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PROSPECTS FOR
GEOTHERMAL COMMERCIALIZATION IN
THE GREENHOUSE INDUSTRY

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INTRODUCTION

This is one of four reports on studies conducted by the Earl Warren Legal Institute on the prospects for commercialization of geothermal energy in selected industries, including greenhousing, potato and onion processing, and certain segments of the lumber and chemical processing industries.¹ These particular industries were selected for study from a number of possibilities suggested in the Institute's earlier survey of existing and potential users,² and from a review of existing engineering and economic feasibility work undertaken by others. Our objective in these studies has been to identify and analyze specific legal, economic and institutional barriers to the direct use of geothermal energy as perceived by firms representing each of the industries selected. The results reported here are based upon extensive personal interviews conducted systematically with substantial numbers of decision-makers representing varied segments of each industry studied.

We focused in this study upon a number of areas considered directly relevant to a particular greenhouse firm's decision to use or not to use geothermal energy for its commercial needs. These areas include: 1) Current fuel uses and problems, and future fuel concerns; 2) Firm decision-making processes, including managerial and financing conventions; 3) Perceived commercial potential for geothermal energy in the industry and mechanisms for stimulating interest; 4) The

1. See also: Prospects for Geothermal Commercialization in the Lumber Industry; Prospects for Geothermal Commercialization in the Chemical Industry; Prospects for Geothermal Commercialization in the Potato and Onion Industry. Earl Warren Legal Institute, 1979-80. In addition to these industry reports, the Institute intends to publish a fifth report synthesizing the results of its work and analyzing its overall implications for government policy.
2. See: Second Interim Report on Legal and Institutional Considerations in the Commercialization of Geothermal Resources for Direct Uses, submitted to the Department of Energy, February 22, 1979.

potential institutional frameworks for user involvement in geothermal development; and 5) The role that government might most effectively play in stimulating user development.

We hope that this report will present a useful description of the greenhouse industry's approach to the possibility of geothermal use, the major factors likely to influence individual decisions in this area, and suggestions to guide both the government and the private developer in encouraging rational development of geothermal resources.

I. BACKGROUND ON THE GREENHOUSE INDUSTRY

The greenhouse industry consists of firms which grow vegetables, flowers, and plants in enclosed, climate-controlled spaces. Vegetable cultivation is a very small segment of the industry, concentrating mainly on tomatoes, cucumbers, and peppers. It suffers from strong competition with Mexican tomatoes and U.S. field-grown vegetables, which can be produced much more economically. Accordingly, greenhouse vegetables are currently grown for the higher-priced specialty market.

The cut flower sector of the industry is quite large, with 299.6 million square feet under glass in the United States in 1974. Thirty-eight percent of that total is in the western states, where the average farm size is nearly twice the national average. Greenhouse flower production grew about 40% between 1969 and 1974; since then, however, growth has declined due to intense competition from Latin American and Israeli producers. Average wholesale prices for long-stemmed roses range from 22 to 25 cents each, and for miniature roses, fluctuate around 16 cents each. Prices for carnations range from 11 to 15 cents per bloom. The peak selling seasons for cut flowers are Mother's Day, Valentines Day, Easter and Christmas. Secretary's week and Thanksgiving are also times of strong sales.

Wholesale pot plant and green plant production is a rapidly growing sector of the industry, with a tenfold increase in production in California over the last six years. Foreign competition has induced many growers to switch from cut flowers to potted plants, which are protected by U.S. government soil import restrictions. Potted plant growers produce decorative bedding plants for outdoor use and indoor potted plants, including seasonal flowering plants such as poinsettias and lilies. Some plants are subject to highly seasonal demand. Easter lilies, for example, are usually marketable only during the Easter season, and

poinsettias, only during the Christmas season. Greenhousers usually plant and cultivate their crops to maximize production during these seasons.

The growers' trade associations tend to organize based upon type of production. However, there are also statewide and national nurseymen's associations, which may include growers of all types of decorative plants, for both indoor and outdoor use. In areas such as California, where greenhouse production is extensive, local organizations such as the San Diego County Flower Association or the Living Plant Grower's Association (Encinitas, California) command a good deal of attention from growers. In states such as New Mexico, where growers are much fewer in number and much smaller, industry interest tends to focus on national organizations and their publications.

Geothermal energy has been very satisfactorily, though not widely, employed in the greenhouse industry for some time. It is used primarily for space heating through a variety of relatively simple heating systems (generally with tubes circulating hot fluid throughout the greenhouse either overhead or under beds), or for soil warming or space cooling.

II. SELECTION OF FIRMS FOR IN-DEPTH SURVEY

In choosing the greenhouse operators for our interviews, we did not attempt to produce a statistically representative sample of the industry as a whole. The industry comprises a great many relatively small firms, as to which accurate size and production figures are not readily obtainable. We therefore decided to interview roughly equal numbers of firms considered by informed industry members to be large, medium-sized, and small, for a total of 15 in-depth interviews. Because food production is a marginal sector of the industry, we chose to focus on companies producing flowers, ornamental plants, bedding plants, and potted plants, and to omit greenhouse vegetable growers.

Greenhouse production in the western United States is significantly concentrated in California and Colorado, and most of our interviews were with growers from those two states. Since we also wished to talk with growers in other areas where geothermal energy may be available, we included representatives from New Mexico, Texas, and Idaho in the survey. We did not, however, confine our survey to firms located near currently identified resources, because we hypothesized that firms in this industry might be willing to relocate to take advantage of resources available elsewhere, and we wished to test this hypothesis.

Our final 15 firms were selected from a set of over 1,000 possible contacts in 13 western states. Concentrating our efforts on California, Colorado, New Mexico, Texas, and Idaho narrowed the field to approximately 400 firms.

In California, a number of contacts were made at the suggestion of Ray Hasek, Senior Environmental Horticulturist at the Agricultural Extension Service of the University of California at Davis. Mr. Hasek helped us to identify growers who might

be innovative, who were particularly large, or who might be especially cooperative. In addition, although many trade associations declined to provide us with membership information, we did obtain names or membership lists from some local trade associations, in particular: Living Plant Growers Association, Encinitas, CA (approximately 100 members); San Diego County Flower Growers Association (approximately 70 members); and Western Greenhouse Vegetable Growers Association, Patterson, CA (no membership data).

For New Mexico, we obtained a "Directory of Nurserymen, Florists and Others Licensed by the New Mexico Department of Agriculture" from that Department's Division of Plant Industry. The Directory enabled us to locate about 40 greenhouse operators for our sample.

The Colorado Department of Agriculture, Division of Plant Industry provided us with a list of 170 "Inspected Greenhouses."

The University of Idaho Agricultural Extension Service furnished us with the names of five potential contacts in that state.

We eventually contacted 28 firms by telephone for a preliminary survey. Scheduling conflicts prevented follow-up with some of these contacts. Others were not interested in participating further, or would merely have duplicated information previously gathered. Three Idaho firms were already using geothermal energy; although our focus was on the decision process of potential entrants rather than current users, we did select one of these firms for follow-up to illuminate some interesting political and economic difficulties reportedly encountered in its first attempts to use geothermal energy. The 15 firms finally selected for lengthy personal interviews are described in detail below.

III. THE FIRMS SURVEYED

A. STATEMENT ON CONFIDENTIALITY OF INDUSTRY INTERVIEW DATA

In the course of its study of potential geothermal users, the Earl Warren Legal Institute conducted personal interviews with representatives of over 50 firms in four selected industries.³ During our initial contacts with these representatives, many expressed strong reluctance to be interviewed regarding company activities because of concerns over disclosure of business information which they or others in their companies might consider proprietary or otherwise confidential. Accordingly, in order to obtain the cooperation necessary to accomplish its task, the Institute assured each respondent that information regarded by the company as confidential would be respected as such by Institute staff members.

In many instances, interviewees prefaced the actual interview with a blanket request for confidentiality. In other instances, respondents indicated during the course of the interview that particular information was confidential and/or proprietary. In all cases, the Institute staff accepted such requests for confidentiality without reservation.

Because so many respondents expressed concern over confidentiality, and because of the difficulty of separating responses on the wide range of topics covered into confidential and non-confidential categories, we decided to eliminate specific attribution in our published reports analyzing the interview data collected. All information is accordingly attributed to interviewees and companies by a fictitious reference, rather than by actual names. In this way, we have been able

³ See Introduction, page iii.

to include in the reports all substantive information in which the public has a legitimate interest, while honoring the respondent firms' expectations of confidentiality and preserving the integrity of representations made on behalf of the Earl Warren Legal Institute.

B. FIRM BACKGROUND

The following tables are intended to provide a convenient reference for basic data on the companies in our survey. Table 1 lists firms alphabetically and Table 2 lists firms by size.

Clarification of some categories of information may be helpful. The firms interviewed varied in size from one very small company operating on half an acre, to one of the largest greenhouse operations in the country, covering a total of 100 acres. Within that range, we designated firms as small, medium, or large depending upon their relative positions between the extremes. Three of the categories in Table 1 - Age of Plant, Stated Role in Innovation, and Stated Growth Philosophy - describe the subjective responses of growers to our questions. The remaining categories are explained in the notes accompanying the tables.

TABLE 1. Firm Background

Firm	Size	Location	Form of Bus.	Age of Plant	Stated Role in Innovation	Stated Growth Philosophy
Acme Greenhouses	Medium	No. Cal	C(F)	1. FU 2. FO	L	S
Best Flower Company	Large	No. Cal	C(F)	VU	L	K
Cooper Nursery	Large	So. Cal	C(UP)	VU	F	F
Dependable Rose Co.	Medium	So. Cal	C(F)	VU	A	N
Earnest Greenhouses	Small	So. Cal	P	VU	F	K
Friendly Farms	Medium	Colo.	C(F)	FU	A	N
Good Greenhouses	Large	Colo.	C(F)	VU	A	F
High Grade Flowers, Inc	Large	Colo.	C(F)	VU	A	F
Industrious Growers	Large	1. Colo 2. No. Cal	C(F)	VU	F	F
Just Flowers, Inc.	Large	Colo.	C(F)	VU	F	F
Keen Greenhouses	Small	New Mexico	P	n/a	L	N
Lovely Flowers	Medium	New Mexico	C(F)	FU	n/a	N
Michael's Greenhouses	Medium	New Mexico	C(F)	n/a	L	N
Nice Flowers	Large	Texas	C(F)	VU	A	N
Old Plant Company	Small	Idaho	P	n/a	A	n/a

Key: Form of Business Entity

C(F) = Corporation (family owned)
 C(UP) = Corporation (unrelated principals)
 P = Partnership

Age of Plant

VU = Very Up To Date
 FU = Fairly Up To Date
 FO = Fairly Old

Stated Role in Innovation

F = Forefront
 A = Average
 L = Let Others Do It

Stated Growth Philosophy

F = Faster Than Industry
 K = Keep Up With Industry
 S = Slower Than Industry
 N = No Growth (status quo)

n/a = no answer

TABLE 2. Companies By Size

COMPANIES	PRODUCTS	ACREAGE	EARNINGS	NUMBER OF EMPLOYEES
LARGE				
<u>Industrious Growers</u>	Cut roses, Potted Plants, Geraniums	35 acres		170
Plant #1				
Plant #2	Ct Rses, Ptd Plnt, Carns	35 acres		170
Plant #3	Cut roses, Field flowers	30 acres		170
<u>Cooper Nursery</u>	Potted plant 3-500 M			120
Plant #1	Chrysanthemums 1.2 M	13.5 acres		
Plant #2	Potted plants 100 M			
	Chrysanthemums 500 M	12 acres		120
<u>High Grade Flowers, Inc.</u>	Roses			
Plant #1	Carnations	12.4 acres		100
Plant #2	Mums			
	Poinsettias	3.74 acres		10
	Easter lilies			
<u>Just Flowers, Inc.</u>				
Plant #1	Carnations	.92 acres		
Plant #2	Carnations		\$2 million gross	50-60
	Roses	13.1 acres		
<u>Nice Flowers</u>	Tomatoes, veg. } 20 M			
	Yard plants } .5 M			
	Foliage plants } 125,000	10 acres, 95 separate greenhouses	~\$4 m or ~\$3 m	125 Full time
	Poinsettias } 100,000			175 Part time
	Hanging fuschia			
<u>Best Flower Co.</u>	House plants	10 acres		100
	Easter lilies			
	Poinsettias			
<u>Good Greenhouses, Inc.</u>	Bedding plants	4.36 acres		
	Geraniums	(under glass)		
	Petunias			
	Easter lilies	2.55 acres		
	Poinsettias	(bench area)		
MEDIUM				
<u>Dependable Rose Co.</u>	Roses 2.3 M			
	Foliage plants 35,000	4.5 acres		22
	Field flowers			

TABLE 2. Companies By Size (continued)

COMPANIES	PRODUCTS	ACREAGE	EARNINGS	NUMBER OF EMPLOYEES
MEDIUM				
<u>Acme Greenhouses</u>				
Plant #1	Roses } 3.5 M/yr	1.84 acres	\$705,000 gross	20-22
Plant #2	Roses }	2.75 acres		
<u>Friendly Farms</u>				
Plant #1	Carnations } 6 M	1.32 } 3.02 acres	_____	10 full time
Plant #2	Carnations }	1.70 }		8 part time
<u>Michael's Greenhouses</u>	Foliage plants Lilies 10,000 Blooming plants Mums 700 per week Kalanchoe 150 pots	2.47 acres	~\$750,000 gross	20
<u>Lovely Flowers</u>	House plants 1 M	1.72 acres	~\$600,000 gross	20-25
SMALL				
<u>Keen Greenhouses</u>	Poinsettias Bedding plants Spring Vegetables (tomatoes, chilies) Foliage plants	.73 acres	_____	2 full time 2 part time
<u>Earnest Greenhouses</u>	Tropical plants	.69 acres	_____	5 3 partners
<u>Old Plant Company</u>	Bedding plants 6,000 Poinsettias 20,000 Lillies 15,000 Mums 10,000 Gloxinus 2,000 Hanging fuschia 1,000 Color plants 60,000	.5 acres	_____	4 full time 4 part time

C. DESCRIPTION OF FIRMS

A. Acme Greenhouses

Location: Northern California

The Acme family started in the greenhouse business in 1907. The interviewee began working in the family business in 1936. Acme Greenhouses is a closely held, family-owned corporation.

The company runs two greenhouse operations in California. Roses are produced exclusively at both sites. One plant covers 1.84 acres; the other, 2.75 acres. The company produces approximately 3.5 million roses every year. Average gross annual earnings for the two sites combined is about \$705,000. In total, the company has 20-22 employees.

Operations at the company's greenhouses are continuous year round. About seven batches of roses are produced every year. The company buys one-year-old rose bushes and harvests the first crop 65-70 days later. Successive crops are harvested every 45-50 days.

The greenhouses at the company's smaller location are fairly old. They are wood framed, and were last renovated in the late 1930's. The larger site was established in 1966. Additions of approximately 20,000 sq. ft. were made each year in 1972, 1975 and 1978, and the company expects to add another 50,000 sq. ft. of greenhouse space. These structures are made of fiberglass with a steel and aluminum frame. Acme has plans to replace the fiberglass with regular glass, since glass has better light transmission.

This is a conservative, well-financed company, and its principals feel no need to grow exceptionally fast.

B. Best Flower Company
Location: Northern California

Best Flower is a closely held, family-owned corporation of which our interviewee is president. His father founded the company in 1910, and it was located at two other northern California sites before moving to its present site on the coast, where all of its greenhouses are now located. The greenhouses cover a total of ten acres and the company employs about 100 workers. House plants are produced year round; Easter lilies and poinsettias are produced seasonally.

Operations at the greenhouses are continuous, yielding approximately six harvests per year.

The first greenhouse at the present location was built in 1961. About 30-40,000 sq. ft. were added two years ago. The company expects eventually to build greenhouses on its entire 35 acres of land.

C. Cooper Nursery
Location: Southern California
Southern New Mexico

Cooper Nursery has two greenhouse operations, one in southern California, and the other in southern New Mexico. Each operation is organized as a separate corporation; each corporation has two shareholders, with one shareholder common to both. The man we interviewed ranks third in the organization after the two owners. He has been with the company for eight and one-half years.

The California greenhouses cover 13.5 acres, and produce 1.2 million mums and 300,000 to 500,000 foliage plants annually. At this location 120 workers are employed. The New Mexico operation was expected to cover twelve acres by the end of 1979. The greenhouses here produce approximately 500,000 mums and 100,000 potted plants per year. This operation employs about 120 workers, but current modernization efforts will reduce this number when completed.

The greenhouses operate continuously. Five or six batches of mums can be expected each year, and four or five harvests of foliage plants. Workers average eight hours a day, five days a week. Irrigation is done every day, and pest control is done on the weekends.

The company's California greenhouses were built in 1966. Its New Mexico greenhouses began operation in 1975. The company, which began operations on a single acre, now has a total of 25-1/2 acres of greenhouses. Growth is limited in California by lack of space, but in New Mexico, operations have expanded from five to twelve acres during the past year.

D. Dependable Rose Co.
Location: Southern California

Dependable Rose Co. began operations in one southern California location in 1916, and moved to its present location in 1949. All stock in this close corporation is owned by its founder, his two daughters and the interviewee's family. The interviewee received a B.S. in mechanical engineering from UC Berkeley in 1962. He worked as a mechanical engineer until he joined Dependable Rose.

The company's single plant produces roses, foliage plants, and field flowers. Its greenhouses cover 4-1/2 acres, with two more acres to be added soon. Dependable owns 19 acres adjacent to its present location.

Dependable produces 2.3 million roses and 35,000 foliage plants annually. It employs 22 people at the greenhouse site, and five additional salespersons in Los Angeles. Dependable's greenhouses operate continuously, year round, in an effort to maintain steady production. Roses are harvested approximately every forty days.

The company's initial greenhouses were built between 1949 and 1960. It is now in the process of increasing its greenhouse space by 45% (about two acres).

E. Earnest Greenhouses
Location: Southern California

Earnest Greenhouses was founded in 1977. Although it is now organized as a limited partnership with three general partners and one limited partner, the partners are considering incorporation. Earnest produces tropical plants, all of which are sold in southern California counties. Our interviewee has a B.S. in plant sciences from UC Davis. He has spent five years in the greenhouse industry.

Earnest's greenhouse covers a total of 30,000 sq. ft., producing 100,000 tropical plants annually. In addition to the three general partners, five employees work at the greenhouse. The operation is continuous year round. Tropical plants are harvested in batches.

Earnest's business has grown quickly since its founding: it started with 8,000 sq. ft. and has expanded continuously. The partners plan to add another 10,000 sq. ft. to their greenhouses this year, and intend ultimately to expand to the limit of their land.

F. Friendly Farms
Location: Colorado

Friendly Farms, a closely held, family-owned corporation, operates facilities at two sites in Colorado, both producing carnations exclusively. Our interviewee was a machinist before founding Friendly Farms. However, his family had been truck farmers for many years previously.

Friendly Farms' greenhouses cover more than 131,000 sq. ft.: some 57,000 sq. ft. at one location, and 74,000 sq. ft. at the other. At about 45 blooms per sq. ft., annual production is around six million carnations at both plants. Eight full-time workers and ten part-time workers are employed at the two plants, which operate continuously, year round.

The company's smaller greenhouse was built in stages between 1965 and 1971. At the larger site, 50,000 sq. ft. were built in 1973, and another 25,000 sq. ft. were added in 1976. The company does not expect to grow at all in the near future, due to vigorous foreign competition in the cut flower market.

G. Good Greenhouses
Location: Colorado

Good Greenhouses is a family-owned corporation with a single greenhouse location. Until 1978, the company produced carnations exclusively, but is now changing to bedding plants - geraniums, petunias, easter lilies, poinsettias, etc., - due to intense foreign competition in carnations.

Our interviewee graduated from the University of Minnesota in 1978 with a B.S. in horticulture. He is now the assistant manager of his uncle's Colorado greenhouses. The family operates a greenhouse business in Minnesota as well.

Good Greenhouses currently has 190,000 sq. ft. under glass, with 111,000 sq. ft. of bench area. The company produces about 1.5 million blooms annually, or about 45 per sq. ft., and operates continuously, year round.

The company's greenhouse was built in 1957, and has undergone periodic expansions since 1967. Sixty-eight percent of the square footage has been added since 1968. The greenhouses were expanded in 1967, 1968, 1971, 1973 (46,000 sq. ft.), 1976 (23,000 sq. ft.), and 1977 (23,000 sq. ft.).

Although the company has grown faster than most firms in the business, it has not shown a profit recently.

H. High Grade Flowers, Inc.
Location: Colorado

High Grade Flowers is a family-owned corporation operating greenhouses at two locations in Colorado. Both operations produce cut flowers (roses and carnations) for the national market, and foliage, bedding and blooming plants (mums, poinsettias, and easter lilies) for the local market.

Our interviewee has a B.S. in electrical engineering. He worked as an engineer for the Office of Naval Communications and the Science Services Administration before joining the family greenhouse business. He and his brothers have been working in greenhousing for ten years. Their father, formerly a truck farmer, founded the business and is the nominal president, though he is no longer active in the operations.

The company has 540,000 sq. ft. under fiberglass and double polyethylene plastic at one location, and 163,000 sq. ft. under fiberglass at the other. In 1978, they produced 45 blooms per sq. ft. of cut flowers. About 100 workers are employed at the larger site, and ten are employed at the smaller. The company is one of the largest greenhouse operations in Colorado, and it operates continuously, year round.

High Grade Flowers began with 5,000 sq. ft. covered in 1967. Production has doubled every year since then, except for the last few years. The company added 190,000 sq. ft. to its operations in 1977, 40,000 sq. ft. in 1978, and 50,000 sq. ft. in 1979. The company's objective has been to grow faster than the industry average. It is seeking to increase its share of the local market for foliage, bedding, and blooming plants in order to cut transportation bills.

I. Industrious Growers
Location: California
Colorado

Industrious Growers is a family-owned corporation and the largest greenhouse enterprise in the country, operating at three locations. Its Colorado plant produces cut roses, potted plants, and geraniums; one of its California plants produces cut roses, potted plants and carnations, and the other, cut roses and field flowers. Our interviewee is one of four brothers who own the company. Their family had previously been farmers. The brothers also operate a distribution company, and one of them is president of the greenhouse operations.

The company's first greenhouse was built in 1948 in California. The Colorado operations began in 1966, and another California plant was added in 1970.

The company has a total of 100 acres under glass at its three sites: 35 acres in Colorado, 35 acres at one California site, and 30 acres at the other California site. The Colorado greenhouses employ 170 workers. The larger California site employs 170 workers, and the smaller site, 100 workers.

A 1978 fire at the Colorado greenhouse destroyed one million sq. ft. of production area, the heating plant, and the company offices. The company has rebuilt this area and is presently operating it at capacity.

K. Keen Greenhouses
Location: New Mexico

Keen Greenhouses operates a single New Mexico plant covering 32,000 sq. ft., of which 15,000 sq. ft. are used for seasonal or temporary production. In the spring, the operation produces bedding plants and spring vegetables (tomatoes and chilies); in the summer, foliage plants; and in the winter, poinsettias. The business is organized as a general partnership. It employs two full-time workers and two part-time workers. The interviewee, one of the partners, has been in the greenhouse business for 27 years.

The company has doubled its output in the last fifteen years, but zoning problems preclude further expansion at the existing site. The last major greenhouse renovation was undertaken three years ago, when Keen changed from single plastic to double inflated plastic walls. Some glass houses remain, but will be converted to double plastic in time, since glass is energy inefficient and expensive to maintain.

The company expects to maintain its small size for the foreseeable future, and Keen's owners have little inclination to change.

L. Lovely Flowers
Location: New Mexico

Lovely Flowers, a corporation, is one of the largest greenhouse operations in New Mexico. It produces houseplants exclusively, and grosses about \$600,000 from sales of approximately a million plants each year.

The interviewee is the company's sole owner. He left the Air Force to start a construction business in New Mexico and got into the greenhouse business in order to finance land speculation. He describes himself as a businessman, not a plant lover, and employs a horticulture specialist as head grower and technician for the operation.

The company's greenhouse was built in 1965. Improvements to the facility have been made continuously since then, expanding from 36,000 to 75,000 sq. ft. in five years, and the company now considers its plant fairly up-to-date. The owner does not presently contemplate further expansions, but is engaged in continuous efforts to improve productivity at the existing plant.

M. Michael's Greenhouses
Location: New Mexico

Michael's is a family-owned corporation which operates two greenhouses located less than a mile apart in New Mexico. It produces foliage plants and blooming plants (mums, kalanchoe, poinsettias, lilies) at both locations. The two operations cover a total of 110,000 sq. ft. They produce 700 pots of mums per week, 150 kalanchoe during the peak holiday season, and about 10,000 lilies, also for the seasonal market. Foliage plants are harvested continuously, but the seasonal blooming plants are harvested in batches during their peak seasons. Gross annual sales approach \$750,000. Twenty people are employed at the two greenhouses, which operate continuously year round.

The interviewee is the owner of Michael's Greenhouses. After a career in the armed services, he retired to New Mexico in 1966 and started the greenhouse business.

The owner built his first greenhouse thirteen years ago, and added a second six years ago. The company has expanded its greenhouse space every year since operations began, at a steady but not rapid pace. It is interested in improving existing facilities and products, but not in developing new products or expanding into new markets.

N. Nice Flowers
Location: Texas

The interviewee is the sole owner of Nice Flowers. Formerly employed as an operator with Texas Power and Light Company, he entered the greenhouse business 18 years ago as a sideline because his in-laws were in the vegetable/plant business.

Nice Flowers is a family-owned corporation with facilities located in eastern Texas. In its 87 greenhouses, the company produces some 20 million tomatoes, other vegetables, and yard plants annually during the spring; about 1/2 million foliage plants during the summer; and 125,000 poinsettias for winter sales. It also produces about 100,000 hanging fuchsias each year. In total, Nice Flowers grows some 257 varieties of flowers and 40 varieties of vegetables, for sales of about 30 million plants and earnings of \$3 million annually. The company employs 125 workers full-time and 175 workers during peak seasons.

The company built its first greenhouses in 1961, and has expanded continually since then. The interviewee states that the company has grown 15-20% every year since its inception, but expects that further near-term growth will be curtailed by labor and fuel problems.

O. Old Plant Company
Location: Idaho

Old Plant Co., a general partnership, operates a single 22,000 sq. ft. plant about 60 miles from Boise, Idaho. It produces potted plants year round and poinsettias, lilies, and spring bedding plants for their respective seasonal markets. The company's annual production is approximately 20,000 poinsettias, 15,000 lilies, 10,000 mums, 2,000 gloxinias, 1,000 hanging fuschias, 6,000 flats of spring bedding plants, and 60,000 four-inch color plants (petunias, marigolds). Old Plant continuously employs four full-time workers, and may employ an additional four or five depending on the season.

The interviewee has been in the greenhouse business for most of his life. He operated a greenhouse in Boise ten years ago but had trouble relocating in the same area when his Boise lease ran out and so moved the operation elsewhere in Idaho. His current operation began in 1969; the facilities were last renovated two years ago with new benches and piping costing about \$30,000.

Old Plant Company is the only company in our survey which is actually using geothermal energy. Its 3,950 ft. hot water well was originally drilled by the government and capped. The company reopened the well, repaired the casing, and began using the fluids immediately. With the help of geothermal energy, our interviewee expects to be able to expand somewhat faster than the industry average; he believes that his resource and market potential will support an operation six or seven times the company's present size.

IV. ANALYSIS OF SURVEY DATA

A. FUEL

In order to realistically assess commercialization opportunities in the greenhouse industry, we examined current patterns of fuel usage for which geothermal energy might substitute. Relevant inquiries began with the types of fuels used and the terms upon which they are purchased. We then sought to determine the ratio of energy costs to total production costs, and the degree of concern felt by firms regarding anticipated price increases for current energy resources, since this information indicates the weight likely to be placed on geothermal's potential advantage as a cheaper energy source. Apart from ongoing cost considerations, we also examined the firms' ability to tolerate fuel supply interruptions and the precautions considered necessary to prevent this, in order to determine the importance of reliability as a factor influencing the decision whether to employ geothermal resources.

1. FUEL SOURCES, USES, AND COSTS

Space heating and cooling comprise the main energy needs of the greenhouse industry. For space heating, the chief fuels used are natural gas and oil. At present natural gas is by far the preferred energy source. Only two firms, both in southern California locations where natural gas is unavailable, use oil exclusively; the other firms which use oil also use some natural gas. Only one of the firms surveyed, Old Plant Co. in Idaho, uses geothermal energy; another firm, in Colorado, uses some coal. For space cooling, all the firms employ purchased electricity.

Actual fuel costs vary by type of fuel, by type of fuel contract (with a

premium for uninterruptable natural gas supplies), and by region.⁴ Accordingly, the firms reported considerable variation in the estimated ratio of energy costs to total production costs, as follows:

- 5% and below	3 companies (B,D,L)
- 5-10%	4 companies (G,H,M,N)
- 10-20%	5 companies (A,E,F,I,J)
- 20% and above	1 company (K)
- no answer	2 companies (C,O)

2. FUEL SUPPLY INTERRUPTIONS

Uninterrupted supply of fuel for space heating and cooling is an extremely important consideration in the greenhouse industry. Although specific tolerance for fuel supply shutdown varies by type of plant grown, location, and time of year, concern over supply interruptions was serious and widespread. For cut flowers, growers distinguished between the economic loss associated with damage to the blooms, and that associated with destruction of the plants themselves which would occur at lower temperatures; both possibilities present serious problems for these growers.

Because of fuel supply concerns, most firms interviewed have some sort of back-up fuel system for space heating or cooling. This includes almost all of the California, Colorado, and Texas firms, but not most of the firms in New Mexico, nor Old Plant Co. in Idaho, which uses geothermal. In all cases, the primary fuel is natural gas and/or electricity; the back-up fuel is usually oil. About half of these companies have actually experienced fuel supply interruptions

⁴ Data on costs for specific fuels are presented in Appendix A.1.C

in the recent past, including all of the firms in Colorado and Texas, but none of the California firms.

3. FUTURE FUEL SUPPLY CONCERNS

As one indicator of possible future activities, we asked the firms what type of energy problems they anticipated in coming years. Rising cost was almost universally cited as the most troublesome problem - only Nice Flowers and Old Plant Co. did not express this concern. Availability of supply was also perceived as a major problem by 8 of 15 firms - all of the California firms, and most of the Colorado firms.

Although energy costs are characterized as a major problem, most of the respondents indicated that they would expect to respond to cost increases by passing them on to their customers. Significantly, several firms said that they could accomodate a doubling or even trebling of fuel prices in this way. Price increases would prompt them to look for new energy conservation techniques, but not for new energy sources. The main stimulus for resource shifts would have to be changes in fuel availability, rather than cost.

The responses provided two other indications that energy conservation, rather than use of alternative energy sources (including solar and geothermal), will be the predominant response to fuel supply problems. Describing specific measures currently being taken to cope with their energy problems, most respondents mentioned energy conservation; in particular, six companies mentioned their recent conversion to polyethylene thermal blankets. And in response to a direct inquiry concerning anticipated changes in future fuel use patterns, six firms mentioned improvements in energy conservation techniques, while only three (all large) mentioned new energy sources.

B. FIRM DECISION MAKING

1. MANAGERIAL STRUCTURE AND DECISION MAKING

To assist in focusing possible policy initiatives, we sought to determine which members of a firm play important roles in decisions affecting energy use. For this purpose, various inquiries were directed to the organizational structure and decision-making process of the companies studied.

Managerial Structure: All of the greenhouse firms interviewed, which included the largest greenhouse operation in the country, are small by American corporate standards. Managerial structures therefore tend to be simple and centralized. The companies are either family-owned corporations or family partnerships (12 firms), or partnerships with two or three unrelated partners acting in close concert (3 firms). Only three companies have active boards of directors (D,H and I); the other companies are managed directly by owners or partners.

The Decision-Making Process: Simple managerial structures typically dictate a relatively uncomplicated decision-making process. No greenhouse firm interviewed had either a separate planning or policy-making department, or an energy manager. In seven companies decisions were made by a single owner, and only two of these consult with technical or financial advisors outside the company (L and N).⁵ Five firms involve two or three family members or partners in informal discussions concerning company decisions. The three firms with active boards of directors submit substantial investment decisions to the board, but day-to-day operational decisions are made by a single person.

5. Nice Flowers in fact hired a European agricultural consultant to advise specifically on energy conservation, in the belief that Europeans are necessarily more experienced in such matters. The consultant determined that existing water wells at Nice Flowers had temperatures of 75° at 200 feet, and recommended deepening these wells to seek higher-temperature geothermal fluids.

As a general rule, it appears that decisions in the greenhouse industry are most often made by informal consultation among few people closely involved in the business enterprise, or who are hired for their expertise. Introducing a new technology in this industry will therefore be largely a matter of convincing individual owners of the advantages of its use.

2. INVESTMENT PROJECT APPRAISAL

The theoretical literature on project appraisal contains a number of investment criteria of varying sophistication. Since the criteria can lead to different conclusions when applied to the same project, it is necessary to know which criterion a firm actually employs. All of the greenhouse firms responding to this inquiry employ only the payback period criterion, which is the simplest and most traditional. Most of the medium-sized firms have a maximum of 2-5 years. These are the criteria used for a "normal" investment project - building a new plant, installing new equipment, etc.

Because geothermal investments are likely to represent a different kind of investment decision than greenhouse firms are accustomed to making, it is useful to know whether these firms would employ a different criterion or hurdle rate for evaluating a potential geothermal investment project. The survey data indicates that all companies would continue to apply the payback period criterion, and most would apply the same hurdle rate. Only three companies would use a different hurdle rate: Cooper Nursery would require a shorter payback period (i.e., a more stringent criterion) because it perceives geothermal as a high-risk investment, while High Grade Flowers and Lovely Flowers would accept a longer payback period because energy costs are rising so rapidly.

C. COMMERCIALIZATION POTENTIAL FOR GEOTHERMAL ENERGY

Dissemination of information on geothermal energy technology, costs and uses is obviously essential to commercial development of the resource. The Institute's survey accordingly attempted to determine how much is now known about geothermal potential in the greenhouse industry, what information would be most useful to encourage future use, and where technical information might most effectively be made available to the industry as a whole.

1. KNOWLEDGE OF GEOTHERMAL

Although all interviewees knew that geothermal energy was being used by some growers in their business, only about half of them knew of a specific greenhouse application. Furthermore, even though two-thirds of those surveyed said they had given thought to using geothermal energy, only two can be said to have done so very seriously: one actually developed a well and is currently using it in his operation; the other is seeking information on temperature gradients in his area because he has 72° water in a shallow well, which may indicate a deeper, hotter resource. Otherwise, four firms had been approached by two different municipal developers about the possibility of locating a new plant to use geothermal, and all rejected the idea without much exploration.⁶ Another respondent made a casual inquiry with an acquaintance at a nearby university about geothermal possibilities in his area but was discouraged by warnings about corrosion problems. Four others dismissed the idea because they did not believe the resource could be found on their property. Almost none of the

6. Three growers were approached by the City of Klamath Falls, but felt that the climate and product market were undesirable.

respondents had any notion of what the actual costs of either exploration, drilling or installation of necessary equipment might be. The current user had his own experience as a basis, but only one other grower had seen any cost figures at all.

While there seems to be widespread general acquaintance with geothermal potential in the greenhouse industry, among these respondents there was a lack of in-depth knowledge. However, a number of firms expressed some optimism for the future of geothermal energy and a belief that it will be an important energy source in the industry in less than ten years. Their perceptions of whether and when geothermal energy might become an important resource in the greenhouse industry are summarized as follows:

Within 5 years	B,D,J,N,O
Within 5-10 years	E,G,I
Within 20 years	F
"When natural gas becomes too expensive"	H

There was some feeling that significant geothermal use will be limited to certain segments of the industry, such as potted plant growing, which uses artificial soil and is therefore more mobile.

2. FACTORS INFLUENCING THE DECISION TO EMPLOY GEOTHERMAL RESOURCES

In order to probe for any basic resistance to the use of geothermal energy, the respondents were asked to identify specific problems which they could foresee in using geothermal in their operations. Only one company anticipated no problems.

The one current geothermal user described some problems encountered when he first attempted to develop the resource - - problems which may signal potential difficulties for future developers. Old Plant Co. was not using geothermal energy in its operation ten years ago, when its lease on land known to have geothermal expired. The owner hoped to develop a hot water well on another property on which he had a lease option. He attempted unsuccessfully to get financing from every local bank as well as from the Small Business Administration. Bank conservatism with regard to greenhouse business loans and geothermal development did not surprise him, but he felt that adverse pressure from a local geothermal heating company may have played a role. Our interviewee speculated that the local geothermal heating company feared drawdown or depletion of its water supply, and thus used its influence to prevent development by independent private users. He also met resistance from the regional power company, which refused to supply power to pump water from the well without a court order.

The remaining respondents focused, however, on a different set of problems. The number of companies mentioning various perceived obstacles to geothermal use were as follows:

Problem	Most Important	Very Important	Important	TOTAL
Availability	6	-	3	9
Costs	2	1	4	7
Water quality	-	2	3	5
Reliability	-	1	3	4
Drilling risks	1	-	3	4
Financing	-	1	1	2
Lack of information	-	-	2	2

It should be noted that the regulatory environment for utilizing geothermal resources and adverse environmental consequences were not identified as significant problems, although this may reflect the respondents' lack of in-depth knowledge rather than informed opinion on these subjects.

It goes without saying that availability of the resource in the right location is of fundamental importance to potential users. When asked whether or not they would be willing to relocate their existing plants to another location specifically to take advantage of available geothermal energy, only three companies responded positively, and one of those conditioned its answer upon skyrocketing energy costs. Seven more companies said that they might be interested in locating a new plant near a resource, and five of these have California plants, but only three actually have plans to open new facilities in the near future.

We asked all firms, however, to rank the factors which influence the choice of plant location. The main factors were climate, location close to product markets, and availability of water and energy supply. The range of responses was as follows:

Factors Important in Choosing a Plant Site:

Factor	Most Important	Very Important	Important	TOTAL	Not Important
Climate	6	-	2	8	1
Close to product market	2	4	5	11	1
Water supply	1	4	4	9	-
Energy supply	-	11	1	12	-
Labor supply	-	3	6	9	-
Raw material supply	-	3	3	6	3
State and local tax, and attitude to business	-	-	1	1	3

In order to abstract from the uncertainty associated with the availability of a geothermal resource in the right location, and to probe further the manner in which other factors will be assessed in the greenhouse industry, we asked this question: If a geothermal resource were discovered near your plant and you were offered the opportunity to use it, what factors might influence your decision whether or not to accept this offer? The following factors were mentioned:

Numbers of Ratings Received by Alternative Decision Factors

Factor	Most Important	Very Important	Important	TOTAL	Not Important
Capital cost	7	3	-	10	-
Operating cost	3	4	-	7	2
Reliability (minimal down time)	2	4	-	6	2
Compatibility with existing equipment	1	2	2	5	1
Availability of a firm, long-term fuel contract	1	-	3	4	-
Ease of maintenance	1	-	3	4	4
Familiarity of the technology	-	1	-	1	5

Combining these two sets of responses, one can conclude that the three main obstacles to the commercialization of geothermal resources in the greenhouse industry, apart from resource availability, are:

a. Uncertainties concerning the cost of using the resource.

As noted previously, very few of those interviewed had any idea of costs involved in utilizing geothermal energy in greenhousing. They worried, however, about such things as the cost of installing circulating pipe in large operations, the cost of drilling coupled with the risk of not finding a resource, and the problems of financing a risky venture.

b. Reliability of the resource. As previously noted, uninterrupted fuel supply for space heating and cooling is essential to the greenhouse industry, since any crop's survival depends upon maintaining a specified temperature range. It is not surprising, therefore, that this factor was singled out as a major potential problem in considering the use of geothermal energy. The danger of a sudden depletion of water supply due to pressure drop, or the prospect of a temperature drop is a serious matter in the industry.

c. Purity of the fluids. In the greenhouse industry the problem of water quality has two different aspects, both of which were of concern to many of the respondents. First, potential corrosion of the transmission system is anticipated as a problem in its own right. Second, even where this problem does not exist or can be managed by equipment design, the possibility of also using the water for irrigation purposes is both an attraction and a danger to greenhouse operators. As noted previously, an available water supply is one of the primary factors determining plant location in the greenhouse industry. If geothermal water could be used for irrigation as well as temperature control, its value would obviously be enhanced. The current geothermal user interviewed, however, emphasized the potential difficulty here. His water was exceedingly alkaline, and he lost a large crop before he was able to find a solution that was safe and economically viable. He finally bought citric acid in bulk and added it to the water mechanically in measured quantities.

The ratings tabulated above also raise another issue. The ratings for capital costs and operating costs are somewhat different, suggesting that these may represent two separate dimensions of investment project evaluation. In many engineering-economics studies, the convention is to combine annualized capital cost and operating cost in a single total annual cost figure, which forms the basis for the evaluation of an investment project. Perhaps this is mistaken: firms may have distinct preferences for capital and operating costs. This hypothesis was borne out by responses to the following question: When confronted with two alternative investment projects with the same total annual costs but with project "A" having high capital cost and low operating cost, and project "B" having low capital and high operating cost, would you prefer one over the other?

Six companies preferred project "B" - low capital/high operating costs. The reason most often given was cash flow problems: the company has no money of its own to invest and will have some trouble borrowing. Not surprisingly, the companies with this preference tended to be the smaller ones who were more naturally averse to large capital investments. To paraphrase one respondent, you can always do something about high operating costs, but you can't go back on capital investments.

Eight companies, on the other hand, preferred project "A" - high capital/low operating costs. These tended to be the larger firms who would have little trouble funding the investment. They were able, therefore, to consider what one described as the advantages of better quality from an original high investment which then promised easy maintenance and thus less operating aggravation. Another found this type of project attractive because the majority of costs are known at the outset, and long-run uncertainties are therefore minimized. One respondent noted the advantage that inflation will increase the value of the investment while decreasing the value of dollars with which one repays the debts.

The distinct preferences stated in response to these inquiries indicate that not only must adequate total cost information be made available to the greenhouse industry, but detailed information separating capital and operating costs will be essential to many growers' decisions as to the use of geothermal energy.

Following analogous reasoning, it is not unreasonable to suppose that the reliability of an energy source may represent a separate and less elastic dimension of preference from cost. To the extent that that is so, policies which focus exclusively on cost incentives, or which assume a commercialization timetable based on projected cost increases for conventional fuels, may fail to address the true concerns of their intended beneficiaries.

In order to probe this question, the respondents were asked whether their firms would simply factor the costs of temporary shutdowns in with other operating costs, or whether they would take account of them separately in evaluating an investment in an energy source. Six of the firms would factor shutdowns into overall costs, but one would do so only if such interruptions could be anticipated and planned for. Five of the firms would consider possible shutdowns as a separate dimension of energy planning because they simply could not tolerate periodic downtime.

In short, there is strong evidence that capital and operating costs represent separate dimensions of greenhousers' preferences in evaluating investment projects, and that reliability is another, distinct dimension of preferences. These findings have clear implications as to the nature and specificity of information which government must make available to potential commercial users. Taken together with the perceived capacity of greenhousers to pass through to their customers even substantial increases in conventional fuel prices, the findings also suggest the relative importance of reliability as a decision factor in this industry, and the need to focus not only information but R&D efforts in this direction.

3. FINANCING A GEOTHERMAL INVESTMENT PROJECT

Project financing in the greenhouse industry is constrained by two opposing forces. On the one hand, most firms in the industry are not highly capitalized, and have limited capacity to draw on internal funds. On the other hand, many conventional sources of external financing, especially commercial banks, are reluctant to lend to the industry on a large scale. Thus,

project financing in this industry is more strongly influenced by the relative availability of internal and external funds, than by the relative cost of these two sources of funds.

For analytical purposes, the respondents were asked to assume that a suitable resource was discovered in the vicinity of a company plant, that a supplier had offered to provide geothermal fluids, and that the firm had decided to accept the offer and retrofit its plant to utilize these fluids: how, then, would the firm finance the retrofit, and would this differ from the financing mechanism normally employed for a similar investment project not involving a new type of energy source? With respect to the latter question, all respondents agreed that the financing of a geothermal retrofitting project would not differ from the financing of a similar non-geothermal project. As for the financing mechanism, four firms (A,F,K,M) would finance a retrofit solely from internal funds; five would finance it with a combination of internal funds and short-term debt (C,D,E,G,L); and three would use a combination of short and long-term debt (B,I,N). In general, the larger firms favored outside funding, while the medium and smaller firms are restricted to internal financing and short-term debt.

Assuming an identified resource nearby and a willingness to exploit it, the respondents also were asked how their firms might expect to finance the front-end costs of resource development. The responses were similar to those given as to retrofit financing, but with less reliance on internal funds and more use of external debt, especially long-term debt.

4. GENERAL SOURCES OF INFORMATION ON TECHNOLOGY

The discussion above focused on what greenhouse respondents know or need to know about geothermal energy if they are to seriously consider

using it in their operations. This section examines the sources normally relied upon by industry members to obtain needed information on new technology in general, and alternative energy developments in particular.

According to those interviewed, there are three major sources of technical information in this industry: trade associations, universities, and other industry members. For information on alternative energy sources, many of the respondents added government to this list.

a. Trade associations. All but one interviewee cited trade associations as a new technology resource. Accordingly, these organizations can be expected to play a central role in spreading industry technology. However, their significance and character vary by region, state and locale. California, for example, is a major producer of greenhouse products. For this reason, there are many local trade associations with large and active memberships, as well as a wide variety of growers' groups organized around speciality production such as flowers, bedding plants, potted plants or vegetables. In New Mexico, on the other hand, greenhouse operations are smaller and more widely scattered: viable local trade associations are therefore difficult to organize, and reliance on national organizations and trade association publications is much greater.

b. Universities. The universities' role in information dissemination similarly varies by location. The University of California Agricultural Extension is a powerful resource in the industry. Its influence extends beyond California, according to a Colorado respondent. In California itself, contact between UC Extension representatives and growers is constant and by all accounts very positive. In Texas, our only respondent reported that he consulted with a nearby Texas A&M experimental station for technical information, particularly on plant diseases and plant culture, and suggested that this may

be a good general resource in Texas. A New Mexico respondent relied upon the University of New Mexico for technical information, and had actually consulted the University concerning geothermal possibilities. Colorado respondents, on the other hand, did not view their state university system as particularly helpful for technical advice or information.

c. Other industry members. Many of the respondents apparently gather much of their technological information through the industry grapevine, by constant communication with fellow growers. This kind of exchange is encouraged at trade association meetings, but goes on informally as well. Several interviewees had visited geothermally-heated greenhouses, or had been in communication with the operators on their own, and many regarded such contacts as a common way of learning about new techniques in the industry.

d. Government. Although only one respondent would look to the government for general technical information, five indicated that they would do so for information on alternative energy resources. Clearly, energy matters involve a different set of expectations, more likely to induce growers to seek government aid. One respondent did indicate that, while he regarded government as an appropriate source of information in this area, he did not know where to find it.

D. POTENTIAL INSTITUTIONAL FRAMEWORK

Most of the inquiries directed to greenhouse operators related to their potential roles as end-users of geothermal energy. However, in many cases geothermal use may depend on institutional arrangements between end-users and other entities contemplating resource development and/or distribution. To determine the need for such institutional arrangements, and to identify structures which might be acceptable to firms in the greenhouse industry, the following

questions were asked:

- 1) To what extent and under what conditions would the firms be willing to undertake resource development for their own use?
- 2) Would they require full control over a geothermal source, or would they be willing to purchase geothermal heat supplied through a distribution system?
- 3) Would firms which controlled a resource be willing to act as suppliers of excess heat to other end-users?

1. PARTICIPATION IN RESOURCE DEVELOPMENT

One possible development arrangement would be for an industrial or commercial end-user to initiate and carry out development of a resource for its own use, either alone or with partners. Accordingly, the respondents were asked to comment on their firms' willingness to participate in various stages of geothermal development -- from lease acquisition, to basic exploration, to production well development at a proven geothermal field. Firms indicating an interest in any of these development phases were asked whether they would expect to act alone or in joint ventures with other parties, such as resource companies, other end-users, or outside investors. Their responses are summarized as follows:

Willingness to Become Involved in Resource Development

Willing to consider resource development	A,B,E,F,G,H,I, J,L,N
Would consider only where resource already identified	A,F,N,O
Would consider only development on own land	D,E,H
Not willing to participate in resource development	B,C,K,M
No response	0

Preferred Structure for Resource Development

Alone preferred	A,D,F,G,H,L,N
Alone only	J
Joint venture preferred	I
No response	E,O

Only four of the 15 greenhouse operators would not consider participation in resource development. Ten are willing to consider some degree of involvement. Most of these, however, are unlikely to seek out resources, and will generally consider exploration only if there are known or probable resources near their existing operations or in areas where they may wish for other reasons to locate a greenhouse.

Even this degree of involvement is doubtful, however, given the problems faced by greenhouse operators in raising capital. The respondents reported a clear preference for engaging in development activities alone, yet since almost all mentioned limited financing ability, they would need venture partners for geothermal resource development, which they are unlikely to seek or to find.

2. NEED FOR CONTROL OVER SUPPLY

An alternative to user participation at the development stage would be an arrangement under which the user has no development or production functions, but merely purchases geothermal heat from an independent supplier, in the same way that it purchases other types of energy.

An important determinant of the feasibility of a retail distribution structure in the greenhouse industry is the extent of the firms' perceived need for control over a geothermal energy source. Accordingly, we asked whether the respondent firms would be willing to tie in to a geothermal distribution system controlled by others. The responses are summarized below:

Need for Control Over Supply

Would strongly prefer to be sole user	G, J, L, O
Willing to hook up to distribution system	A, B, C, D, E, F, H, I, K, M, N

Four companies, including the one currently using geothermal, would strongly prefer to be sole users in order to guarantee an adequate and constant energy supply. The current user once considered hooking up to a distribution system in Boise, Idaho, but rejected the idea because constant maintenance problems of the old system appeared likely to result in supply interruptions.

The eleven remaining firms would all be willing to be served by a distribution system. Indeed, four of these (B, C, K and M) would consider geothermal use only in that context, since they are unwilling to participate in resource development activities, either because of reluctance to gamble in an unfamiliar area, or inadequate financial resources.

3. WILLINGNESS TO ACT AS SUPPLIER

Even where a firm's primary interest in geothermal is to meet its process needs, both internal economic considerations and broader policy objectives may be served by the distribution of excess fluids or spent heat to downstream users. Downstream distribution by the primary user would be a means to recoup a portion of high front-end development costs. From a policy perspective, the general disinclination of many industrial and commercial users to engage in resource development, and the possibility of premature disposal of useable fluids, suggests that distribution systems will be required to encourage maximum beneficial use of the resource.

In order to assess the potential role of primary users as resource distributors, we asked whether firms which might control a geothermal resource

would be interested in extending their activities to include sales of surplus heat to other end-users. Sales to one or two nearby plants or to a municipality were suggested as one level of activity; initiating the creation of a heating district or an industrial park was offered as another possibility. Whatever their anticipated level of involvement, firms were asked how the prospect of public utility regulation would affect their interest in distributing excess heat, and whether they would consider distribution if such activities were likely to subject them to such regulation.

Willingness to Act as Supplier

Willing to supply one or two other companies	A,B,C,D,E,F,G, H,I,L,M,N
Would also consider setting up heating dis- trict or industrial park	A,B,D,F,G,H,I, L,N
Not willing to supply others	J,K,O

Almost all of the greenhouse firms would be interested in selling surplus heat to one or two other companies. Only Just Flowers and Old Plant would not, preferring to expand their own greenhouses rather than to get into the energy business. In addition, nine of the firms would consider setting up a heating district or industrial park to utilize the geothermal energy. Dependable Rose would limit its activity to a heating district, because it would not want to participate in the industrialization of its neighborhood (it is located in the midst of 300 acres of contiguous greenhouses).

Still Interested if Subject to Regulation as Public Utility?

Yes	B,D,F,H,I
Depends on kind or degree of regulation	A,E
No	C,G,L,M,N

The generally positive responses to the possibility of distribution shifted somewhat when the respondents were confronted with the prospect that public utility regulation might be imposed. Less than half of the firms would still be interested in supplying others under such a circumstance, and it was clear that most of these were unfamiliar with the nature of public utility regulation. The others would no longer be willing or expressed strong reservations. One major concern was that as a public utility, the firm would be obligated to guarantee the supply of heat to its customers.

E. THE ROLE OF GOVERNMENT

1. EVALUATING EXISTING PROGRAMS

Awareness of Programs. Most of the greenhouse growers surveyed were unaware of any government programs promoting commercialization of geothermal energy. While five companies knew of the Utah Roses geothermal demonstration project, none associated it with a government program. When asked if they thought the government was doing enough to promote geothermal energy, the firms' obvious answers were reflected in one grower's observation that if few people know of government efforts, not enough is being done.

When existing programs were described to the respondents and their comments solicited, the responses were generally favorable:

Geothermal Loan Guarantee Program (GLGP): Twelve companies approved of the GLGP in principle and would be willing to apply if they decided to utilize geothermal energy. Five companies expressed an absolute need for such assistance to finance geothermal use. The one grower already using geothermal (0)

maintained that banks were reluctant to loan to greenhouse businesses because of the minimal tangible assets available if the business failed, and viewed the GLGP as one way to overcome that problem. Another greenhouse owner (L) was less sanguine, noting that guarantee programs of other government agencies such as the Small Business Administration, Production Credit Administration, and FHA had failed to overcome bank conservatism or had biases of their own, and surmising that the GLGP would be of no greater use to his company than were other government-backed loans for which it had applied.

PON/PRDA. Feasibility studies and demonstration projects met with approval from most growers: twelve companies indicated they would not require further proof of technology in the private sector. Five firms (B,C,D,L and M), however, would not find economic data from government projects wholly credible, because it is not derived under competitive conditions.

On the whole, greenhouse growers were more favorably inclined toward government-sponsored support of geothermal development than respondents in other industries surveyed. This probably reflects in part the undercapitalized condition of the industry, which makes some members more receptive to government financial assistance.

2. RECOMMENDATIONS FOR FUTURE PROGRAMS

To assess the kinds of programs which greenhouse growers would view as most helpful in commercializing geothermal energy, 13 different possibilities were presented and values were assigned to each. The following table summarizes these responses.

Program	Most Important	Very Important	Important	Total	Not Important	Opposed
Invest-Tax Credit	2	2	1	5	0	0
Accelerated Depreciation	1	4	0	5	0	0
Direct Subsidies	0	1	2	3	0	4
Loan Guarantee	0	2	4	6	0	-
Loan Forgiven if Project Unsuccessful	1	1	1	3	0	2
Subsidy Becomes Loan if Successful	1	0	2	3	0	1
Provide Testing Facilities	-	-	1	1	0	1
PRDA	0	2	2	4	1	0
Cost Share Industry R&D	0	1	1	2	0	0
PON	1	3	2	6	1	0
Resource Identification	2	4	1	7	0	0
Resource Development	1	2	0	3	1	0
Information Dissemina- tion on Resources and Technology	2	5	1	8	0	0

Information and Resource Identification. Most of the growers surveyed felt that they did not have the kind of concrete information they would need to think seriously about using geothermal energy. They focused prominently on three kinds of information -- location of resources, specific character of resources (i.e., water quality and temperature), and technical feasibility in their operations -- as important areas of concern for government to address. Several respondents argued that most greenhousers would do nothing until such

information was readily available, because the risks of locating and developing resources were too great for a low-capital industry. This conclusion was reinforced in subsequent questioning when the interviewees were asked directly where the government should concentrate funds if they are strictly limited. The majority (8) mentioned resource identification.

Other Programs. Other types of programs which received almost equally strong positive reactions from growers were demonstration projects, loan guarantees, accelerated depreciation, and investment tax credits. On the other hand, there seems to be only mild support for direct subsidies and very strong opposition by those who responded negatively to these types of programs. One grower responding to the proposed forgivable loan program acknowledged that total forgiveness eliminates the investment incentive necessary to a successful enterprise, and expressed concern about potential abuses.

Federal vs. State Programs. Nine out of 15 companies surveyed were indifferent as to whether the state or federal government administered programs in which they might participate. Only two companies had a preference and offered specific comments. A California grower felt that state government was more accessible and would therefore be a better vehicle for commercialization programs. A New Mexico respondent, on the other hand, preferred the federal government on the ground that his state government is controlled by rural interests which, in his view, would be less likely to administer such programs equitably.

V. CONCLUSIONS

A. CURRENT FUEL CONCERNS

- Of the fifteen firms interviewed, thirteen use natural gas exclusively or in combination with other fuels for space heating. Thus, geothermal energy will most likely displace gas if used widely in the industry.
- All firms use electricity for space cooling, and the sole geothermal user combines it with geothermal fluid for greater efficiency. Geothermal energy could reduce electricity requirements as well in some cases.
- Thirteen of the fifteen firms interviewed have an interruptable supply of some fuels, but the same number have some sort of back-up arrangement for emergencies. This indicates the importance placed upon a reliable, continuous energy supply. Geothermal energy use will therefore depend upon assurances of reliability. However, the convention of maintaining a back-up system could reduce this concern to some degree.
- Greenhouse growers are concerned about rising costs of fuel, but perceive that they will be able to pass on considerable increases or to reduce fuel use by conservation or crop adjustments. Accordingly, rising costs alone are not likely to induce shifts to geothermal in this industry.

- The prospect of unavailability of fuel will be a far stronger inducement for growers to shift to alternative sources. Only the Colorado firms have experienced recent supply interruptions, and these appear to be routine rather than due to overall short supply. However, as with increased costs, the initial response to supply problems will be to conserve energy through insulation and crop rotation techniques, rather than to seek alternatives.

B. DECISION MAKING

- Most greenhouse companies are small partnerships or family businesses. Therefore, consideration of geothermal energy as a fuel source will involve relatively uncomplicated owner/operator decisions.
- Investment projects involving the use of geothermal energy will be evaluated much like any other investment project. The simplest investment criteria, payback, will be used by most companies, but the larger companies will tend to require a shorter period (from one to five years), while the smaller companies will allow a somewhat longer payback period (seven to fifteen years).

C. COMMERCIALIZATION POTENTIAL FOR GEOTHERMAL ENERGY

1. ATTITUDE TOWARD GEOTHERMAL

- Greenhouse growers know that geothermal energy can be and is used successfully in their industry, but they have little information on costs, which is of paramount importance in

their consideration of geothermal as an alternative to conventional fuels.

- While most growers think that geothermal energy will be important in their industry within ten years, the consensus is that availability will be limited and that the primary beneficiaries will be those already located near a resource, or the more mobile potted plant sector of the industry which relies on artificial soil.

2. ANTICIPATED PROBLEMS

- Growers anticipate several significant problems with use of geothermal energy: a) Availability of the resource in the right location is the predominant concern. Very few growers are inclined or willing to relocate to use a resource, since their present locations are based on a rational assessment and balance of requirements such as climate, market, energy, water, labor, and raw material supply; b) The cost of developing is also paramount in growers' minds. Financing an exploratory venture is too risky for most, and even installation of retrofitting equipment will put a serious strain on a low capital industry; c) Reliability of energy supply is crucial to greenhouse production. As noted previously, growers are prepared to use a back-up system for emergencies, but they depend heavily upon the stability of their supply because interruption often results in serious economic loss. Accordingly, reliability is often viewed as a separate

consideration from overall cost considerations; d) Water purity is another concern. If a geothermal resource were of a quality useable in irrigation as well as heating, it would serve two basic industry requirements. However, contamination of the product by use of impure water as well as maintenance problems associated with corrosive fluids were seen as problems by about 1/3 of the respondents.

- As evidenced by the one existing geothermal operation sampled, new independent user/developers may encounter resistance from prior developers attempting to prevent possible depletion or drawdown. This has serious implications for any government program which focuses on independent user development. Such a focus may sponsor conflict among potential and existing developers which, in the long run, will discourage rather than encourage full and efficient development of any particular resource.
- Unfamiliar technology per se is not a significant barrier to geothermal use in the greenhouse industry. While many in the industry desire to know more about the technology, most are persuaded that it is not complex, and is easily transferable to existing operations.
- The regulatory environment for single-user development of geothermal resources was not identified as a significant problem, but this may reflect lack of specific knowledge rather than informed opinion.

3. FINANCING

- Many growers express distinct investment preferences as between operating costs and capital costs of investment projects, and will need to have these broken out in any geothermal cost data provided to them. Generally, small growers cannot finance high front-end costs, while larger ones may prefer them if they offer lower long-term operating costs.
- The greenhouse industry is undercapitalized, and therefore has difficulty obtaining conventional financing. Growers are more strongly influenced by the relative availability of internal and external funds than by relative costs of funds.
- Financing of a geothermal project would not be considered differently than any other investment project by most greenhouse operators. The larger firms will tend to go outside for funding in any event, while the small firms generally must rely on internal funds or short-term debt.

4. INFORMATION NETWORKS

- Trade associations are the most common source of technical information in the greenhouse industry. The national nursery associations reach most growers to some extent, particularly those in states without active local organizations. In California, however, local specialty associations have large

active memberships involved with the concerns, for example, of flower growers or potted plant growers. These types of associations would be effective conduits for government promotion of geothermal energy.

- Universities in some states are an important source of technical information for growers. The University of California Agricultural Extension has constant contact with individual growers and their associations in many western states concerning economic and technological matters as well as strictly agricultural issues. Serious interest in geothermal energy at the Extension could therefore have substantial impact in the industry as a whole.
- Individual growers communicate frequently and productively with one another. For this reason, general knowledge of demonstration projects is widespread in the industry; all but one of the growers interviewed had heard of geothermal use in greenhousing, and most were aware that geothermal can be a viable technology in the industry. However, growers almost universally lack the kind of specific information on resource sites, fluid characteristics, costs and potential savings which would be essential to serious consideration of geothermal as a substitute energy source in their operations.
- Government is expected by many growers to provide them with information on alternative energy. Few greenhouse operators,

however, feel that these expectations have been met, and most do not know where to make specific or general inquiries.

D. POTENTIAL INSTITUTIONAL FRAMEWORK

- Greenhouse operators express an overwhelming preference for purchasing geothermal energy through a distribution system developed by someone else. Growers are very reluctant to consider participating in development anywhere but on their own property, and do not favor joint development enterprises. Government programs which focus on individual user development are unlikely to interest growers who are strongly tied to traditional methods of purchasing energy from an outside supplier, and who regard their business as greenhousing, not energy development.
- Most growers would be willing in principle to consider supplying others with surplus from a resource they might control, but the prospect of public utility regulation resulting from such activities significantly altered that attitude. More than half the respondents were wholly unwilling to be regulated; the remaining ones either were not aware of the implications of regulation, or had strong reservations about it. Overall, utility regulation would present a serious barrier to user development involving downstream distribution.
- More than half the respondents theoretically would consider developing an industrial park around a resource they controlled. However, this fact must be taken in the context of the firms' strong preference not to become involved in development.

E. THE ROLE OF GOVERNMENT

- The overwhelming majority of growers surveyed knew nothing of existing government programs to promote geothermal development. If the government is to provide meaningful assistance to the greenhouse industry, high priority must be given to disseminating available information to industry members who might benefit from the substantial efforts already under way by DOE.
- To encourage geothermal use in their industry, growers perceive a primary need for information on resources -- where they are, what the water quality is, and what temperatures are available. Secondly, they express a need to know more about utilization technology in greenhousing application: they know it exists, but they are interested in learning specifics.
- The government is seen as a natural leader in the energy field. Those surveyed generally respond positively to some degree of government participation in alternative energy development benefiting the greenhouse industry. Demonstration projects, for example, have substantial credibility with growers. Financial assistance in the form of loan guarantees would be welcomed by many growers, who generally have low capital reserves and difficulty obtaining conventional financing. On the other hand, these small entrepreneurs and independent-minded business people tend to reject direct government intervention in the nature of subsidy programs, which they fear might limit their independence and encourage abuses. For maximum impact in this industry, DOE efforts

must be realistically tailored to these attitudes prevailing among industry members who have traditionally operated without government support or intervention.

- Tax incentives such as investment credits and accelerated depreciation are mildly interesting to growers, but insufficient to entice most of them to take risks of the magnitude they believe are involved in geothermal development.
- If greenhouse operators were to participate in government programs, most would have no strong preference as to whether the state or federal government administers the programs.

Appendix A

IV.A Fuel

1. Fuel Sources, Uses, and Costs

a. Fuel Uses and Sources

Space Heating

(O)	Relies entirely on geothermal energy
(D,E)	Rely entirely on oil
(A,B,F,K,L,M,N)	Rely entirely on natural gas. A and B do employ oil as a standby energy source.
(I,M)	Employ both oil and natural gas
(C,G)	Employ gas and purchased electricity. G relies on oil as a standby fuel source.
(H)	Uses oil, gas and electricity
(J)	Uses oil, gas and coal.

Space Cooling

All firms	Electricity. O uses geothermal fluids in combination with electric fans.
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b. Type of Fuel Contract

(A,C,D,E,F,G, H,I,J,K,L,M,N)	Uninterruptable supply. Firm A must use less than 300,000 cu. ft. per day to remain on uninterruptable. Firm D must use less than 100,000 cu. ft. per day to remain on uninterruptable.
(B,G,H,I,J)	Interruptable.

A.1. c. Costs of Fuels for Specific Greenhouse Companies by Type of Fuel

Company	Price	Comments
ELECTRICITY		
Acme	\$200/month	winter
	\$400/month	summer
Best	\$5,000/month	3/79
	\$14,000/month	summer
Cooper	\$0.0436/kwh	- - -
Dependable	\$150-250/month	- - -
Earnest	\$150/month	winter
	\$300/month	summer
High Grade	\$2,500/month	fisc year ending 2/79
Just	\$0.0325/kwh	- - -
Old Plant	\$150/month	- - -
OIL		
Cooper	\$0.54/gallon	diesel
Earnest	\$0.53/gallon	diesel
Good	\$0.41/gallon	#2 heating oil
Just	\$0.55/gallon	- - -
COAL		
Just	\$35/ton	1977
NATURAL GAS		
Acme	0.2428¢/therm	- - -
Best	\$20,000/month	March
	\$13,000/month	summer
Cooper	0.2040¢/therm	- - -
Dependable	\$28-33,000/year	over last 3 years
	\$0.165/sq ft of greenhouse	- - -
Friendly	\$0.60/sq ft of greenhouse	- - -
High Grade	\$1.70/1000 cu ft	interruptable
	\$1.76/1000 cu ft	uninterruptable
Just	\$1.80/1000 cu ft	interruptable
	\$1.90/1000 cu ft	uninterruptable

A.2 Fuel Supply Interruptions

a. Comments

- (A) Roses can survive one week of 30° temperature. Blooms might be destroyed, but plants would survive.
- (D) A southern California company can tolerate a fuel interruption indefinitely as long as roses don't freeze, however, subsequent quality and therefore price would suffer.
- (E) Could tolerate loss of fuel indefinitely given mild temperatures.
- (F) If suffered heating system shutdown when temperature below zero would lose entire crop within an hour.
- (C) During hot weather loss of electricity for more than one hour would lead to some financial loss. If for several hours, could cost as much as \$500,000.
- (L) Can handle about a ten-hour loss of fuel supply in an emergency.

b. Back-up Fuel Arrangements

<u>Company</u>	<u>Primary Fuel</u>		<u>Back-up Fuel</u>		
	<u>Gas</u>	<u>Elec</u>	<u>Type</u>	<u>Capacity</u>	<u>Time</u>
A	x		Oil		1 month
B	x	x	Oil		10 days
C	x		Diesel	36,000 gal	
D	x		Diesel		1 month
F		x	Nat. gas		
G		x	Diesel		
H	x		#2Ht.Oil	200,000 gal	1 heating season
I	x	x	Diesel	800,000 gal	1 mo. electric several mo. gas
J	x	x	Oil	490,000 gal	
L	x	x			
N		x	Diesel		

- (E) Has no back-up. Company uses diesel purchased on spot market to heat greenhouses. Said they could use liquid propane if diesel became unavailable.
- (F) Does not maintain back-ups for gas-fired boilers and space heaters since has uninterrupted gas supply. Uses natural gas burning generator to back up electricity.

A.2. b.
(continued)

- (I) Maintains three standby generators with total of 500-600 kw capacity.
- (J) Estimates 10,000 gal. of oil per night needed to operate greenhouses in event of gas supply interruption. Maintains two 50 kw generators at one facility which automatically operates if electricity fails.
- (K) Used to have butane fired back-up system but dropped it because it would take two hours to set it up and by that time crop would be ruined. Spokesman did say he would feel more comfortable with a back-up, although local gas company has a back-up line on which he depends.

c. Recent Experience of Fuel Supply Interruptions

- (B,K,M,O) No Information
- (F,G,H,I,J,N) Some recent interruptions. F's electricity is interrupted once a year for a short period due to power line falling from accumulated snow or the like. G said historically the gas supply is interrupted about 4 times a year for a total of several weeks. In 1978, however, it was 8 times, including one period of two weeks. Electricity is usually interrupted about once a year. H said gas interrupted about 200 hours during 77-78 heating season. I's gas was interrupted for about 600 hours and electricity for between 24 and 48 hours during same season. J experienced a 60 day gas supply interruption during the 78-79 heating season.
- (A,C,D,E,L) No interruptions in recent past. A last used oil reserves during a freeze in 1972. C's gas supply was last interrupted two years ago.

3. Future Fuel Supply Concerns

a. Future Concerns

- (A,B,C,D,
E,G,H,I) In addition to price, saw availability as major concern.
- (G,K) Saw no problem with future fuel supply. G was somewhat concerned about natural gas though not oil.

b. Estimate minimum cost increase that would induce you to seek alternative energy.

- (A,B) Even 100% increase wouldn't do it. B looked into solar but found it too expensive and technology too unstable.

A.3. b. (D,G,H,J)
(continued)

Energy supply shortage rather than price is biggest factor. D could sustain 200-300% increase in energy costs, but 100% increase would cause review of energy policy with more expansive conservation measures as goal. G would merely pass on increased costs. H would rather pass on costs but if met resistance would look for alternatives. Has considered solar in past. J noted that a 100% energy cost increase could increase unit price of product by only 1 or 2 cents. He said he could adopt Israeli growing methods should energy costs become prohibitive. He would not consider geothermal unless alternative measures were inadequate.

(M) Could afford somewhat more for energy, but if costs went up 10-20% per year would go to two crops per year according to season.

(E) Selling in 5 years so not interested in capital intensive alternatives. Had considered solar and wind before building greenhouse, but chose diesel because of lower cost.

c. Future changes in fuel use expected?

(C,D,F,G,H,I) Expected major changes in energy conservation techniques.

(H,I,N) Expected developments in use of alternative sources such as solar or geothermal.

(B) Thought some kind of change in industry's fuel use patterns would be necessary for industry to survive.

Appendix B

B. Firm Decision-Making

1. Managerial Structure and Decision Making

a. Forms of Business Entity

(A,B,F,G,H,I,J,L,M,N)	Family or single owner corporation
(O)	Family partnership
(E)	Partnership (unrelated)
(C,D,K)	Corporation (unrelated partners)

b. Locus of Decisions?

(B,F,J,M,O)	By interviewee (owner or president)
(L,N)	By owner w/ outside technical financial consultants.
(A,C,E,G,K)	By interviewee in consultation w/ partners.
(D,H,I)	By interviewee day to day w/ board approval of major investments.

B. 2. Investment Project Appraisal

a. Hurdle Rates for Evaluating 'Normal' Investment Projects

Company	Replace Old Equipment	Expand an Old Plant	Build a New Plant
	(Maximum Acceptable Payback Period in Years)		
A	N/A	N/A	N/A
B	N/A	← 7-15 →	
D	N/A	← 10 →	
F	N/A	← 10 →	
M	N/A	9	10
L	← 7 →		N/A
N	← 7-8 →		N/A
E		4-5	→
H		4-5	→
I		4-5	→
J		4	→
C		2-5	→
K		1	→

(K)

Cannot afford to invest more than \$5,000 at a time. They are unwilling to borrow money so the scope of their operation is limited.

(A)

Company has no specific criteria to apply to investments. Company is not in debt and has excellent cash position and therefore doesn't worry about payback. More concerned with efficiency. Growing roses is owners work and joy.

b. Hurdle Rate for a Hypothetical Geothermal Project

(A,B,D,E,F,G,
H,I,J,K,N) Same as for any other investment project.

(C) Shorter payback period.

(H,L) Longer payback period .

Appendix C

C. Commercialization Potential for Geothermal Energy

1. Knowledge of Geothermal Energy

a. Know of potential as a source of energy?

yes A,B,C,D,E,F,G,H,I,J,L,M,N,O

no K

b. Heard of Commercial Applications?

yes all

(A,D) Heard of geothermal greenhouse operated by San Lorenzo Nursery in Thermal, CA. A visited the operation.

(B) Knew of family operating geothermal greenhouses in Susanville and Calistoga, CA. Also heard of geothermal greenhouses in Nevada.

(C,L,M,N) Knew generally of geothermal greenhouses in New Mexico. N read an article in a trade magazine encouraging growers to locate in New Mexico.

(F,G,K) Heard generally of geothermal greenhouses in Colorado. F heard they were having water quality problems.

(A,D,H,I,J) Heard of Wright Bros. geothermal greenhouse project (Utah Rose Co.) outside Salt Lake City.

c. Seen cost figures for geothermal exploration, drilling or installation?

(A) Seen drilling cost figures for Utah Rose Co.

(O) Has cost data from his own geothermal operation.

d. Ever considered using geothermal energy?

yes A,C,E,F,H,J,L,M,N,O

no B,D,G,I,K

C.1. d. [Ever considered using geothermal energy?]
(continued)

(A,D,E,F)

Dismissed idea because did not think geothermal could be found on their land. A had former employer who investigated possibility of locating in Klamath Falls. E was approached by contractor from Susanville.

(L)

Heard of greenhouse for sale near a resource in Truth and Consequences, N.M. Decided location too far from his distribution system.

(M)

Read about geothermal before going into business. Checked with a friend at the University of New Mexico who discouraged him by warnings of corrosion problems.

(N)

Hired a European energy consultant who tested water temperature from irrigation well, found 72° water, and suggested further exploration.

(C,H,J)

Approached by people from City of Klamath Falls. C was approached by the Klamath Falls City Council. The company indicated that it would locate there if the city successfully drilled a geothermal well at a specific location. The well was a dud. The interviewee, a production manager, recommended against the Klamath Falls location because of inadequate sunlight. He cited a report which concluded that Southern California growers could not be attracted to Klamath Falls, even with cheap energy source, because 1) the move would be too capital intensive - the greenhouses, the geothermal well and the back-up system, and 2) there would be low return on investment.

The Klamath Falls Chamber of Commerce contacted another firm (H) about three years ago about the potential for operating geothermal greenhouses there. The owner went there to talk to them about it, but finally felt that Klamath Falls was too far from his market and from a population center, thus causing transportation problems and an inadequate labor supply, and the price of land with geothermal potential was too high.

Another firm (J) also investigated the

C.1. d. [Ever considered using geothermal energy?]
(continued)

possibility of locating a new greenhouse in Klamath Falls. He was contacted by community representatives at the suggestion of Ackie Brown, a Chicago greenhouse manufacturer.

e. Know of possible uses for geothermal energy in greenhouse business?

(A,B,C,D,E,F,G,H,I,J) Heat greenhouses

(A,I,J) Irrigation if the water is pure

(E) Heat propagation

(O) Cooling

f. When, if ever, will geothermal energy be an important resource in the greenhouse industry?

(B,C,J,N,O) Important within five years. B felt potted plant greenhouses which use artificial soil are more mobile than those affected by natural soil quality and thus more likely to locate near a resource.

(E,G,I) Important within five to ten years.

(F) Important in twenty years.

(H) Important when gas becomes too expensive or when gas supply has diminished considerably. Would use today if thought it economically feasible.

(B,C,G) Will always be limited to certain segments of the industry.

C.1. Factors Influencing the Decision to Employ Geothermal Resources.

a. Problem(s) anticipated in using geothermal energy in your business?

no N

already using O

(A,C,D,E,F,G,H,I,J) Availability in the right location

(B,C,F,G,M) Water quality problems, i.e., corrosion, salinity, potentially damaging to plants.

C.2. a. [Problem(s) anticipated in using geothermal energy in your business?]
(continued)

(C,D,H,I)	Drilling risks
(D,E,F,G,J,K,L)	Costs
(D,F,H,J)	Reliability
(E,H)	Financing

Problem	Most Important	Very Important	Important	TOTAL
Availability	6	-	3	9
Costs	2	1	4	7
Water Quality	-	2	3	5
Reliability	-	1	3	4
Drilling Risks	1	-	3	4
Financing	-	1	1	2
Lack of Information	-	-	2	2

b. Willing to relocate existing facilities to take advantage of geothermal energy?

yes	B,D,L
no	A,E,F,G,H,J,M,N

c. Willing to locate a new plant near a resource?

yes	A,B,C,D,H,I,L
no	M

d. Future plant plans?

(E,H,I)	New plants planned in next 5 years.
(A,B,D,O)	No new plants in the foreseeable future.

C.2. e. Factors important in choosing a plant site?

Factor	Most Important	Very Important	Important	Total	Not Important
Climate	6	-	2	8	1
Close to product market	2	4	5	11	1
Water Supply	1	4	4	9	-
Energy Supply	-	11	1	12	-
Labor Supply	-	3	6	9	-
Raw Material Supply	-	3	3	6	3
State and Local Tax and Attitude to Business	-	-	1	1	3

f. Assuming resource available, which factors influence a decision whether or not to use?

Numbers of Ratings Received by Alternative Decision Factors

Factor	Most Important	Very Important	Important	TOTAL	Not Important
Capital Cost	7	3	-	10	-
Operating Cost	3	4	-	7	2
Reliability (minimal down time)	2	4	-	6	2
Compatibility with existing equipment	1	2	2	5	1
Availability of a firm long-term fuel contract	1	-	3	4	-
Ease of maintenance	1	-	2	3	4
Familiarity of the technology	-	1	-	1	5

- C.2. g. If considering two projects with same annualized costs: "A" - high capital/low operating, and "B" - low capital/high operating, which would you prefer?

(B,C,D,F,H,I,J) Project "A"

(A,E,G,K,L,M) Project "B"

- h. If you would experience periodic, temporary shutdowns, would you factor it into costs or account for it separately?

(A,B,D,E,H,J) Factor into costs. A, only if shutdown can be anticipated and planned for.

(F,G,L,M,N) Consider separately. L, M and N said they cannot afford to have systems down periodically.

C.3. Financing a Geothermal Investment Project

a. Financing a Plant Retrofitting

Internal Funds:

(A,J,K,M)

A said that they borrow very infrequently since they have strong capital reserves. F said that if they can't finance a project out of their own capital reserves, they won't invest. They would never borrow money for this type of project. K also said that, although they cannot afford to invest more than \$5,000 at a time, they would not be inclined to go outside and borrow money for an investment project. J said that they used to finance investments such as this with long-term loans from banks and other lenders, but now, they would finance the retrofitting of their greenhouses to use geothermal only from capital reserves or with government financing.

Combination of Internal Funds and Short-term Debt

(C,D,E,G,L)

C said that the type of financing they got would depend on the total amount involved. They would probably borrow if the amount was substantial. D and E indicated that they would prefer to use capital earnings to the extent possible, and to finance the remainder with short-term loans. When E recently built

C.3. a.
(continued)

a new greenhouse at a cost of \$25,000, they took in a limited partner to help finance the project; in return for his investment, he will receive a percentage of the profits from the greenhouse. G said that normally the company would finance a major equipment replacement or renovation with long-term loans, but it has presently extended its long-term loan credit to the limit. Therefore, it would have to rely on internal funds or short-term debt.

Combination of Short and Long-term Debt:

(B,I,N)

I said they would finance a long-term asset with long-term debt, and a short-term asset with short-term debt. They would also seek financing from the Small Business Administration and other government agencies in addition to private banks. N stated that if the investment would require less than \$100,000, they would finance it with a short-term loan from the bank. If the investment would require \$500,000 or more, they would use a long-term FHA loan.

b. Financing Resource Development

(A)

Exclusively internal funds

(D,E)

Internal funds to extent possible and then short-term debt for balance.

(G,L,N)

Combination short-term debt and long-term loans. G said would borrow short-term if under \$40,000. If 100,000 or more would attempt to borrow from Federal Land Bank or other government sponsored loan program. L has problems getting bank financing for greenhouse business though no problem financing construction and land speculation business. Even with substantial assets from other businesses, banks won't loan for greenhousing.

(C,F,H,J)

Long-term debt. C would prefer a Federal Land Bank Loan. F would go to a bank or credit union. H would look to private banks and public, i.e., Federal Land Bank or Production Credit Administration. Also expressed an interest in government loans.

C.4. General Sources of Information on Technology

a. Most important sources of information on new technology?

- (A,B,C,D,E,F,G,H,I,
J,K,L,M,N,O) Trade Associations and trade journals. M said there was no viable trade association in his locality (N.M.) so he relies on trade papers. L goes to national conventions to keep up with the industry.
- (A,B,C,D,E,F,G,H,I,J,N) Universities. I and J noted that Colorado State University was a poor source and that University of California extension service is the best. N uses Texas A & M experimental station near him.
- (A,B,C,D,F,H,I,J) Others in industry. L says competitors are close mouthed.
- (E) Government. All others said they got little help from the government.
- (C) Own R&D.
- (K,M) Equipment and Supply Companies.

b. If looking for alternative energy, where do you make first inquiries?

- (A,B,C,D,E,F,G,I,M) Universities
- (A,C,E,F,I,J) Trade associations and journals
- (A,C,F) Others in industry
- (C,D,G,H,I) Government
- (H,I,N) Outside consultants
- (O) Los Alamos Lab, Sandia Corp.
- (N) Local gas and electric utilities. They know water temperatures, pressures and depth in the area.
- (E,F) Equipment suppliers
- (D) San Diego County Energy Conservation expert.

Appendix D

D. Potential Institutional Framework

1. Willingness to become involved in resource development

Willing to consider resource development	A,B,E,F,G,H,I,J,L,N
Would consider only where resource already identified	A,F,N,O
Would consider only development on own land	D,E,H
Not willing to participate in resource development	B,C,K,M
No response	O

2. Preferred structure for resource development?

Alone preferred	A,D,F,G,H,L,N
Alone only	J
Joint venture preferred	I
No response	E,O

3. Need for control over supply

Would strongly prefer to be sole user	G,J,L,O
Willing to hook up to distribution system	A,B,C,D,E,F,H,I,K,M,N

4. Willingness to act as supplier

Willing to supply one or two other companies	A,B,C,D,E,F,G,H,I,L,M,N
Would also consider setting up heating district or industrial park	A,B,D,F,G,H,I,L,N (<u>D</u> would not consider industrial park because it opposes industrialization of its neighborhood.)
Not willing to supply others.	J,K,O (interested in greenhouses, not energy business)

D.5. Effect of regulation on interest in distribution?

Still interested

B,D,F,H,I

Depends on kind or degree
of regulation

A,E

No longer interested

C,G,L,M,N

(A,C,L)

Concerned that they would be
obligated to guarantee supply.

Appendix E

E. The Role of Government

1. Evaluating Existing Programs

a. Aware of Government Programs?

yes C, O

no A, B, D, E, F, G, H, I, J, L, M, N

against ALL K (refused to discuss government programs)

b. Rating of Existing Programs

GLGP

favorable A, B, C, D, E, F, G, H, I, J, N, O

PON/PRDA

favorable A, C, D, E, F, G, I, J, N

unfavorable H

Tax Incentives

favorable A, D, E, F, G, H, I, J, N

c. Willing to Apply for GLGP?

yes A, B, C, D, E, F, H, I, J, L, M, N
(F, H, I, N: on site inspection would be necessary)

no G (B, C, D, L, M: had reservations about the reliability of economic data not derived from competitive market.)

d. Need to Apply for GLGP

yes E, I, L, M, O

no A

E.1. e. Is Government Doing Enough

yes	D,I
no	A,G
insufficient information	B,C,E,F,H,N

d. Government Demonstration Projects Credible?

yes	A,B,C,D,E,F,H,I,J,L,M,N (F,H,I,N: on site inspection would be necessary)
no	G
(B,C,D,L,M)	Had reservations about the reliability of economic data not derived from competitive market.

E.2. Recommendations for Future Programs

a. What should the government do?

Program	Most Important	Very Important	Important	Total	Not Important	Opposed
Invest-Tax Credit	2 (D,F)	2 (A,H)	1 (I)	5	0	0
Accelerated Depreciation	1 (F)	4 (A,C,H,I)	0	5	0	0
Direct Subsidies	0	1 (J)	2 (C,E)	3	0	4 (B,F,G,I)
Loan Guarantee	0	2 (H,J)	4 (C,E,L,N)	6	0	-
Loan Forgiven if Project Unsuccessful	1 (I)	1 (D)	1 (E)	3	0	2 (A,C)
Subsidy Becomes Loan if Successful	1 (I)	0	2 (C,E)	3	0	1 (H)
Provide Testing Facilities	-	-	1 (C - for equipment companies)	1	0	1 (H)
PRDA	0	2 (E,G)	2 (C,D)	4	1 (H)	0
Cost Share Industry R&D	0	1 (I)	1 (C)	2	0	0
PON	1 (G)	3 (A,C,E)	2 (I,N)	6	1 (H)	0
Resource Identification	2 (H,J)	4 (C,E,I,M)	1 (N)	7	0	0
Resource Development	1 (J)	2 (A,C)	0	3	1 (I)	0
Information Dissemina- tion on Resources and Technology	2 (C,E)	5 (A,D,H,I,M)	1 (N)	8	0	0

E.2. b. Where should funds be concentrated?

(B,I)

Finance Technical R&D. B said technology needs to be proved feasible. I thought cost burden too high for greenhouse growers.

(A,C,D,E,F,G,H)

Resource Identification. A, C, and E said anything else is irrelevant unless the resources are available. D, G, and H felt location I.D. was important to determining feasibility and is most expensive process which when complete would allow private capital to take over.

c. Prefer Federal or State Programs?

(A,B,C,E,F,G,H,I,J,K)

No difference

(D)

Likes state better because more accessible.

(L)

Likes federal government better because state politics controlled by rural interests.