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DOE/ET/27196-T12
(DE83016236)

GEOTHERMAL DIRECT HEAT STUDY
IMPERIAL COUNTY, CALIFORNIA

May 1983

Work Performed Under Contract No. FC03-79ET27196

VTN Consolidated, Inc.
Irvine, California

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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GEOHERMAL DIRECT HEAT STUDY

IMPERIAL COUNTY, CALIFORNIA

**County of Imperial
Department of Public Works
Courthouse
El Centro, California 92243**

This report was prepared with the support of the United States Department of Energy under Cooperative Agreement No. DE-FC03-79ET27196 between Imperial County and the United States Department of Energy. Any opinions, findings, conclusions, or recommendations expressed do not necessarily reflect the views of the United States Department of Energy.

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May, 1983

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1.0 INTRODUCTION

Imperial County contains the world's largest source of hydrothermal geothermal energy. Utilization of this vast resource for direct heat applications will require a full-scale effort from Imperial County, the geothermal resource owners and developers, and potential users of the heat. To develop an orderly plan of development, Imperial County, in conjunction with the U.S. Department of Energy, authorized this Geothermal Direct Use Study.

The major intent of the study was to identify potential applications of geothermal energy which would be compatible with the agricultural activities in the County and develop a plan to attract potential users to the area. The intent of the first effort was to identify general classifications of industries which could utilize geothermal heat in production processes. Two levels of analyses were utilized for this effort. Initially, activities relying on previously developed engineering and industrial concepts were investigated to determine capital costs, employment, and potential energy savings. Second, innovative concepts not yet fully developed were investigated to determine their potential applicability to the agricultural base of the County.

These investigations indicated that the major potential applications of geothermal heat would involve industries related to food processing or other direct agriculture-related uses of raw materials produced or imported to the County. These general categories of agricultural use involve:

- o Manufacturing, including food processing, dehydration, canning, and freezing.
- o Agricultural production such as nurseries and cattle feedlots.

- o Processing, including crop refrigeration.

The findings of this Study, particularly the data on direct heat applications and uses in the food processing industry, can be utilized by existing County businesses, as well as those the County might wish to attract. Existing County businesses will, most likely, be among the best prospects to utilize direct heat applications.

Based on identification of the various applications, an implementation plan which can be utilized by the County to market direct heat applications was developed. This plan involved two major efforts--development of an information booklet and identification of about 2,300 companies involved in the chosen industries. The information booklet provides a background on geothermal energy, data on direct heat applications, uses in the food processing industry, and a profile of the Imperial Valley. The intent of the booklet is to provide initial information to potential direct heat users about the use of geothermal energy and to interest them in locating in the Imperial Valley. A marketing plan utilizing the brochure has been developed. It is recommended that a County employee be designated as a marketing point of contact to oversee the marketing of direct heat uses.

A socioeconomics analysis examined the potential effects on the County from development of direct heat projects. Specific effort was directed to examining the municipally provided services such as sewer, water, and solid waste disposal. Based on the projected employment requirements for new industries and the capacities of existing services, demand created by direct use development could be met by existing facilities. Thus, the socioeconomic impacts will be minor and no problems are anticipated.

The Study also examined the County's planning and permitting requirements for direct heat projects. This analysis resulted in development of specific new procedures which could be utilized in conjunction

with existing permitting procedures. The new procedure primarily involves initial determination of project size, type, and location, prior to further processing under existing County regulations and authorities. Based on this procedure, projects would be classified as small (less than 5.0 acres) or large, agriculture or non-agriculture-related and inside or outside an existing Geothermal Overlay Zone. Depending upon these determinations and the expected environmental impacts of the project, processing would be accomplished by the Zoning Administrator or through a Conditional Use Permit.

In addition to the permitting procedure, this Study identified industrial performance standards for direct heat projects. The intent of the performance standards is to set an upper limit on certain environmental parameters which must be met by new direct heat projects before they could proceed.

The Imperial County Direct Heat Use Committee provided guidance on the direction and content of each task during the conduct of this Study. Committee members were Mr. David Pierson, Chairman, Director of Public Works (retired), Mr. Richard Mitchell, Planning Director, Mr. Claude Finnell, Agricultural Commissioner, and Ms. Susanna Lydick, County Administrative Officer. The daily conduct of the Study was under the direction of Ms. Margaret Rands, Geothermal Coordinator.

2.0 IDENTIFICATION AND ECONOMIC ANALYSIS OF GEOTHERMAL HEAT APPLICATIONS

2.1 Classification of Geothermal Heat Applications

Practically any process or activity which requires thermal energy below 400°F can be adapted to utilize the geothermal resources in Imperial County. Thus, the possibilities for direct use of geothermal heat in the County are almost unlimited. The processes described in this chapter can be implemented at any of the four major Known Geothermal Resource Areas (KGRAs) in the County--Heber, Brawley, East Mesa and Salton Sea--or at other geothermal resource locations where the temperatures may not be as high. Generally, direct heat applications of geothermal energy require only a small portion of the geothermal fluid needed for electrical power plant applications.

Since the heat requirements for direct use projects are generally lower than for electrical power plant applications, location of the facility relative to the geothermal resource is not critical. However, since the investment in direct use projects is substantially lower than for electrical power plants, in order to minimize the relative cost of fluid transmission and disposal, facilities will, most likely, locate as close as possible to the geothermal resource. Location of the facility in relation to the geothermal resource may vary considerably by the type of project and the temperature of the resource.

A secure, long-term supply of geothermal energy may be a key factor in developing new industries in Imperial County. The long-term supply of geothermal energy will be an attractive catalyst for development of new direct heat uses in the County. The long-run uncertainty of supply and the expected cost escalation of petroleum based fuels will make geothermal energy an attractive alternative. Notwithstanding the need for a source of energy, factors such as cost of raw materials, capital investment requirements, transportation availability and cost, labor

availability, environmental considerations and the local business environment will also be major factors in determining the feasibility of individual projects.

In order to systematically evaluate potential direct use applications, five major categories of analysis were developed--agriculture, aquaculture, food processing, ethanol production, and manufacturing.

2.1.1 Agriculture

This group of applications deals directly with the main economic activity of Imperial County. Applications in this category would be used at the primary level by the farmer, rancher or stockman or perhaps cooperative groups of these individuals. Representative projects include crop refrigeration, greenhouse operation, and feedlot operations.

2.1.2 Aquaculture

The intensive culture of certain aquatic species is enhanced by using geothermal heat to warm the aquatic environment. Applications in this category include growing Malaysian prawns, channel catfish, and tilapia. In addition, geothermal resources can be utilized for hydroponic growing of certain crops.

2.1.3 Food Processing

This category is directly linked to the agricultural activities of the region. Food processing divides into two sub-categories; processing activities normally done in the Imperial County using energy sources that can be replaced by geothermal energy, and processing activities not currently done in the County which could be attracted by the availability of geothermal energy. Representative of the former sub-category would be sugar refining and cold packing. The latter

includes vegetable canning, freeze-dry operations, and vegetable dehydrating.

2.1.4 Ethanol

The conversion of organic material into ethanol for use as a motor fuel has recently aroused a great deal of interest. The combination of an alternate energy source, a local supply of feedstock, and a nearby market makes Imperial County a prime candidate for a geothermal ethanol industry. There are two general versions of the ethanol process. The traditional route uses carbohydrate feedstock in the form of grains or sugar which is fermented and distilled. A newer process seeks to convert more complex carbohydrates in the form of cellulose, hemicellulose and lignins into forms which can be fermented.

2.1.5 Industrial and Manufacturing

Geothermal fluid can be used for process heating, refrigeration or motive steam in most manufacturing or industrial applications. In such service it would replace fossil fuel and electricity. Industrial and manufacturing industries are welcomed by Imperial County, but the scope of this study does not permit addressing unlimited types of industrial or manufacturing applications.

2.1.6 Other Applications

There are significant opportunities to utilize high temperature geothermal heat in various direct use applications. The scope of this study did not include analysis of these processes and applications. There are opportunities in the County for development of such applications.

2.2 Review of Published Data

The initial task in evaluating potential direct use applications was a review of published data. Most of this literature has been published in the last decade. The largest part of the research has been funded through federal grants, contracts, and study programs. Review of this body of research indicates that a wide range of projects have been studied, some in extensive detail. These reports generally show a good economic incentive for development.

The body of literature provides an important function in revealing and discussing novel applications and providing a starting point for a commercial project. The Department of Energy publishes a comprehensive bibliography of geothermal literature titled "Geothermal Updates." This periodical was utilized as the basis for the literature search. Appended to this report is an extracted bibliography of the significant publications concerning direct applications, grouped according to the various categories.

2.3 Activities Best Suited to Imperial County

The data available in the literature were augmented by interviews with a number of firms and individuals currently pursuing direct applications projects in the County. These contacts covered a large spectrum, from academic researchers to government sponsored private researchers to individuals engaged in private commercial ventures. The types of projects also cover a wide range, from production of ethanol to crop refrigeration. The information gained from these contacts was mainly qualitative, although some additional quantitative data were obtained.

The firms contacted included current projects, such as aquaculture greenhouses and vegetable dehydration. Contacts were also made with universities, commercial/industrial businesses and engineering firms. The organizations contacted and the specific projects involved are shown at the end of this section.

2.3.1 Agriculture

2.3.1.1 Greenhouses. Geothermally heated greenhouses are currently being operated in several western states. Since all of the existing greenhouses are located in areas that experience cold winters, the main use of geothermal energy is to heat greenhouses. This not as important in Imperial County. However, geothermal air conditioning of greenhouses by ammonia absorption refrigeration could potentially be feasible. Some interest has been expressed in growing specialty vegetables and cut flowers in geothermal greenhouses in Imperial County. Geothermal greenhouses in operation in other areas are growing tomatoes and cucumbers, both of which are currently grown in Imperial County. In a greenhouse, the planting density is much higher and since the growing environment, nutrition, and pests are carefully controlled, the per acre yield is five to ten times as great as for field crops. Also, greenhouses can be located on land that is not suitable for cultivation or irrigation.

Figure 2.1 is a block diagram of a typical 15-acre greenhouse complex. This facility uses a relatively low resource temperature of 200°F. The complex would use a maximum of 31.5 MMBtu/hr for heating at night during six months of the year, with daytime requirements less. Daytime cooling would be required for four months, and the maximum load would be 35.5 MMBtu/Hr. The annual geothermal heat requirement is 98,500 MMBtu. This would displace about 20,500 barrels of oil annually. The irrigation water requirements for greenhouses are considerably less than for field row crops. About 4.5 acre-feet per year are required for the typical installation. The primary utility requirement is electricity, and about 30 kW are used. The only significant effluent is waste irrigation water. The typical facility would cost \$4,800,000 (mid 1980) to build and employ 18 people.

Although not yet studied in great detail, geothermal fluid could be utilized to heat agricultural irrigation water in the winter.

Alternatively, if of acceptable water quality, geothermal fluid could be mixed and utilized for irrigation purposes. Use of heated water could have a positive impact on the yield of field crops.

2.3.1.2 Crop Cooling and Packing. Many important vegetable crops must be cooled immediately upon harvesting and kept refrigerated until they are shipped. In the case of lettuce and similar crops, this is done by vacuum refrigeration. Melons, carrots, and broccoli are usually cooled in forced-convection cold rooms prior to shipment. The refrigeration required by this process is provided by mechanical refrigeration units using ammonia or freon as the refrigerant. The necessary cooling could be provided by ammonia absorption refrigeration using geothermal heat as the energy source. There are currently no commercial enterprises using geothermal refrigeration. Ammonia absorption refrigeration was the primary source of refrigeration prior to the invention of mechanical refrigeration. It is still in use where low level heat is available. Therefore, even though no geothermal applications now exist, the technology can be considered mature and low risk.

The vacuum refrigeration process is a version of evaporative cooling. The produce to be cooled is placed in an air-tight chamber or retort, and then a vacuum is pulled by mechanical vacuum pumps. When the vacuum reaches the "flash point," the moisture in the produce vaporizes, causing the produce to be chilled. However, the vacuum pumps are not able to handle this additional vapor load. Therefore, the moisture is condensed by refrigerator coils before it reaches the vacuum pump.

A typical geothermal vacuum cooling installation would consist of four "full carlot" retorts. These would be capable of cooling 2,560 cartons of lettuce per batch every 30 minutes. That is a rate of 140 tons/hr and requires a maximum of 2,000 tons of refrigeration. This would normally be a peak load, and the seasonal average throughput will be

less. The installation would operate during the four month lettuce harvest. A block diagram of the typical installation is shown in Figure 2.2. The facility would require about 11,000 MMBtu/yr of geothermal energy at 300°F. About 310 gpm of cool geothermal fluid at 200°F would be returned for reinjection. There would be no other effluents. The only utility requirement is 1,000 kW of electricity. The geothermal energy used would displace an equivalent of 1,830 barrels of oil per year. A typical facility would cost approximately \$3,000,000 to construct and employ about eight persons. Retrofit of existing facilities could also be accomplished. The cost and feasibility of retrofitting would depend on the existing facility.

Cold rooms are extensively used in Imperial County to cool perishable crops prior to shipment. Geothermal refrigeration can replace mechanical refrigeration in this service. A typical cold room has 200,000 cubic feet of storage space and requires a fairly uniform load of 150 tons of refrigeration. The harvest season for the various perishable crops extends from mid-October through early July. The major crops requiring cooling are melons, carrots, broccoli, tomatoes, and asparagus. A block diagram of a typical cold room operation is shown in Figure 2.3. The geothermal refrigeration requires geothermal fluid at 300°F and rejects it at 200°F. About 17,400 MMBtu/yr of geothermal heat is used, equivalent to 2,900 barrels of oil annually. There are no effluents from this operation. The electrical requirement is 50 kW for lighting and small motors. A typical facility would cost about \$1,200,000 to build and employ approximately eight persons.

2.3.1.3 Alfalfa Dehydration. In 1980, alfalfa was the number one crop in Imperial County for both acreage and value. About 9% of the crop was dehydrated for high quality fodder, while over 90% was exported from the County. The heat for dehydrating the alfalfa is currently obtained from natural gas. Studies have shown that geothermal heat can be used to dry alfalfa. Besides providing a high quality feed, alfalfa drying has another benefit, since the cost of transporting dried

alfalfa is considerably less than baled alfalfa hay. A typical plant would process 120 tons/day of field-chopped alfalfa. About 318 gpm of geothermal fluid at 300°F would be required, and the fluid would be rejected at 160°F. This would generate 176,000 MMBtu/yr, which is equivalent to 32,000 barrels of oil per year. These figures are based on operating full time with an on-stream factor of 90%. The process would eliminate the emissions of combustion products associated with conventional dehydration facilities. The typical facility would require about 500 kW of electrical power. The plant would cost \$300,000 and employ 12 persons. A block diagram of the plant is shown in Figure 2.4.

2.3.1.4 Feedlot Operations. In 1980, beef was the number one agricultural commodity in Imperial County, with over 625,000 head fattened in feedlots. There have been several studies on applying geothermal heat to feedlot operations. These studies have proposed to incorporate a biogas facility to convert the cattle waste to methane and a residue suitable for feed. In this context, geothermal heat would be used to heat the anaerobic digester and dry the residue. Most feedlots also use heat to prepare the cattle feed.

Figure 2.5 is a block diagram for a typical 10,000 head feedlot. Geothermal steam is used in the feed mill to dry the residue from the biogas plant and heat the biogas digester. This facility requires 220 gpm of geothermal fluid at 350°F. The fluid is rejected from the facility at 150°F. About 138,000 MMBtu/yr of geothermal heat is used. This is equivalent to 25,000 barrels of oil per year. Since there is a large feedlot industry in place in Imperial County, a large number of new feedlots would most likely not be built. Rather, the geothermal facilities would be added to existing feedlots (or perhaps even a relocation of existing feedlots). Therefore, only the geothermal and biogas facilities are considered here.

The biogas process requires 45 gpm of raw water to make a slurry with the manure. A large part of the slurry water is provided by recycling centrifuge effluent (centrate). However, in order to prevent a build up of soluble salts and other contaminants, a purge stream of 36 gpm of centrate is withdrawn from the system. This stream constitutes the major effluent from the facility, which might be used for irrigation. If not, it would probably go to an evaporation pond. The other major emission from the facility is the odor from the residue drying operation. However, the odor should be no worse than those emissions normally associated with a feedlot. The modifications to the feed mill would cost about \$50,000. There would be no additional requirements of utilities or manpower. The biogas plant requires 285 kW of electricity. The plant would cost \$5,560,000 and employ seven persons. The residue dehydration would require 500 kW of electricity, with capital costs of about \$300,000. It would employ about six persons.

2.3.2 Aquaculture

2.3.2.1 Malaysian Prawns. Malaysian prawns are currently being raised commercially in the Coachella Valley. Low temperature geothermal heat is used to heat the growing ponds. In addition, there is an experimental facility operated by the Oregon Institute of Technology. Temperature requirements are generally not high. Geothermal fluid of 150°F should be adequate to grow prawns. Fresh water is required to replace evaporation and permit the removal of waste materials. A Malaysian prawn farm could probably be located anywhere in the Imperial Valley.

2.3.2.2 Hydroponic Agriculture. Geothermal fluid can be utilized to hydroponically grow crops. Under these conditions, the geothermal fluid is utilized as the growing medium for the crops. The fluid must be of fairly high quality or clean in order to provide the necessary nutrients for the crop. Hydroponics is an excellent method to control the level of nutrients available for the crops. The nutrients can be

added to the geothermal fluid, as required. Since hydroponics has been utilized for growing a variety of plants for a number of years, the technology and methodology are available and known.

Notwithstanding these advantages, the use of geothermal fluids as a medium for hydroponic agriculture in Imperial Valley may be limited. Most geothermal fluids in Imperial Valley will probably not be suitable as a growing medium for hydroponic agriculture due to the brine chemistry of the water.

Although not suitable as a direct growing medium, geothermal fluids may be used as a heat source for other fluids. Under these conditions, any of the geothermal resource areas in Imperial Valley would be a suitable location for hydroponic agriculture.

2.3.2.3 Catfish. Catfish are currently being grown in Imperial County. There is also a geothermally heated catfish farm in Idaho which produces 500,000 lb/yr of fish. By warming the fish raceways in winter, the growing season is extended, thereby increasing the yield of a given facility.

Figure 2.6 is a block diagram of a geothermal catfish farm. This particular design uses once-through irrigation water in the fish raceways. The main contaminant added by the catfish is ammonia, which should enhance the irrigation water. Relatively low temperature geothermal fluid is required. The fluid inlet temperature is 200°F, and it is rejected at 100°F. To avoid contamination of the irrigation water, the heat is transferred by a heat exchanger. The annual heat requirement is around 256,000 MMBtu. Utility requirements are 80 kW of electricity. The capital cost of the facility would be approximately \$110,000, and it would employ about 30 persons.

2.3.3 Food Processing

2.3.3.1 Vegetable Dehydration. Dehydrated onions are an important product for Imperial County. They are currently dried using fossil fuel heat. An onion drying plant using geothermal heat is currently operating in Nevada. Other vegetables such as carrots, celery, okra, broccoli, asparagus, and garlic can also be dehydrated. A typical drying plant will process 10,000 lb/hr of vegetables and require 760 gpm of 230°F geothermal fluid which will be returned at 171°F. By processing a variety of vegetables, the plant would run near full capacity for half the year and at reduced capacity for the remainder of the time. About 90,000 MMBtu/yr of geothermal heat is used, an amount equivalent to 15,000 barrels of oil per year. The electricity requirement is 500 kW, and the capital cost would be \$4,600,000. The plant would employ 75 persons. A typical drying plant is illustrated by the block diagram in Figure 2.7.

2.3.3.2 Vegetable Freezing. Currently there is no frozen food industry in Imperial County. The energy required for freezing and cold storage is an important cost in this business. As shown in previous sections, geothermal energy is suitable for refrigeration. A block diagram for a typical geothermal frozen food plant is shown in Figure 2.8. A typical plant would operate for about six months per year, the average product residence. Geothermal fluid of 300°F is required at a rate of 40 gpm, to be rejected at 200°F. The energy requirement of 1,920 MMBtu/yr is equivalent to about 400 barrels of oil per year. About 50 kW of electricity are required. A typical plant would cost about \$890,000 and employ eight persons.

2.3.3.3 Produce Canning. There is no significant canning industry in Imperial County. However, many vegetables which can be canned are grown, notably tomatoes. Low and intermediate temperature heat is required for washing, peeling, cooking, and sterilizing. All of these needs can be met by using geothermal heat with a fluid temperature of 250°F to 350°F.

Although produce canning is facing competition from the increased use of frozen, freeze dried, and fresh produce, an opportunity remains to attract this industry to the County. Many canning operations were established in former agricultural areas which have become urbanized. Under these conditions, the opportunity for plant expansion is limited due to a lack of space and associated high land costs. In addition, the plants must compete for labor in the higher cost urban area markets. Regulatory considerations in urban areas may also hinder or make expansion or new plant construction expensive. Major produce canners such as Hunt's Food and Campbell have shown an interest in locating in Imperial County for these reasons.

In addition to canning of produce, geothermal energy can be utilized to process sugar beets. Since sugar beets have a high water content, after crushing the beet, geothermal fluid provides heat to drive off the excess water prior to further processing. Under these processes, geothermal fluid would displace the use of natural gas driers in the sugar beet processing. Since the water is removed from the beets, the cost of transporting the product is greatly reduced.

TRW and the DOE have extensively documented this process at the Holly Sugar Plant, near Brawley. Their findings indicate use of geothermal in this manner is technologically, economically and environmentally feasible.

2.3.4 Ethanol

There is good potential in Imperial County for the development of an ethanol industry. The transportation system necessary to provide feedstock exists, the Southern California area provides a large potential market, the grain byproduct can be utilized by local feedlots, and abundant geothermal energy is available for the processing plant. Several projects have been proposed to be built in Imperial County. These range in size from 5 to 20 million

gallons of production per year. There is an operating geothermal ethanol plant in eastern Oregon producing two million gallons per year.

Figure 2.9 is a block diagram of a typical 10 million gallon per year geothermal ethanol plant. The plant requires 2,450 gpm of 280°F geothermal fluid which is rejected at 205°F. The plant is designed for continuous operation with an on-stream factor of 90%. The thermal energy usage of 545,000 MMBtu/yr is equivalent to 90,800 barrels of oil per year. Although the process calls for extensive internal water recycle, make-up water of about 210 gpm is required to replace the loss in drying the grain residue. The major liquid effluent is the purged water stream which would either be discharged to the agricultural drains or evaporated in ponds. About 170 gpm of this material is produced. The major gaseous effluent is the carbon dioxide emitted during fermentation. The typical facility requires 5,500 kW of electric power. The plant would cost around \$40,000,000 and employ 50 persons.

2.3.5 Industrial and Manufacturing Uses

2.3.5.1 Mineral Recovery. One of the earliest efforts to utilize geothermal heat in Imperial County was the recovery of potassium chloride from high salinity brine. The process consisted of evaporation and crystallization of the brine and separation of potassium chloride from the residue. The high salinity brines of Imperial County contain a number of valuable minerals including silver and gold, and an improvement of recovery technology could make this industry feasible.

There has been considerable interest in minerals recovery in Imperial County. Firms have considered the feasibility of producing potash and other minerals from the geothermal brines. Studies have been conducted by the U.S. Bureau of Mines to investigate the possibility of mineral recovery from the Salton Sea geothermal brine. Although not directly

related to agricultural activities in the Valley, mineral recovery from geothermal brines could be feasible.

2.3.5.2 Industrial Heating and Cooling. Heating of buildings with geothermal energy has been utilized for years in various locations in the U.S. and other parts of the world. Generally, the geothermal fluid is pumped or flowed directly to the structure or area to be heated. Depending on the application, a heat exchanger or direct piping may be utilized in the process.

Cooling of buildings through the use of geothermal energy could also be accomplished. The process is similar to that involved in cooling produce. However, in this case an industrial building or area would be cooled. The use of this application would provide a constant source of cooling for industrial production.

2.3.5.3 Fertilizer Production. Nitrogen based fertilizers are important agricultural chemicals. The Valley Nitrogen Producers plant, near the Heber KGRA, can manufacture 600 tons/day of anhydrous ammonia. One study has shown that a significant amount of the energy used by this plant can be replaced by geothermal energy. Figure 2.10 is a block diagram of this process. Approximately 4,465 gpm of geothermal fluid at 360°F is used in this process. The rejected fluid is 216°F. Based on an on-stream factor of 90%, about 2,500,000 MMBtu/yr of geothermal heat is required. This is equivalent to 420,000 barrels of oil per year. The heat is used in the form of steam to drive some of the large compressors in the ammonia plant. Since this process would be added to the existing plant, no additional labor is required. The estimated cost of the additions is about \$9,500,000.

2.4 Innovative Concepts

There have been a number of uses proposed for geothermal energy which have not been thoroughly investigated or require technology not

currently available. They were not examined in the detail of the previous applications, since details are not available. They are described briefly in this section because of the potential for future use in Imperial County.

2.4.1 Industrial Park/Utility District

Most of the applications discussed in the previous sections require only a single well or a part of the production of a single well. For single applications, the risk of drilling a well in a new area is difficult to justify. This problem is avoided if several applications can be located at a developed reservoir. By having several users, many of the problems associated with direct use are solved. First, the risk of exploration and field development is shared. The assurance of a steady demand for geothermal fluid in a large enough quantity is likely to encourage the owner of a resource to develop it. Also, since the various applications use heat at different temperatures, an industrial park or utility district would allow the most efficient use of the fluid. The existence of a developed industrial park where a potential user will find an established, assured source of geothermal energy would promote the direct use of geothermal heat. The uses and methods of application would vary greatly, depending upon the reservoir temperature, uses for the fluid, and size of the facilities involved.

2.4.2 Power Plant Low-Level Heat

This concept is similar to the industrial park in that a central source of geothermal energy is provided. In this case, it is associated with a geothermal power generating plant, and reject heat from the power plant would be utilized.

2.4.3 Ethanol from Cane Sugar

Cane sugar is an excellent feedstock which can be grown in Imperial County. It has several advantages over other feedstock. It can be

grown all year at high yield, making large storage facilities unnecessary. In addition, since the sugar is not completely refined or granulated, much of the refining expense can be eliminated.

2.4.4 Ethanol from Cellulose

Plant fiber is composed of three main constituents--cellulose, hemicellulose, and lignins. Cellulose and hemicellulose can be chemically or thermally degraded into fermentable sugars. Two processes for accomplishing this are now in the experimental stage. One, developed at the University of California, uses nitric acid to break down the cellulose. A pilot plant based on this process and designed to process wood chips is being operated in northern California. The second process uses geothermal heat to degrade the cellulose. This process was developed at Colorado State University and has been used to successfully convert corn stover to ethanol. Since the cost of feedstock is the major component in the cost of ethanol produced from grains, either of these processes has the potential to reduce the cost of ethanol to an economically attractive level. The Imperial Valley can provide a ready source of plant fiber, as well as the geothermal energy required by the process.

2.4.5 Guayule Rubber

The guayule plant is a desert plant indigenous to the Southwest and contains a latex suitable for rubber manufacture. Mexico has been conducting research into guayule processing and plans to operate a 5,000 ton/yr pilot plant. The process requires hot water for processing the plants and coagulating the latex. This heat could be provided by geothermal fluid. Since guayule is a desert plant, it could be cultivated on currently unproductive land.

2.5 Conclusions

There is a wide variety of potential applications of geothermal energy to industrial processes. The availability of this abundant and reliable resource can be a major attraction to industries which must locate and utilize large amounts of energy in their industrial processes. Since many of the applications rely on previously used engineering and industrial applications, location in the County should prove advantageous to firms which can utilize geothermal heat as an energy source.

Although industrial applications such as heating, cooling and mineral recovery are attractive, the County's agricultural base is the most obvious attraction to a new resource user. The agricultural-related industries, such as food processing, would have the greatest potential for future development. The County's desire to expand this base and provide opportunities for growth should provide a basis for growth of this section of the Valley's economy.

For further information on the uses of geothermal energy, see the Appendix.

2.6 Persons and Organizations Contacted

Aqua Farms Mecca, California Don Grajcer	Malaysian Prawn Aquaculture
CH ₂ M-Hill Irvine, California Mike Saylor	Feedlot Biogas
CH ₂ M-Hill Boise, Idaho John Austin	Potato Processing
Colorado State University Fort Collins, Colorado Dr. Antonio Moreira	Ethanol from Cellulose
Courtwright Irrigation La Grande, Oregon Burt Courtwright	Geothermal Ethanol
Del Rio Farms Brawley, California Mark Veysey	Geothermal Ethanol
D.O.E. San Francisco, California Hillary Sullivan	Direct Heat Applications
E.G. & G. Idaho Iver Engen Bill Toth Jud Whitbeck	Direct Heat Applications Direct Heat Applications Agricultural Geothermal Uses
Fish Breeders Niland, California George Ray	Channel Catfish
Geo Products, Inc. Oakland, California Kenneth L. Boren	Greenhouses, Ethanol from Cellulose
Geothermal Food Processors, Inc. Nevada B. C. McCabe, Jr.	Vegetable Dehydration
Idaho Office of Energy Boise, Idaho Bill Eastlake	Direct Heat Applications

Persons and Organizations Contacted (continued)

Imperial County Agriculture Extension Keith Mayberry	Produce Cooling
Kershaw & Sons Brawley, California Dick Kershaw Jerry Soboleski	Feedlot Operations Feedlot Operations
Lawrence Berkeley Laboratory Berkeley, California R. L. Fulton	Direct Heat Applications
Joe Maggio, Inc. Holtville, California	Vegetable Cooling
Mobile Products Services Burlingame, California Robert Dench	Vacuum Cooling
Nevins Company Los Angeles, California Lee Bruger	Vacuum Cooling
Oregon Institute of Technology Klamath Falls, Oregon Dr. Paul Lienau	Direct Heat Applications
P.G.&E. San Francisco, California Pablo Maciel	Feedlot Biogas
Pressure Cool Company Indio, California Diven Meredith	Vegetable Cooling
Republic Geothermal, Inc. Santa Fe Springs, California Mike Walker Terry Thomas	Direct Heat Applications Direct Heat Applications
Shipper's Ice El Centro, California	Commercial Refrigeration
TRW Redondo Beach, California Lee Leventhal	Sugar Beet Processing

Persons and Organizations Contacted (continued)

Ultrasystems, Inc.
Irvine, California
Bill Prentice

Geothermal Ethanol

University of California
Davis, California
Dr. Leonard Morris

Produce Handling

VTN, Inc.
Irvine, California
John Lane

Geothermal Ethanol

Westec Services, Inc.
San Diego, California
Chris Lane

Direct Heat Applications

GREENHOUSES

OTHER UTILITIES

30 Kw Electric

OPERATING LABOR

18 Persons

PLANT CAPITAL COST

\$4,823,000 (Mid 1980)

Figure 2.1

VACUUM COOLING

OTHER UTILITIES

1,000 Kw Electric

OPERATING LABOR

8 Persons

PLANT CAPITAL COST

\$3,000,000 (Mid 1980)

Figure 2.2

VEGETABLE COOLING

OTHER UTILITIES

50 Kw Electric

OPERATING LABOR

8 Persons

PLANT CAPITAL COST

\$1,200,000 (Mid 1980)

Figure 2.3

ALFALFA DEHYDRATION

Figure 2.4

FEEDLOT OPERATIONS
(BASIS: 10,000 HEAD OF CATTLE)

Figure 2.5

AQUACULTURE - CATFISH

Figure 2.6

ONION DEHYDRATION

Figure 2.7

FROZEN VEGETABLES

Figure 2.8

ETHANOL

Figure 2.9

FERTILIZER PRODUCTION

OTHER UTILITIES

8,400 Kw Electric (Incremental)

PLANT CAPITAL COST

\$9,500,000 (Incremental Mid 1980)

Figure 2.10

3.0 CASE METHODOLOGY, ASSUMPTIONS, AND SOURCES OF TECHNICAL AND ECONOMIC DATA

3.1 Agriculture

3.1.1 Greenhouses

The heating loads shown on the block flow diagram were taken from a report by Lineau (1978), corrected to a location at El Centro by allowing for the difference in heating degree days. Data for heating and cooling degree days were taken from the California Solar Data Manual (Berdahl 1978). Cooling loads were calculated from cooling degree days using the same method, and the corresponding geothermal heat loads for absorption refrigeration were calculated, using methods presented by Harris (1977). The interior temperature of the greenhouse was assumed to range between 70°F and 80°F. The capital cost is from Lineau (1978), corrected to mid-1980 by using the C.E. plant cost index from Chemical Engineering magazine. Operating labor is from the report by Geonomics (1977), and assumes the number of persons required per acre is constant. The electric power requirement is from Lineau (1978).

The amount of fossil fuel that could be displaced by using geothermal energy for the example given is equivalent to 20,500 barrels of oil per year. This assumes a fuel value of 6.0 million Btu per barrel of oil, and a heater efficiency of 80%.

3.1.2 Crop Cooling and Packing

The heating loads shown on the block diagram were estimated from data provided by vendors of this type of equipment, as were the capital cost, manpower and utility consumption. The annual energy consumption of the vacuum cooling system was based on operations during the four month harvest season at half the maximum throughput for 10 hours per

day. The annual energy consumption of the cold room operations was based on a nine month season for fall and spring melons, plus the carrot and broccoli harvest in winter and spring. The estimate was based on an average usage of half the maximum capacity.

3.1.3 Dehydrated Alfalfa

The heating load shown on the block flow diagram is based on alfalfa with an initial moisture content of 75%, and dried pellets with a moisture content of 10%. These figures and a requirement of 8000 Btu per pound of dried pellets are from the report by Lineau (1978). A plant cost from the same source, for a smaller plant, was corrected to the plant size shown by using an exponential factor of 0.6 on the size ratio. The resulting cost was updated to mid-1980 by use of the C.E. plant index. Operating labor assumes a requirement of three persons per shift and three shifts per day. The electrical requirement of 500 kW is assumed to be the same as for onion dehydration. Assuming continuous year-round operation, the fossil fuel that could be displaced by using geothermal energy for the example given is equivalent to 32,000 barrels of oil.

3.1.4 Feedlot Operations

The heat load for the feed mill was estimated from data provided by an Imperial County feedlot operator. The digester heat load was taken from CH₂M Hill (1980). The residue dryer is very similar to an alfalfa dryer, so the same heat load values were used and adjusted for the different quantities of material. The annual heat consumption figures were based on continuous operation of the feedlot. The cost of the feed mill geothermal equipment was estimated by the Ben Holt Co. The cost of the biogas plant was taken from CH₂M Hill (1980), and corrected for size and date of construction. The residue dryer was estimated to cost the same as the alfalfa dryer.

3.2 Aquaculture

3.2.1 Malaysian Prawns

The qualitative data presented were obtained from publications and interviews with persons engaged in this industry.

3.2.2 Catfish

The flow rates, fish density, annual production, facility size, and water temperature shown on the block flow diagram are taken from an article by Ray (1979). For the facility described in the article, geothermal water is mixed with cold well water to achieve the desired temperature. Since the salt content of Imperial County brines will generally make direct mixing unacceptable, indirect heating is used in the example shown. A temperature of 60°F was assumed for the incoming irrigation water; higher temperatures would reduce the heating load. The capital cost is a preliminary factored estimate based on the use of concrete raceways. Operating labor is an estimate only. The electric power requirement is based on pumping the irrigation water.

If it is assumed that heating will be required for four months of the year, the oil equivalent of the geothermal energy used would be 53,300 barrels per year. This does not, however, represent displaced oil. The economics of catfish aquaculture are such that the cost of fossil fuels would be prohibitive.

3.3 Food Processing

3.3.1 Vegetable Dehydration

Heating loads for dehydration vary with the vegetable being dried. The heating and utility requirements shown in the block flow diagram for onions are from a report by Lineau (1978). Operating labor and plant

capital cost are from an article in Geothermal Resources Council Bulletin, Vol. 7, No. 5, with the capital cost updated to mid-1980 by use of the C.E. plant cost index. The same article states that the plant is expected to replace 117 million cubic feet of natural gas per year while processing onions, celery, and carrots. Correcting for plant size and converting to the oil equivalent gives a figure of 15,000 barrels of oil per year.

3.3.2 Freezing

Refrigeration heat loads, utilities, operating labor, and plant cost are from a report by Harris (1977). The plant cost was updated to mid-1980 by using the C.E. plant cost index. Geothermal heat loads to supply the absorption refrigeration loads were calculated using methods presented in the same report. The fossil fuel displaced by using geothermal energy for this example is equivalent to 400 barrels per year of oil.

3.3.3 Vegetable Canning

Data on the temperatures required for canning are found in the Geothermal Resources Council Special Report No. 7.

3.4 Ethanol

The heating loads shown on the block diagrams were based on a report by Stenzel, et al (1980). The capital cost and manpower requirements are composite values based on several proposed projects. Wheat was chosen as the feedstock for the typical plant so that published data could be used directly. If corn is the preferred feedstock in Imperial County, the energy requirements or plant economics should not significantly change.

3.5 Industrial and Manufacturing

3.5.1 Mineral Recovery

No quantitative data for this process were available in the literature.

3.5.2 Fertilizer Production

The heat loading shown in the block diagram was derived from a report by Sherwood (1977). The cost of plant modifications was corrected to mid-1980 by using the C.E. plant cost index.

3.6 Cost of Geothermal Heat

In order to evaluate the economic incentive for substituting geothermal heat for traditional energy sources, the price at which geothermal energy can be obtained must be known. There are two ways to determine the price of geothermal energy. One is to price it to be competitive with alternative energy sources on a Btu delivered basis. Using this formula, the cost of geothermal energy will fluctuate with the price of oil and gas.

The second method is to price the energy based on the cost of production. On this basis, the cost will vary from site to site depending on the costs of well drilling and exploration, fluid composition, and other factors. Recent unpublished analyses made by the Ben Holt Co. indicate that the current cost of producing fluid from a 300°F to 400°F reservoir in Imperial County would be around \$.15 to \$.25 per thousand pounds of fluid. For an application using 300°F fluid and rejecting it at 200°F, this would result in an energy cost of \$2.00/MMBtu, which would compare favorably with natural gas at \$3 to \$4/MMBtu, or crude oil at \$5 to \$6/MMBtu. Low-level heat at 200°F should be available from power plant reject streams at considerably less cost.

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Jones, J.L. "The Economics of Methane Production by Bioconversion of Cattle Feedlot Residues", SRI International, 72nd Annual Meeting A.I.Ch.E., San Francisco, November 1979.

Linden, J.C., V.G. Murphy and A.K. Moreira. "Wheat Straw Autohydrolysis", Department of Agriculture and Chemical Engineering, Colorado State University, Fort Collins, Colorado, Proceedings VI International Fermentation Symposium, Pergamon Press, 1981.

Lineau, P.J. Agribusiness Geothermal Energy Utilization Potential of Klamath and Western Snake River Basins, Oregon, DOE Report IDO-1621-1, Geoheat Utilization Center, Oregon Institute of Technology, March 1978.

McCabe, B.C., Jr. "Brady Hot Springs Greenhouse Projects", Geothermal Energy Magazine, Vol. 1, No. 1, August 1973.

Murphy, V.G., J.C. Linden, A.R. Moreira and K. Dockrey. "Use of Geothermal Hot Water to Pretreat Lignocellulosic Materials", Presented at Second Chemical Congress of the North American Continent, Las Vegas, Nevada, August 1980.

Ray, L. "Channel Catfish (*Ictalurus Punctatus*) Production in Geothermal Water", Geothermal Resources Council, Special Report No. 5, A Symposium of Geothermal Energy and Its Direct Uses in the Eastern United States, April 1975.

Reistad, G.M. Direct Application of Geothermal Energy, DOE Report DOE/ET/20501-T1, Oregon State University, 1979.

Rosenbruch, J.C. and R.G. Battage. "Geothermal Agricultural Applications - Hobo Wells Hydroponics", Geothermal Energy Magazine, October 1976.

Sherwood, P.B. and K.L. Newman. Engineering and Economic Feasibility of Utilizing Geothermal Heat from the Heber Reservoir for Industrial Processing Purposes at Valley Nitrogen Producers, Inc., El Centro Agricultural Chemical Plant, DOE Report SAN-1323-3, Wester Services Inc., September 1977.

Stenzel, R.A. et al. Ethanol Production for Automotive Fuel Usage, DOE Report DOE/ID/12050-3, Bechtel National, Inc., August 1980.

4.0 SOCIOECONOMIC EFFECTS

4.1 Introduction

The primary purpose of this task is to identify the potential social and economic effects from development of geothermal direct heat applications in Imperial County. The intent of the task is to identify potential impacts so that planning for any necessary services and facilities can be initiated. The estimated population which might enter the County as a result of employment generated by direct heat application would be the primary concern. Any substantial incoming population would require additional public and private investment in facilities, in addition to increases in the operational costs of providing services.

The analysis undertaken in Tasks 1 and 2 identified the potential types of industries, the related employment, and investment requirements for direct heat applications. The analysis indicated that, depending upon the type of industry involved, employment increases could vary from six to 75 persons. The related investment could be as high as \$40 million for an ethanol plant to as low as \$110,000 to initiate aquaculture catfish farming in the County. A summary of the major types of industry identified in Tasks 1 and 2, and their employment and investment requirements, is shown on Table 4.1.

The major areas of concern for Task 3 would be the addition of new workers to the County and the resultant increase in population which might occur. This population would require additional public services, especially those provided by the County or other public agencies within the County. In addition to the service requirements, capital investment in facilities would also be required if a large incoming population is expected. As indicated in Table 4.1, the maximum expected employment for new industry utilizing direct heat would be 75 workers for a vegetable dehydration facility. Based on this size

TABLE 4.1
SUMMARY OF DIRECT GEOTHERMAL HEAT APPLICATIONS
INVESTMENT AND EMPLOYMENT

<u>Use</u>	<u>Investment</u>	<u>Employment</u>
<u>Agriculture</u>		
o Greenhouse	\$ 4,800,000	18
o Crop Cooling & Packing		
- vacuum	3,000,000	8
- cold room	1,200,000	8
o Alfalfa Dehydration	300,000	8
o Feedlot Operations		
- biogas	5,560,000	7
- residue dehydration	300,000	6
<u>Aquaculture</u>		
o Malaysian Prawns	N/A	N/A
o Catfish	110,000	30
<u>Food Processing</u>		
o Vegetable Dehydration	4,600,000	75
o Vegetable Freezing	890,000	8
o Produce Canning	N/A	N/A
<u>Ethanol</u>	40,000,000	50
<u>Fertilizer Production</u>	9,500,000	N/A

N//A = Not Available.

work force, management and administrative persons would likely total four to six workers. Based on the skills required in the vegetable dehydration process, most of the remaining work force would likely be met by workers already in Imperial Valley. Thus, the management or administrative staff could potentially come from outside the local area. This additional work force would result in a small new population to the County.

Analysis of employment and unemployment data for the County indicates an historically high level of unemployment. The latest data available indicate the annual average unemployment rate in Imperial County was 24.1% in 1979 and 22.7% in 1980. Normally, unemployment in the County has been highest during the summer months, with a gradual decline during the late fall and winter when agricultural activities are at a peak. As a basis of comparison, unemployment in the State of California during 1979 and 1980 averaged about 8%. Based on this consideration and the analysis of the type of employment and industry involved, it is unlikely that a significant number of outside or non-local workers would be entering the Imperial County area.

4.2 Public Service Issues

Early identification of public service needs is important for long-range planning in Imperial County. Constraints resulting from passage of Propositions 4 and 13 limit the ability of local taxing agencies to raise the necessary revenues to implement large-scale capital improvement programs. Recent changes in Federal programs, especially sewer and water grants administered by the Environmental Protection Agency, will necessitate greater reliance upon local taxing agencies to identify revenues to implement capital improvement projects.

In addition to this concern, capital improvements to public facilities often require long lead-times to ascertain necessary approvals, identify funding sources and mechanisms, design, bid, environmentally

approve, and construct. This process could involve years, while the level of service to existing users deteriorates.

The other major consideration involving public facilities is matching revenues and costs. This problem would occur when the geothermal investments (revenues) are located in one taxing area and the public facility needs (costs) in another. This is likely to occur in Imperial County where the KGRAs are located primarily in unincorporated areas, while the expected needs for facilities would occur in incorporated areas. Under current conditions, there is no method for distributing the costs and revenues between the jurisdictions.

4.3 Public Facilities and Services

The three primary facilities and services maintained by the public sector in Imperial County are water, waste water collection and treatment, and solid waste disposal. All incorporated cities provide water and sewer services to the residences within their incorporated areas. With the exception of El Centro, solid waste is collected by the cities, with the County owning and maintaining the disposal sites. Solid waste in El Centro is collected under contract by a private firm.

Private firms currently provide electricity, gas, and telephone services in Imperial Valley. These firms normally recover investment costs through the rates charged to customers. Normally, these services are provided as required at a rate sufficient to recover investment, operation, and maintenance costs. Thus, these services are not included in this analysis.

4.3.1 City of El Centro

The City of El Centro provides water and sewer services for residences located within the incorporated city area. The average annual water

usage in the city is approximately 150-200 gallons/day/person. The city is in the process of constructing a water clarifier, which should double the capacity of the water treatment system. Upon completion, the system should be able to serve twice the current population of the city.

The water distribution system is also being upgraded to eliminate a dead-end line and replace it with a loop system. In addition, plans have been developed to add an 18-inch pipeline to serve the western portion of the city. The water distribution system is in good condition, so there are no requirements for major capital improvements to the water system in the City of El Centro.

The City of El Centro also provides waste water treatment and distribution to residences located within the city. The sewerage treatment facility currently treats approximately 4.5 million gallons per day of waste water and has a treatment capacity of approximately five million gallons per day. The city is currently in the process of adding equipment to reduce maintenance and operational costs, but will not increase the treatment capacity of the plant. There are no plans to add capacity to the sewerage system.

4.3.2 City of Brawley

Brawley provides water and sewer treatment services to residences located in the city and in the Brawley County Water District, a 360-acre area east of the city.

Current average annual water usage in Brawley is about 250 gallons/day/person. The water treatment facility has a 30% reserve for pumping purposes. The city does not have a reserve capacity to store filtered water, but this is not a critical problem. The water distribution system is in good condition, and there are no plans to expand its capacity or change it. The city estimates the water treatment facility could accommodate an additional 1,000 connections.

Brawley also collects and treats sewage in the incorporated areas and for the Brawley County Water District. The treatment facility is operating at 40% capacity. A recently completed major rebuilding program added a clarifier, digester, and storage ponds. Thus, no addition of facilities is expected in the near future. The collection system is in good condition and does not require any investment at this time.

4.3.3 City of Calexico

Calexico, the County's third largest city, provides sewer, water, and solid waste services to residents within its boundary. The sewage treatment plant has a capacity of 1.9 million gallons per day, and the average annual flow is approximately 1.0 million gallons per day. Thus, no additions to the treatment plant are anticipated.

The Calexico water system can provide additional service without expansion. Current annual average consumption within Calexico is approximately 3.7 million gallons per day. The water treatment plant has the ability to provide 10.0 million gallons per day. Thus, additional capacity is not anticipated at this time. The distribution system is currently operating without major problems.

4.3.4 Imperial County

Eleven Class II-2 Solid Waste Disposal sites currently meet the need for disposal of non-hazardous solid wastes. Areas at several County disposal sites are used for disposal of certain special wastes under Water Quality Control Board permits. The 11 sites provide for the disposal of solid waste within 15 miles of most population centers in the County. Each of the seven incorporated cities of the County lies within 11 miles of a landfill site. Imperial County landfills have substantial remaining capacity; no site closures are anticipated before the mid-1990s, and most sites have capacity sufficient to last well into the next century.

In addition to the Class II-2 sites, there is also a privately operated Class II-1 geothermal waste disposal site in the County. The County is currently studying the possibility of establishing another Class II-1 site for geothermal waste disposal.

Imperial County Solid Waste Management Plan will ensure services are provided as necessary to meet the needs of any new industries locating in the County.

5.0 POTENTIAL GEOTHERMAL DIRECT USE DEVELOPERS

The previous analysis (Section 2.0) identified general industries which would be compatible with the agricultural base of Imperial County. These were then classified according to the Standard Industrial Classification (SIC) code, a system developed by the Office of Management and Budget for classifying all types of companies doing business in the United States.

Once these SIC codes were established, the information was given to Dun & Bradstreet Marketing Services to provide names of companies within the selected industries. Based upon the industries identified in the initial meeting and subsequent discussion with the County Geothermal Direct Heat Committee, a total of 26 SIC codes were identified and given to Dun & Bradstreet as a basis to conduct a records search. In addition to the SIC code parameter, only companies in the U.S. with annual sales of \$5.0 million or more were selected. Table 5.1 presents a summary of the industries and companies.

Information on the selected companies was provided by Dun & Bradstreet on index cards, which indicate company name, address, telephone number, chief executive, SIC code(s), sales volume and number of employees. In addition, a statistical summary and one set of peel-off mailing labels were provided. A sample card is shown at the end of this section.

TABLE 5.1
SUMMARY OF INDUSTRIES AND COMPANIES

SIC Code	Industry	Number of Firms
0181	Ornamental nursery products	88
0182	Food crops grown under cover	13
1089	Horticultural species, nec	3
0279	Animal specialties, nec	5
0723	Crop preparations services	306
1474	Mining of potash, soda and borate minerals	10
1492	Mining of gypsum	2
2011	Meat packing plants	427
2013	Sausages and other prepared meats	14
2032	Canned specialties	50
2033	Canned fruits and vegetables	233
2034	Dried and dehydrated fruits and vegetables	50
2035	Pickled fruits and vegetables	110
2037	Frozen fruits, fruit juices and vegetables	116
2046	Wet corn milling	27
2047	Dog, cat and other pet food	73
2063	Manufacture of beet sugar	14
2074	Manufacture of cottonseed oil	30
2076	Vegetable oil mills, except corn, cottonseed and soybean	17
2077	Animal and marine fats and oil, nec	69
2211	Broad woven fabric mills	121
2869	Industrial organic chemicals, nec	180
2873	Nitrogenous fertilizers	97
3111	Leather tanning and finishing	72
3295	Minerals and earths, ground or otherwise treated	57
4222	Refrigerated warehousing	17
Total		2,481

nec = not elsewhere classified

SAMPLE-DUN & BRADSTREET CARD

D-U-N-S NUMBER 07-020-0214		NAME & ADDRESS (MAIL ADDN BELOW LINE) KERN VLY PKNG CO OF B KSFLD 7100 S H ST BAKERSFIELD CA 93307				SEQ # 75	
SIC CODES 2011						JOB # 4314	
						STARTED ★ 1976	
LINE OF BUSINESS MEAT PACKERS				SALES VOLUME ★ \$3,000,000			
EMPL HERE 120	TOY EMPLS 120	HQS N/A	BR N/A	MFG YES	WHOLE LOC YES	SUB N/A	HQS D-U-N-S NO. N/A
NATL 000	STATE 04	CNTY 268	CITY 0509	DATA 055	PARENT D-U-N-S NO. N/A		
TELEPHONE NO. 805-831-2752				CHIEF EXECUTIVE K FUDNICK PR			

★ Does not apply to branches

R indicates minimum of range

N/A not available

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6.0 PLANNING POLICIES AND IMPLEMENTATION PROCEDURES TO FACILITATE DEVELOPMENT OF GEOTHERMAL DIRECT HEAT USES

6.1 Introduction

It is a stated goal of the County of Imperial to encourage the development of its geothermal resource. To date, the County, in the Geothermal Element to the General Plan and the Terms, Conditions and Standards for the Development of Geothermal Energy, has developed policies and permitting procedures for electrical generation projects. This task provides recommendations for County policies regarding direct heat utilization. The objective is to develop planning policies which will enable the County to encourage the utilization of geothermal resources for direct heat projects, while assuring the projects meet appropriate County standards.

6.2 Current Policies

Within the County of Imperial, there are seven developable designated Known Geothermal Resources Areas (KGRAs). These are: 1) Salton Sea; 2) Brawley; 3) East Brawley; 4) South Brawley; 5) Westmorland; 6) East Mesa, and 7) Heber. Other areas of the county are also being explored for geothermal resources. To date, major geothermal development in the County has occurred within these KGRAs. Three of the KGRAs, Brawley, Heber and the Salton Sea, contain a county-designated Geothermal Overlay Zone (G-Zone), which permits geothermal development under certain conditions. These include approval of a Conditional Use Permit for the proposed project, based upon appropriate environmental documentation, and the acquisition of other requisite permits, including air, water and solid waste. The Conditional Use Permit specifies the conditions under which a specific development may occur, the monitoring and mitigation measures that must be implemented, and other conditions as determined by the County.

For geothermal development to occur in an area outside of a G-Zone, either within or outside of a designated KGRA, the developer must obtain a zone change and Conditional Use Permit. Processing of the permits can proceed concurrently. Current procedures to obtain a zone change involve submittal to the County Planning Department of an application for a zone change, including an Environmental Information Form. This is reviewed and, if complete, an Initial Study is conducted. This goes to the Environmental Evaluation Committee which determines whether an EIR is necessary. If no EIR is required, a Negative Declaration is prepared. If an EIR is required, a one-year time limit is imposed on the granting or denial of the zone change.

6.3 Problems and Issues

Under current County procedures, certain specific issues surround the development of direct heat projects. These involve KGRA designations, G-Zones, private or public lands, and compatibility with agricultural development.

The Geothermal Element to the General Plan has been interpreted to allow the creation of Geothermal Overlay (G) Zones both within and outside designated KGRAs. The Geothermal Element also stipulates that geothermal development for electrical generation can occur only within a G-Zone. The development for direct heat uses is not specified. It appears, therefore, that direct heat projects would be allowed within a G-Zone, but, unlike electrical generation, may also be allowed outside of a G-Zone.

For purposes of this discussion, the County may be grouped into three land use classifications: 1) G-Zone/ non-G-Zone; 2) public/private, and 3) agricultural/non-agricultural. The G-Zone/non-G-Zone designation reflects County planning decisions; public/private designates land controlled by the BLM or County policies; and agricultural/non-agricultural indicates its current use. Therefore, land within the County may

be public or private and within or outside of an agricultural area which may or may not be overlain by a G-Zone. The realm of possibilities is depicted on the following Figure 6.1. Other land designations include marginal or prime agricultural land.

6.4 Discussion and Recommendations

The two major land status designations within the County are public, under jurisdiction of the BLM, and private, under County control. For purposes of this discussion, only private land will be addressed, since this is the area under the jurisdiction of the County.

Another land designation involves KGRA status which is a federal designation for an area known to contain geothermal resources. This designation is of decreasing importance, as County administrative procedures are no longer dependent on it. The KGRA status is determined by resource suitability for electric generation and does not consider the potential for direct heat development. It is therefore recommended that this designation not be considered for determining and administering development of the County's geothermal resources for direct heat uses. It is therefore not depicted on Figure 6.1.

The second land status to be considered involves the Geothermal Overlay (G) Zone, within which geothermal electrical development can be permitted upon the developer's fulfillment of specified conditions imposed by the County. Within a G-Zone, the primary concerns would be location of a proposed direct heat use and the conditions of a CUP. This designation is a critical element in the permitting process for direct heat uses, as its establishment reflects a finding by the County that geothermal development may be appropriate in specified areas.

The third important land designation is its agricultural status. This is critical because of the County's economic dependence on agriculture and the expense of creating land suitable for agricultural uses.

FIGURE 6.1
IMPERIAL COUNTY
LAND STATUS AND ZONING POSSIBILITIES

It may not be necessary to develop Terms, Conditions, and Standards specific to direct heat use, since the current "Terms, Conditions and Standards" are applicable to any geothermal well, whether used for electrical or for direct heat purposes. Similarly, County Zoning Codes can be applied to the facilities constructed to utilize the geothermal resource for direct heat use(s).

6.5 Recommended Procedures

6.5.1 Project Rationale

It is suggested that County permit requirements be based, in general, on the size of the project, since small projects would utilize less land area and create fewer environmental impacts. The following two criteria should be utilized for this determination:

<u>Subject</u>	<u>Criteria</u>
1. Land Area	A small project would utilize 5.0 acres or less of surface land area.
2. Number of Geo-thermal Wells	A small project would utilize a maximum of one production and/or one injection well and have geo-thermal fluid flow of no more than an average of 100,000 pounds/hour.

The small projects would require only the approval of the County Planning Director. Large projects would require a Conditional Use Permit or an Environmental Impact Report and, possibly, a zone change.

In addition to the size criterion, the agricultural base of a project should be considered in the permit procedure. This consideration is consistent with the County's policy to maintain agriculture as a major economic base. The following description should be used to define agricultural and non-agricultural projects. As a general statement, an agricultural project is one which utilizes local area plant or animal raw materials, or produces an agricultural product or promotes the

cultivation of local products to be used as raw materials. Local area is defined as within Imperial County.

Agricultural Project

Uses plant or animal raw materials which are raised in or imported to Imperial County to produce or process an agricultural or food product. Examples include using local and/or imported crops for freezing, drying, canning, or greenhousing, using local and/or imported livestock for slaughter, using local and/or imported corn to manufacture ethanol, corn syrup.

Non-Agricultural Project

Uses local or imported mineral-based raw materials or other materials which could not be produced locally. Examples include tin for can manufacture, paper for labeling.

Although project size and type would likely be the primary factors determining the permit requirements, specific zoning performance standards should be adopted by the County as a basis to control the development of direct heat projects. These performance standards would be set forth in the CUP and act as an upper limit which must be met in order to undertake and operate the project. Enforcement of performance standards would minimize the environmental impacts of the project. Performance standards would provide guidance to developers in planning and engineering their projects.

The intent of these procedures is to provide guidelines or a series of administrative steps which could be utilized by the County or a potential direct heat developer to ascertain the permitting and environmental documentation requirements. The proposed procedures provide the framework to develop specific County regulatory requirements which could be set forth in the County's Administrative Procedures and Zoning Code. The procedures should be considered a sequence of checks or reviews to be utilized in determination of the necessary project documentation. As discussed above, the three major areas of concern involve location within or outside of a G-Zone, the size of the project, and whether the project is agricultural or non-agricultural.

Once a direct heat project is proposed for development within the County, the criteria of location, size, and agricultural or non-agricultural would be determined by the Planning Department from information supplied by the developer. The location of a project would be within or outside of a G-Zone. The project could be small or large, agricultural or non-agricultural. The outcomes of these determinations and their related permitting requirements are shown in the following table and discussed in the cases.

<u>G-Zone Status:</u> <u>Size of Project:</u>	<u>Inside</u>		<u>Outside</u>	
	<u>Small</u>	<u>Large</u>	<u>Small</u>	<u>Large</u>
Agricultural	Case 1	Case 2	Case 3	Case 4
Non-agricultural	Case 2	Case 2	Case 4	Case 4

6.5.2 Process Determination

The following examples are based on the project determinations and describe the various conditions under which the County's geothermal direct use permitting procedures would occur.

Case 1 (small agriculturally-oriented project, within a designated G-Zone)

With a small, agriculturally-oriented project, within a designated G-Zone, the County's Planning Director, acting under the authority designated by the Board of Supervisors as the County's Zoning Administrator, could authorize the development. This procedure requires notification of the surrounding property owners that the project is going to be decided, but does not entail a formal hearing. Since the project is small and the G-Zone would have previously been subject to environmental documentation, additional analysis would not be required. A Negative Declaration would provide sufficient environmental documentation for the project to proceed.

Case 2 (large, agriculturally-oriented and/or any non-agriculturally-oriented project, within a designated G-Zone)

With a large agriculturally-oriented and/or non-agriculturally-oriented project within a designated G-Zone, approval of a CUP from the County Planning Commission would be required prior to development of the project. The environmental documentation would be similar to that required for Case 1.

Case 3 (small, agriculturally-oriented project, outside of a designated G-Zone)

Since the project location is outside of a designated G-Zone, previous analysis of the area would not have been completed. Thus, for a small, agriculturally-oriented project, outside of a designated G-Zone, a CUP would be necessary. The environmental documentation requirements could be fulfilled by a Negative Declaration. If significant environmental effects of the project are identified in the Initial Study, the developer would be required to provide mitigation measures to a point where no significant environmental effects would occur.

Case 4 (large, agriculturally-oriented and/or any non-agriculturally-oriented project, outside of a designated G-Zone)

Large agriculturally-oriented and/or non-agriculturally-oriented projects outside of a designated G-Zone would require a zone change, if not within an industrially zoned area, a CUP, and an EIR or Negative Declaration.

6.6 Industrial Performance Standards

Use of industrial performance standards provides a method of classifying and zoning industries in accordance with their environmental effects upon the community. They have been described as being a rational basis for industrial zoning. Performance standards can be

used instead of the typical use lists which comprise many city and county zoning ordinances. The use lists have two major advantages: 1) they are easy to write; 2) they are relatively simple to administer and enforce. However, use lists do not do an effective and equitable job in zoning, as it is difficult to include in a use list all possible new industries, changes in existing industries, or new technology. This is especially important relative to direct heat uses, since new applications and technologies may be required for projects. Another shortcoming of use lists is that they fail to distinguish between plants manufacturing the same product. Also, the size of a plant has a tremendous bearing on potential environmental effect, but this is not taken into consideration in most use lists. Finally, most industrial nuisances are not associated directly with the product manufactured, but with the process utilized.

In order to overcome these and other inequities of use lists, performance standards can be utilized in industrial zoning to translate the classical light, medium, and heavy industrial categories into well-defined, meaningful terms dealing with environmental effects. The environmental effects which can be controlled in zoning performance standards are noise, vibration, air pollution, glare, fire, explosion hazards, heat, liquid waste, and solid waste.

6.6.1 Administration of Performance Standards

Effective administration of performance standards will be required to achieve the desired environmental protection. Administration should be divided into two steps: 1) prior to construction; and 2) after the plant is built. The first effort will involve the evaluation of the design and operational characteristics of the plant to determine in advance whether it is likely to meet required performance standards. In administration after the plant is built, the least expensive procedure would be for the County to act only upon a complaint. Alternatively, the County could require projects to undergo a conformance

check after construction to ensure that performance standards are being met. Projects could then be checked annually or at some other time.

6.6.2 Designing Performance Standards

Generally, performance standards for industry should be designed with a particular community in mind. There are two methods for establishment of performance standards: 1) ambient standards; and 2) emission rates. With the ambient standards approach, a particular level of environmental contaminant is established. The performance standard which will ensure that these levels are not exceeded is then set.

Ambient controls on nuisance effects are another approach for emission controls. An emission control specifically states to the potential project developer the exact amount of nuisance that will be permitted. Since specific emissions, discharge, and disposal requirements have been established by federal, state, and county regulatory agencies, these standards must be met in order for projects to proceed within the County. These requirements provide the basis for establishing specific performance standards

Among the specific factors which affect performance standards are:

1. Size of the County and type of direct use projects which might be attracted to the County.
2. Other industries in the County.
3. Existing federal, state, and county regulatory requirements.
4. Complexity of the standard. The standards should be drafted so that they can be understood and enforced locally.

In writing the performance standards, it is useful to include a statement of intent to clarify the purpose of that section of the zoning ordinance and to give the community some principles to fall back on when the ordinance language is questioned. The zoning ordinance should also include a statement indicating how the standards should be applied.

6.7 Specific Standards

As indicated in the previous discussion, designation of performance standards requires analysis of a variety of factors prior to a final determination of the criteria. Specific standards should be established to maintain or, where appropriate, improve the existing ambient environmental conditions in the County.

The proposed performance standards should be subject to the same public review as those required for other ordinances in the County. This review should include, as a minimum, a public hearing before the County Planning Commission and Board of Supervisors, with opportunity for testimony from the public and other interested parties.

The primary intent of performance standards is to provide a method of classifying and zoning industries in accordance with the environmental effects upon the area. The specific standards must initially be met by the developers when the permit application is submitted. If the standards cannot be initially met, the developer should be required to undertake appropriate measures to mitigate the non-performing criteria so that the project will be in compliance when operations begin. Subsequently, the criteria should be measured in order to ensure compliance with the specified standard.

The County has previously set forth extensive Terms, Conditions and Standards for drilling and operation of geothermal wells. These standards provide an initial basis for further identification of

standards related to direct use projects. The major areas for further definition are air emissions, surface water discharge, waste handling and disposal, geothermal fluid disposal, odor emissions, glare, obstructions, electronic interference, and intrusion on agricultural activities. Many other criteria for these areas of concern have been set forth in county, state, and federal regulations.

Recommended performance standards for direct use products in the County are shown on Table 6.1.

TABLE 6.1

RECOMMENDED PERFORMANCE STANDARDS
FOR DIRECT HEAT GEOTHERMAL PROJECTS

Subject	Criteria
Air Emissions	Projects shall meet all County of Imperial Air Pollution Control District standards for emissions.
Surface Water Discharge	No discharge of water to the land surface shall be permitted, except under conditions approved by the State Regional Water Quality Control Board and the Imperial Irrigation District. In these cases, projects shall meet discharge standards set by these agencies. In no case shall geothermal fluid be discharged to the surface, except in approved containment facilities.
Waste Handling and Disposal	All waste, whether liquid or solid, must be disposed in compliance with County, state, and federal regulations.
Odor	Projects shall not release harmful or obnoxious odors or gases. Compliance with this standard shall be measured at the project boundary by a panel appointed by the Planning Commission.
Noise	The maximum sound pressure level from any project shall not exceed 65 dBA at the lot-line when measured with a Sound Level Meter which conforms to requirements of the American National Standards Institute. In no case shall sound pressure level from a project exceed 60 dBA at the nearest residence. In all cases, noise shall be muffled so as not to be objectionable due to intermittence, beat, frequency, or shrillness.
Glare	All lights shall be directed or shielded to confine all direct rays to the site.
Obstructions	All facilities and structures should be in compliance with guidelines set forth in Federal Air Regulations Part 77 and be marked and lighted in accordance with Federal Aviation Administration Standards.

TABLE 6.1 (cont.)

Subject	Criteria														
Electronic Interference	No project shall operate electrical equipment which will have a detrimental effect on the reception of radio or television signals.														
Siting Criteria	<p>No projects shall be permitted to interfere with agricultural activities in the County, including cultivation and crop dusting. In addition, the following minimum distances shall be observed when siting facilities, unless waived by the Planning Commission.</p> <table> <tr> <td>Outer Boundary of Parcel:</td><td>30'</td></tr> <tr> <td>Permanent Public Waterway:</td><td>50'</td></tr> <tr> <td>Public Roads (centerline):</td><td>80'</td></tr> <tr> <td>Residence:</td><td>100'</td></tr> <tr> <td>School:</td><td>500'</td></tr> <tr> <td>Hospital:</td><td>500'</td></tr> <tr> <td>Any other development:</td><td>100'</td></tr> </table>	Outer Boundary of Parcel:	30'	Permanent Public Waterway:	50'	Public Roads (centerline):	80'	Residence:	100'	School:	500'	Hospital:	500'	Any other development:	100'
Outer Boundary of Parcel:	30'														
Permanent Public Waterway:	50'														
Public Roads (centerline):	80'														
Residence:	100'														
School:	500'														
Hospital:	500'														
Any other development:	100'														
Vibration:	No vibration shall be produced which is transmitted through the ground and is discernible without the aid of instruments at, or at any point beyond, the lot line.														
Heat:	There shall be no emission or transmission of heat or heated air so as to be discernible at the lot line.														
Fire and Explosion Hazards:	All activities involving use and storage of flammable and explosive materials shall be provided with adequate safety devices against the hazard of fire and explosion and adequate fire-fighting and fire suppression equipment and devices standard in the industry. Burning of waste materials in open fires is prohibited. Relevant provisions of other state and local laws and regulations also shall apply.														

7.0 DEVELOPMENT PLAN

7.1 Introduction

The presence of large-scale geothermal resources in Imperial County presents a unique opportunity for industrial-type development. Although the development of geothermal resources should be compatible with the existing agricultural activities, development of direct heat uses could ultimately provide a basis for diversifying the economic base of the County. This diversification can provide stability in employment, opportunity for additional growth, and the basis for increased tax revenue to the County.

Development of a viable plan to market the potential direct heat uses of these geothermal resources will depend upon a variety of factors. The initial steps of the marketing plan have been completed in the previous tasks. Task 1.0 identified the potential types of uses which could be compatible with the agricultural base of Imperial County. Task 4.0 identified the individual businesses, within the larger industrial classifications identified in Task 1.0. For Task 6.0, a survey was utilized to assist in identifying the specific needs of the individual market participants and to develop a method to fulfill the needs of this market.

The identification of the market indicated two broad categories of potential direct use applications for the County. The largest potential market would be those related to food processing or other direct agricultural-related uses of raw materials produced or imported to the County. These general categories of agricultural use involve:

- o Manufacturing, including food processing, dehydration, canning, or freezing.

- o Agricultural production, such as nurseries and cattle feed-lots
- o Processing, including crop refrigeration

The other category of potential direct use involved other manufacturing activities. The primary identified uses are:

- o Industrial chemicals, including ethanol or fertilizer.
- o Textile production, including fabric mills.

The specific companies with \$5.0 million or more in annual sales located in the United States have been identified by Dun & Bradstreet (D&B). According to data supplied by D&B, there are 2,325 companies which meet these criteria. This information is shown on three-by-five index cards, a statistical listing, and pressure-sensitive mailing labels (see Section 5.0).

7.2 The Marketing Plan

The primary intent of the marketing plan is to distribute information about the potential for geothermal direct use applications in the County and to provide sufficient incentive so the potential user will ultimately locate in the Valley. This plan will suggest a method for distribution of information to potential users. The ultimate decision, of course, will depend upon a series of complex choices made by the individual company. The County must be willing to provide an attractive setting for the company and extensive personal contact in order to influence the location decision.

The marketing plan has been designed to minimize expense and to provide maximum distribution of the available information. Since distribution of information will entail costs to the County, where possible, "no cost or minimum cost" methods should be utilized.

The recommended marketing plan would involve two major tasks--selection of priority industries and companies, and distribution of the booklet. The initial step would be to review the 26 SIC codes and prioritize the industries as to those most likely to locate in the County.

Upon completion of this effort, a second ranking should be made of the companies within the identified codes. The purpose of this selection is to further identify companies which might locate in the Valley. Potentially, companies within California should be selected to receive the information booklet first.

Prior to distribution of the information booklet, a cover letter or letters should be developed to highlight information in the booklet relevant to the particular recipient. The cover letter should be signed by the County's point of contact.

The booklet should then be mailed to the selected initial group of 50 to 100 businesses. Following this distribution, a program of follow-up should be implemented to include a letter or telephone call to solicit response to the brochure and its information. The follow-up can be done on a small scale to minimize expense to the County.

The intent of this follow-up is to identify information which may need clarification and/or expansion and can be accomplished through alterations to the cover letter. For example, if specific information on the resource temperature is necessary, it can be added to the cover letter. If no further information is necessary, changes in the cover letter would not be required.

Following this initial mailing, an additional series of booklets can be mailed, to provide a wider distribution to the selected industries. Potentially, another follow-up survey could be conducted.

In addition to the mailing of the brochure, a program of news releases/ notifications should be implemented. For the most part, this method can provide free dissemination of information. A news release should be prepared for local and national newspapers, professional, technical, and trade journals and magazines, the California Energy Commission, the Geothermal Resources Council, the Economic Development Administration, the California State Chamber of Commerce, and associations related to the identified industries. The release should indicate the findings of this study and provide a brief summary of the information contained in the booklet.

If the information is provided as a news release, it will often be published as a news item free of charge. Under these conditions, the information should be sent to the California Energy Commission and the Geothermal Resources Council with an indication of the intent and purpose of the release.

In addition, the news should be released through the U.S. Department of Energy and the U.S. Department of Commerce, Economic Development Administration. Both agencies can provide a wider distribution of information through their particular channels. Each of these sources or agencies should be contacted prior to sending the news release. A brief discussion with the agency will to ensure the information is included in their mailings.

7.3 Marketing Point of Contact

In addition to the effort involved in distribution of the information booklet, the marketing plan should include extensive personal contact with potential direct heat users. This personal contact will most certainly be required to convince a company to locate in the County and develop a direct heat project. To accomplish this effort, the County should designate a marketing point of contact for direct heat projects, with overall responsibility for marketing direct heat projects for the

County. Necessary support from County departments should be made available.

The County's Division of Community and Economic Development (DCED) is responsible for economic development activities for the County. The DCED has developed an extensive information package related to activities in Imperial County and a program for distribution of the data. Since the DCED has the assigned responsibility for development, this Department should be designated as the marketing point of contact. This designation would be consistent with their current activities.

The marketing point of contact within DCED should be responsible for a wide range of activities. The intent of this function is to provide continuous liaison between the County and potential heat users. Specific activities of the position would include:

- o Further develop and refine the marketing plan.
- o Maintain contact with geothermal resource developers in the County.
- o Identify specific opportunities for projects.
- o Maintain and provide technical, financial, marketing, community and regulatory information to potential direct heat users.
- o Provide data on the availability of land for development.
- o Coordinate the status of federal, state and county permitting activities, as necessary.
- o Attend appropriate geothermal industry conferences and meetings.

Since this will be a wide-ranging function, the marketing point of contact should command the respect of geothermal resource developers, officials and industries within the County, and regulatory and permitting agencies.

Notwithstanding the large market outside of the local area, businesses within Imperial County could develop direct heat projects. Since most of these firms should be familiar with the geothermal resources in the County, businesses within the identified SIC codes should be sent an information booklet and, if appropriate, individually contacted by the marketing point of contact. Development of a project by a local firm would indicate the viability of direct use projects and be a source of publicity for geothermal energy.

7.4 Direct Heat Use District

Investment in geothermal production and injection facilities is often one of the most prohibitive aspects of geothermal projects. For electrical generation projects, the required investment in the geothermal facilities, although substantial, is not disproportionate to the total investment in the project. However, for direct use projects, the investment to develop dedicated production and injection facilities can become a major share of the total project. Depending upon the project, the investment in the geothermal facilities may exceed all other capital costs and can be a major barrier to development of direct use projects.

A potential method to spread or allocate the cost of this investment is to establish a direct heat use district patterned after a geothermal heating district. Although it could be part of an electrical generation project, a direct heat district could be developed at the site of any geothermal resource.

The distribution system, from the resource developer to the direct heat user, would have certain characteristics of a heating district. As such, a heating district is subject to regulation by the Public Utilities Commission (PUC). However, there are currently no established PUC procedures or regulations to apply to the distribution and purchase of geothermal heat for direct use. The legal staff of the PUC makes decisions on a case-by-case basis. Therefore, a project cannot be designed to achieve a desired "fit" with the regulations. Rather, a proposal must be submitted to the PUC which would then be analyzed and receive a project-specific ruling. There is legislation proposed which would provide limited exemptions to relieve the possibility of certain projects being classified as public utilities.

The distribution system could be publicly owned, privately owned, or be a joint venture. Public ownership could be established by a city, county, or special district, provided authority has been granted by state law. The special district is an independent local government unit created to carry out a single or limited number of specific functions.

Major considerations in selecting a local government entity to operate a geothermal direct use system include: the location of geothermal resources in relation to the local government's boundaries; the ability of the local government to operate outside its boundaries; the legal power of the local government to perform specific geothermal activities, such as exploration, production and disposal, reservoir management, distribution and sales, and financing; the applicability of state public utility oversight of the local government operation, and the type and accessibility of the governing body and management system employed by the local government.

Geothermal districts can also be undertaken by private enterprise, either through existing investor-owned utilities or new ventures organized specifically for the project. As geothermal developers, private

enterprises enjoy considerable tax incentives, which are unavailable to other entities. These include accelerated depreciation, intangible drilling deductions, depletion allowance, and business and energy investment tax credits. An example of requirements for a private district is the City of Klamath Falls Preliminary Model Ordinance for Municipal Geothermal District Heating and Reservoir Management, Article 4, Private Heating Services, Section 39, Establishment, Services, and Conditions. The private facilities would be subject to city and state regulations and standards, with the following minimum provisions: 1) the franchise shall be for no longer than twenty (20) years; 2) the franchise shall require that such land developers compensate the City annually with a franchise fee in an amount to be negotiated, and 3) such franchised geothermal heating systems shall be subject to City acquisition at depreciated fair market value upon the expiration of the franchise.

Another possibility is to establish a nonprofit cooperative or development corporation, a type of private entity generally organized to provide a service without profit for the public's benefit. Unlike local governments, whose legal powers are limited by the state constitution and statutes, nonprofit cooperatives can engage in any lawful activity that serves business purposes, such as geothermal district heating.

Another operating structure is a joint venture between the public and private sectors, or between units of local government. Such joint structures could include local governments or cooperatives on the public side, with investor-owned utilities or resource companies on the private side. Geothermal districts are particularly suitable for joint ventures, based on one party producing the resource, a second party distributing it, and perhaps a third party providing financing to one or both of the other parties. As such, it is an effective means of assembling expertise, spreading risks, and increasing financing options.

A number of operating and financial benefits can be achieved through joint structuring. In the case of geothermal resource production, a private developer's investment can be leveraged to improve potential returns, while also enjoying substantial tax benefits. In the case of resource distribution, where private developers are disinclined to come under public utility regulations, public entities are able to utilize tax-exempt financing and public utility exemptions to their advantage.

Such joint structuring also provides the opportunity for innovative project financing. The tax credits accruing to a system could be "traded" from a public operating entity to a private financing entity in exchange for more favorable financing terms. Or, a project's contractors or suppliers could provide services or equipment in return for an equity share in the project, thereby reducing initial capital and financing costs, and providing a major incentive for superior contractor and supplier performance in the project.

Other opportunities could be explored, related to the type of direct use projects being contemplated. Such innovative financing arrangements would be suggested by the size of the project in terms of both cost and resource demand. Other factors would include type and duration of the project, project owner, previous industry experience, experience of the project proponent, timing for return on investment, and potential for PUC regulation.

APPENDIX
BIBLIOGRAPHY OF GEOTHERMAL USES

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★U.S. GOVERNMENT PRINTING OFFICE:1983-646-069 2081