds for geothermal planning and development. With its portion of the revenues, the CEC has established the Local Government Grant Program. These grants can be used by local government entities for resource confirmation, as capital for demonstration projects or to plan for future development.

Direct use and small-scale electric demonstration projects can be partially funded by the CEC. Such projects will provide actual operating experience, produce data on performance and costs, and serve as models for duplication elsewhere by the private sector.

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TABLE 1

PRIORITY AREA EVALUATION CRITERIA

A. RESOURCE DEVELOPMENT	
• TEMPERATURE	Above 50°C (122°F)
• WELL DEPTH	Less than 760 m (2,500 ft) Prefer 460 m (1,500 ft.) or less
• TOTAL DISSOLVED SOLIDS	Less than 5,000 ppm Prefer 1,000 ppm or less
• DISTANCE TO POTENTIAL APPLICATION SITE	Less than 1.6 km (1 mi)
• LOCAL PERMITTING FOR TOTAL PROJECT	Less than 9 months

B. ECONOMIC DEVELOPMENT FACTORS

- ADEQUATE LABOR BASE
- COMMUNITY SERVICES
- CONCENTRATED HEAT LOAD
- LAND COSTS
- ATTRACTIVE LIVING CONDITIONS
- OVERRIDING FACTORS
- ADEQUATE TRANSPORTATION TO MAJOR MARKETS
- RAW MATERIALS
- REASONABLE UTILITIY RATES
- FAVORABLE BUSINESS CLIMATE
- LOCAL FINANCIAL INSTITUTIONS

TABLE 2

TARGET COMMUNITIES IN GEOTHERMAL RESOURCE AREAS

Priority I	Priority II		Priority III
• Susanville	• Calistoga	• Sonoma Valley	• Napa Valley
• Litchfield	• Kelly Hot Springs	• Wendel - Amedee	• Surprise Valley
• Salton Sea Field	• Sierra Valley	• Bridgeport	• Likely
• Ontario Hot Springs	• Mammoth Lakes	• Lake Isabella	• Bassett-Kellog Springs
• Lake Elsinore	• Trona	• Desert Hot Springs	• Twenty-Nine Palms
	• Mecca	• East Mesa Field	• Winchester Area
	• Pasa Robles	• L.A. Basin	• Warner Hot Springs
	• San Bernardino		

FIGURE 1

PRIORITY GEOTHERMAL RESOURCE AREAS

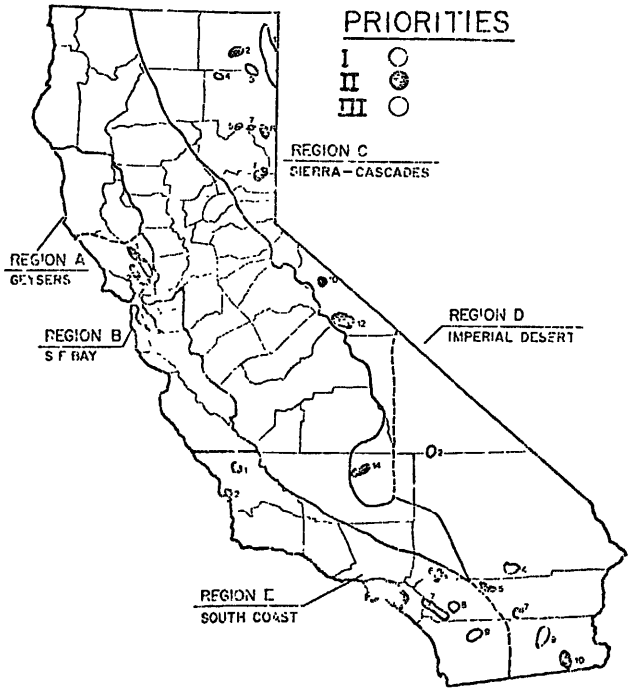

TABLE 3

PRIORITY APPLICATION CRITERIA

- ECONOMIC OUTLOOK
- ENERGY SENSITIVITY
- REPLICATION
- GEOTHERMAL COMPATIBILTIY
- ECONOMIC DEVELOPMENT FACTORS
- HISTORICAL USE (WORLDWIDE)
- BRANCH PLANTS
- OVERRIDING FACTORS