QUARTERLY TECHNICAL PROGRESS REPORT

GEOTHERMAL SPACE/WATER HEATING FOR MAMMOTH LAKES VILLAGE, CALIFORNIA

CONTRACT NO. E(04-3)-1316

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I. SUMMARY OF WORK COMPLETED

During the first three months of this one-year study to determine the technical, economic and environmental feasibility of heating the town of Mammoth Lakes, California using geothermal energy, the following work was completed.

A) Literature concerning both geothermal and conventional hydronic heating systems was reviewed and put on file.

B) Estimates were prepared for the monthly electrical energy consumption and peak electrical demand for space and water heating in Mammoth Lakes Village in 1980. The estimated 1980 peak demand for electric space and water heating is 49MW.

C) An analysis of the energy potential of the Casa Diablo geothermal reservoir was completed. Data from well flow tests indicate flow rates and temperatures well in excess of the 1980 peak demands for all of Mammoth Lake Village. However, additional reservoir data are required prior to constructing a large scale geothermal district heating system.

D) Discussions were held with U.S. Forest Service and Mammoth County Water District employees, to obtain their input to the feasibility study.

Details of the work summarized above are contained in Sections II to V of this report.

II. LITERATURE SURVEY

Papers, reports and other references containing information on district hydronic heating systems, both conventional and geothermal, were obtained and reviewed. Information relevant to the project was cataloged and put on file for ease of access. The references which were reviewed are listed in the following table.

In addition, project personnel visted the Geo-Heat Utilization Center at Oregon Institute of Technology and toured the geothermal heating systems at OIT and in the town of Klamath Falls. The OIT campus employs hot water coils in forced air heating systems, baseboard convectors for perimeter space heating and water to water heat exchangers for domestic hot water heating. The space and water heating systems proposed for Mammoth Lakes Village are expected to be similar to the OIT systems.

The literature survey has been completed.

LIST OF LITERATURE REVIEWED

1. American Society of Heating, Refrigerating, and Air Conditioning Engineers, ASHRAE Handbook & Product Directory, Handbook of Fundamentals, 1972, Applications Volume, 1974, Equipment Volume, 1975 and Systems Volume, 1976.

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6. Donovan, L.E. and A.S. Richardson, Feasibility/Conceptual Design Study for Boise Geothermal Space Heating Demonstration Project Building Modifications, ANCR-1246, October, 1975.

7. Howard, J.H., Present Status and Future Prospects for Nonelectrical Uses of Geothermal Resources, UCRL-51926, October, 1975.

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9. Jeskey, J.C. and A.B. Longyear, Susanville Geothermal Energy Project, Workshop Proceedings and Final Technical Report, July, 1976.

10. Keller, J.G. et. al., Geothermal Space Heating of a Geothermal Drilling Rig, ANCR-1241, June, 1975.

11. Lienau, P.J. and J.W. Lund, Proceedings of the International Conference on Geothermal Energy for Industrial, Agricultural and Commercial-Residential Uses, Klamath Falls, Oregon, 1974.

12. Lienau, P.J., J.W. Lund, G.G. Culver and D. Ford, Klamath Falls Geothermal Mini-Heating District Feasibility Study, Oregon Institute of Technology, October, 1976.

13. Nannen, L.W., F. Kreith and R.E. West, An Investigation of the Technical and Economic Feasibility of Using Low Temperature Geothermal Sources in Colorado, Energy, Volume 1, 1976.

14. Proceedings, Eleventh Intersociety Energy Conversion Engineering Conference, South Lake Tahoe, Parts IV and V, 1976.

15. Proceedings, Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, Volume 3, Section IX, 1975.

16. Proceedings, Use of Domestic Hot Water for Space Heating, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Washington, D.C., 1971.

III. LOAD SURVEYS

At the present time, approximately 90% of the space and water heating energy in Mammoth Lakes Village is provided by electrical energy from Southern California Edison Company (SCE). In order to determine the characteristics of the heating loads and heating systems currently in use, various surveys are being conducted. The results of these surveys to date are summarized below.

A. PRELIMINARY HEATING ENERGY AND DEMAND ESTIMATES--1980

Estimates have been prepared for the monthly electrical energy consumption and peak electrical demand for space and water heating in Mammoth Lakes Village for 1980. The monthly energy consumption was estimated first, followed by a demand estimate.

1. Monthly Electric Heating Energy

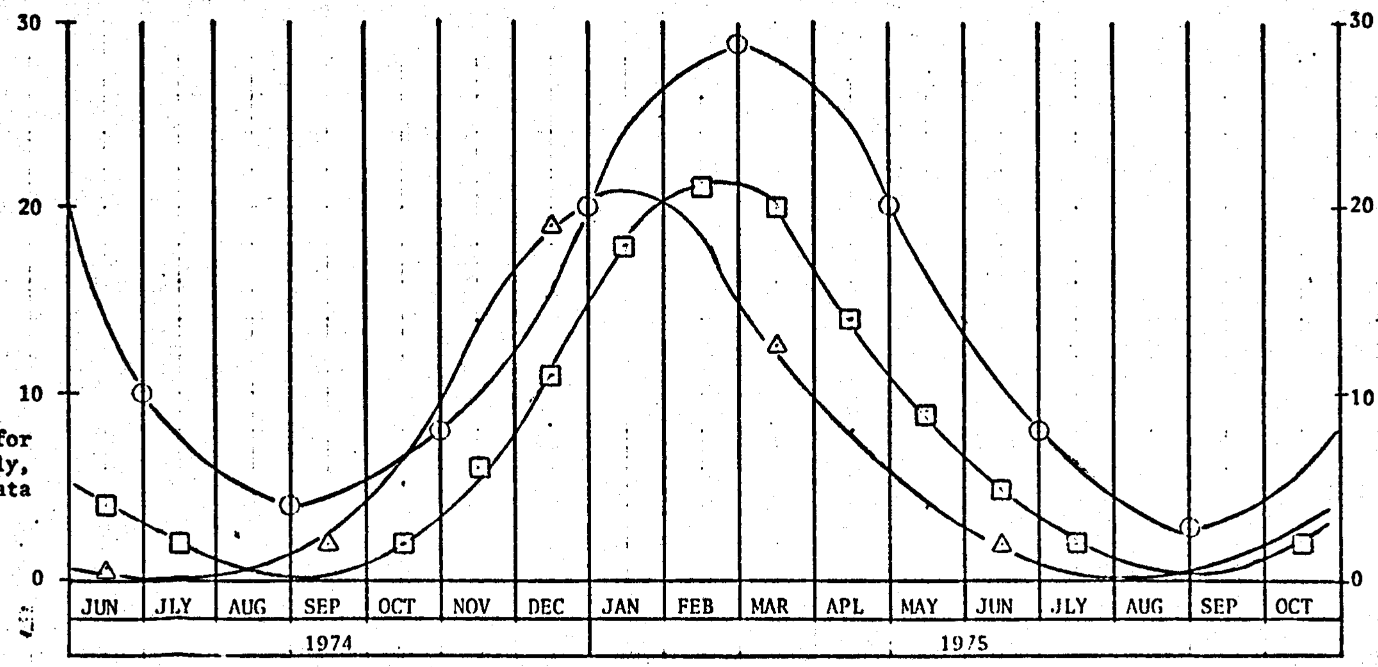
A tabulation of monthly electrical energy consumption by various categories was made using SCE Document MR 367. This document records energy consumption in KWH and number of meters for various customer classifications (i.e. residental, commercial power, commercial lighting, industrial, street lighting, etc.) and for specific geographical areas. The period from June 1974 through October 1975 was investigated as that period was more typical in terms of ambient temperature, load growth and skier activity, than the 1975-1976 season which experienced an unusually warm winter.

As a first step in determining that portion of the total load which is attributed to heating, the rate categories from the "MR-367's" which have no heating associated with them such as Residential Lighting, Commercial, Industrial and Public Authority Power (which is 3 phase power) and Street Light loads were neglected. Secondly, those loads which were very small compared to the total were neglected to simplify the analysis. The remaining KWH/month were tabulated as item 1) on the attached Figure I. Item 2) in the tabulation indicates the number of meters for which the energy consumption rates were recorded. The average KWH/meter/month was calculated, tabulated as item 3), and plotted using a "O" symbol in Figure I.

Estimates of the energy used in 1974-1975 for space heating were taken from a previously completed internal SCE study of multiple unit dwellings which used temperature data from Bishop, California. Bishop is located about 40 miles southeast of Mammoth Lakes. Mammoth Lakes is approximately 5000 feet higher in elevation than Bishop, therefore, the average ambient temperatures may be in the order of 10°F cooler than Bishop. It appears, however, that this does not introduce a significant error in estimated heating loads. When the calculated space heating loads using the warmer Bishop temperatures

	JUN	JLY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APL	MAY	JUN	JLY	AUG	SEP	OCT
1) Recorded Energy (KWH X 1000)	4103	1192	3822	452	2919	1915	5271	8281	11149	7063	8288	6748	4157	2242	1920	1806	2666
2) Number of Meters	3629	3629	3822	3639	3655	3679	3856	3865	3864	3866	3866	3868	3870	3874	3874	3876	3882
3) Average Energy Use (KWH/Meter) ○	1130	328	1000	124	798	520	1367	2143	2885	1837	2144	1745	1074	578	495	465	686
4) Calculated Space Heating (KWH/Meter) △	58	0	0	0	530	1395	1874	2101	1404	1143	612	279	58	0	0	0	530
5) Shifted Space Heating (KWH/Meter) □	400	150	0	0	200	550	1100	1800	2100	2000	1400	900	500	200	0	0	300
6) Average Occupancy (People/Unit)	1	1	1	1	1	2	5	7	7	6	2	1	1	1	1	1	1
7) Calculated Water Heating (KWH/Meter)	250	250	250	250	250	330	580	750	750	660	330	250	250	250	250	250	250
8) 1980 Village Space Heating (KWH X 1000)	1924	722	0	0	962	2645	5291	8658	10101	9620	6737	4329	2405	962	0	0	2405
9) 1980 Village Water Heating (KWH X 1000)	1203	1203	1203	1203	1203	1587	2770	3608	3608	3175	1587	1203	1203	1203	1203	1203	1203

Monthly Energy Use
(KWH/Meter X 100)



NOTE: Symbols (○ △ □) are for curve identification only, they do not designate data points.

FIGURE I
MONTHLY ELECTRICAL ENERGY FOR SPACE AND WATER HEATING
MAMMOTH LAKES, CALIFORNIA

are plotted and the resulting curve is aligned with the total load curve previously estimated, the calculated values appear to be very reasonable. The calculated space heating values from the Bishop study were tabulated as item 4), and plotted using a "△" symbol. After this curve was aligned with the 1974-1975 season total load curve, the resulting monthly KWH space heating values were retabulated as item 5).

Estimates of the electrical energy used in 1974-1975 for water heating were based on data from the 1969-1970 Report of Load Research Committee of the Association of Edison Illuminating Companies (AEIC). This report tabulates annual KWH consumption for hot water heating as a function of family size (unit occupancy).

The average number of occupants per unit was somewhat arbitrarily estimated. A large majority of the installed meters in Mammoth serve condominiums. It is our understanding from discussions with local residents and review of the Mono County Plan that many of the condominiums are often unoccupied during the summer season, and filled to capacity with relatively large groups during the ski season. Thus the assumed occupancy ranged from 1 to 7 people per unit as tabulated as item 6) of Figure I.

Based on the unit occupancy estimates above, monthly KWH use for water heating was estimated from AEIC data, and tabulated as item 7) in Figure I. The maximum monthly electrical energy consumption for hot water is in the order of 750 KWH/month.

The estimated 1974-1975 monthly space and water heating loads were multiplied by 1.3 to obtain an estimate for 1980 monthly energy consumption. The multiplier is based on the ratio of the recorded peak load for Mammoth Lakes in 1975 to the estimated peak load of 1980. The 1980 per unit energy rates were multiplied by the average number of units in 1974-1975 to obtain the total 1980 estimated rates as tabulated as items 8) and 9) in Figure I.

The estimated rate of load growth is the most uncertain parameter in estimating the 1980 heating loads. The development of Mammoth is a strong function of many variables such as economic conditions, environmental restraints, water availability, weather and winter sports popularity. Depending upon the magnitude of changes in these variables, the electric load growth estimate can vary substantially.

The estimated monthly electrical energy heating requirements for Mammoth Lakes Village in 1980 are summarized below, and shown graphically in Figure II.

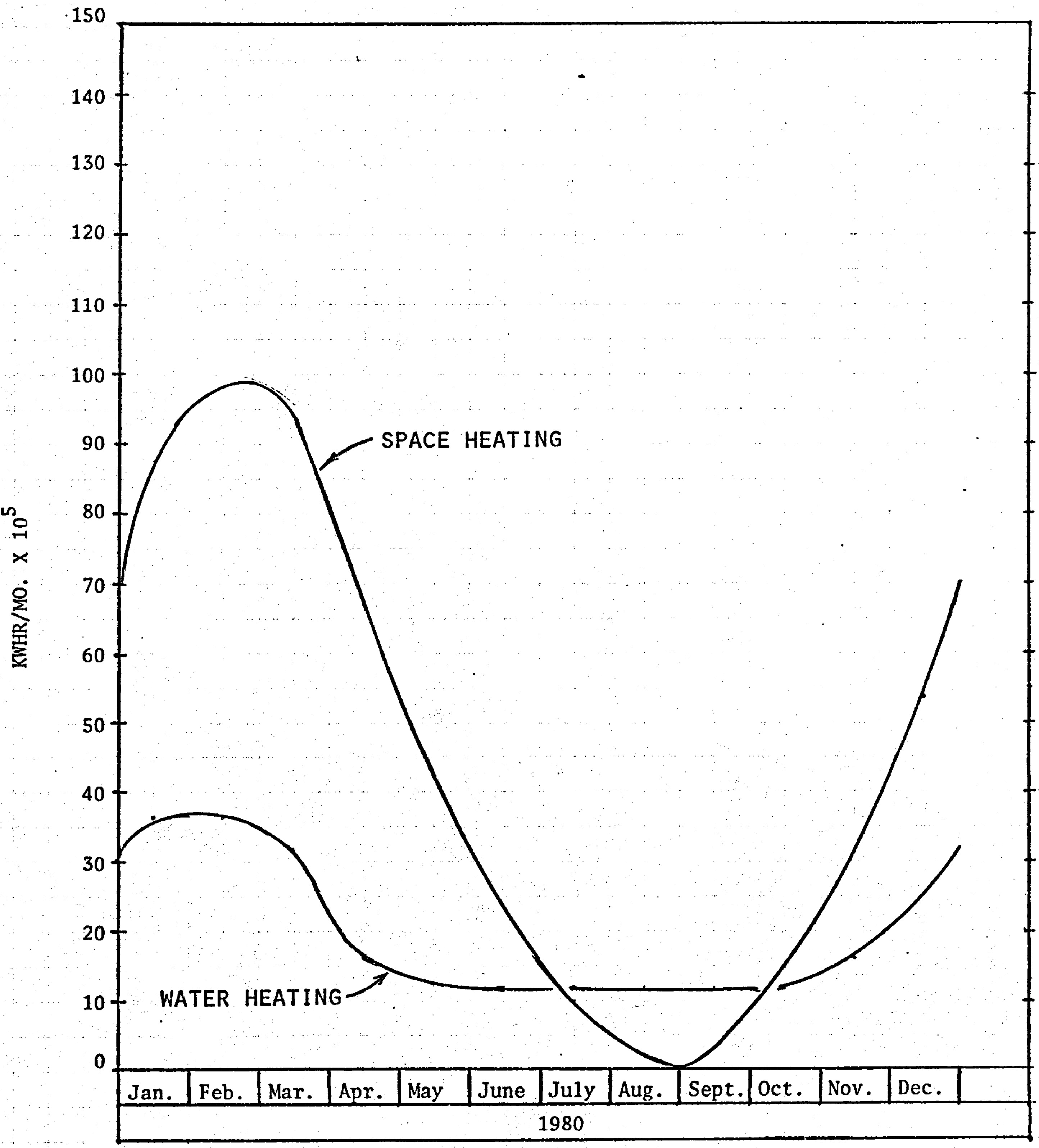
	SPACE HEATING (KWH X 1000)	WATER HEATING (KWH X 1000)
JAN	8,700	3,600
FEB	10,000	3,600
MAR	9,600	3,200
APR	6,700	1,600
MAY	4,300	1,200
JUN	2,400	1,200
JUL	1,000	1,200
AUG	0	1,200
SEPT	0	1,200
OCT	2,400	1,200
NOV	2,600	1,600
DEC	5,300	2,800

2. Peak Electric Heating Demand

Two independent approaches were utilized to estimate peak electrical space heating demand for Mammoth Lakes. In the first, studies from the Association of Edison Illuminating Companies (AEIC) which provide demand verses temperature relationships for residential resistance heating were used. Based on a maximum temperature differential of 50^{o}F (outside ambient of 20^{o}F and an inside temperature of 70^{o}F), the AEIC data suggest an average electric space heating peak demand of approximately 8.5 KW per customer.

During the 1974-1975 winter peak (which was more "typical" in terms of weather and unit occupancy due to winter sports activities than subsequent winters) SCE records indicate there were approximately 3,700 residential customers in Mammoth Lakes. Multiplying the average 8.5 KW heating demand per customer by 3,700 customers yields approximately 31 MW. This

FIGURE II
ESTIMATED MONTHLY HEATING ENERGY
MAMMOTH LAKES VILLAGE - 1980



compares to a total peak of 41 MW recorded at Casa Diablo Substation which essentially exclusively serves Mammoth Lakes.

Load studies indicate that the relationship between energy use and demand is a linear one. This relationship was used to re-estimate the peak space heating demand and thus provide a check on the figure calculated above. Thus, using figures from the peak month, February 1975:

$$\frac{\text{Heating Peak Demand}}{\text{Total Peak Demand}} = \frac{\text{Heating Energy/Month}}{\text{Total Energy/Month}}$$

where,

Heating Peak Demand = (to be determined)

Total Peak Demand = 41 MW recorded at Casa Diablo Substation

Heating Energy/month = 11,149,000 KWh estimated from SCE records of major loads in Mammoth associated with heating, Feb. '75.

Total Energy/month = 14,238,000 KWh from SCE records. Mammoth, Feb. '75

Therefore, $\frac{11 \times 10^6 \text{ KWh/mo}}{14 \times 10^6 \text{ KWh/mo}}$ (41 MW) = 32 MW

This estimate of 32 MW corresponds quite closely with the 31 MW calculated above utilizing the AEIC studies.

As noted in Section III.A.1 above, a figure of 1.3 is used to escalate demand and energy figures from 1974-1975 to 1980.

This results in an estimate of peak electric space heating demand of 41 MW in 1980.

Residential electric water heating load curves from AEIC studies indicate that an average peak water heating demand per customer is 1.5 KW. Multiplying 1.5 KW by the 3,700 customers in Mammoth yields a total peak of approximately 6 MW for electric water heating.

Applying the growth estimate of 1.3 as above, the estimated 1980 peak electric water heating demand becomes approximately 8 MW.

In summary, the following breakdown of peak electric load demand for Mammoth Lakes in 1980 will be used in this feasibility study.

Space heating	41 MW
Water heating	8 MW
Other	5 MW
Total	54 MW

B. SATURATION SURVEY

A saturation survey is being undertaken to determine the numbers, types and configurations of space heating and water heating systems currently in use in Mammoth Lakes. The survey will determine which facilities have propane gas or electric water heating and space heating systems, which have central plant systems, which have forced air, radiant, baseboard or wall heater systems. This information will assist in the determination of which existing facilities might lend themselves to conversion to geothermal heating systems. It will also provide data for design of geothermal heating systems for facilities not yet constructed.

Field trips and discussions with Edison personnel in the area have yielded the following preliminary results;

- Condominiums, which account for the majority of the heating loads in Mammoth, generally employ an individual electric water heater for each unit. We are aware of only one out of the approximately forty complexes which has propane central plant water heating systems. Condominiums generally use baseboard and wall type electric space heaters rather than central plant or forced air heating systems.

- Some motels and commercial establishments utilize central propane gas water heating systems. Motels generally utilize individual unit electric wall or baseboard space heaters.

-Restaurants generally employ electric or propane central forced air space heating units.

-Single family dwellings utilize both propane and electric water and space heating systems.

The preliminary reconnaissance indicates that there are a significant number of facilities which appear to be suitable for retrofit to geothermal heating.

SCE's Energy Services group is currently conducting a "door to door" survey of the approximately 150 commercial customers in Mammoth to obtain the data described above. In addition, SCE personnel are canvasing by telephone the forty condominium complexes and a number of the single family dwellings in town to obtain the described data.

The Preliminary Reconnaissance is complete. The Field Survey and the Telephone Survey are scheduled for completion by mid-January 1977. This completion date will be approximately six weeks beyond the originally scheduled date; however this should not impact the overall study schedule.

C. METERING

Data gathered from electric meters will serve to assist in estimating space and water heating energy consumption and demand requirements. These data will be correlated with recorded ambient temperatures, and will provide substantial input to the design of geothermal heating systems for new and existing facilities. The following data will be gathered.

32 (day chart) charts ? or (32 day) charts 30 two-day charts 32 charts which record for a day?

Electric System Demand - Edison utilizes thirty two day circular charts at Casa Diablo Substation which record the total electric demand continuously for the Mammoth Area. These charts have been made available for use in this study. Since the bulk of the electric demand in Mammoth is attributable to heating, review of these demand charts provides a good definition of the heating demand in the area.

Heating Energy Consumption - In order to determine typical energy consumption rates for condominimums and commercial and governmental facilities, elapsed time indicators are being installed "down stream" of controlling thermostats on both electric space heaters and electric water heaters in several businesses and dwelling units in Mammoth. By multiplying the number of hours that the space or water heater is in operation per month by the kilowatt ratings of the heaters, the energy consumption in KWH is determined. A ratio of heating energy consumption to total energy consumption within Mammoth will be developed for various types of establishments. Given these ratios and the Edison records for total energy consumption, the current and forcasted heating energy requirements should be determinable with fair accuracy.

Ambient Temperature Recorder - It is planned to install a continuously recording ambient temperature thermometer at an Edison facility in Mammoth to provide data for correlation with recorded energy use and demand. The temperature data will be used in design of the geothermal heat exchange plant and the individual facility heating systems.

System demand meters are installed and operating, and historic data have been obtained for review and analysis. Heating energy consumption meters (elapsed time indicators) will be installed through January 1977, and data will be collected at least through completion of this feasibility study and perhaps beyond. Interviews with candidate SCE customers for meter installation has been initiated. Efforts are under way to locate and install a multipoint ambient recording thermometer. In the mean time, published daily high and low temperature readings for Mammoth are being collected.

IV. RESERVOIR ANALYSIS

To determine if a sufficient quantity of geothermal energy is available to serve the heating needs of Mammoth Lakes Village, an analysis of the Casa Diablo reservoir has been completed. The results of the analysis are summarized below.

A. INTRODUCTION

The Casa Diablo geothermal area is a 90 acre parcel of land located at the intersection of U.S. Highway 395 and California State Highway 203, about three miles east of the town of Mammoth Lakes, Mono County, California. The Casa Diablo site is owned in fee by the Magma Power Company of Los Angeles, California.

Casa Diablo is located within the Long Valley portion of the Mono-Long Valley Known Geothermal Resources Area (K.G.R.A.) established by the Secretary of Interior under the Geothermal Steam Act of 1970 (30 UCS 1001-1025 (1970)). Long Valley lies in a large caldera, about 150 square miles in area, formed 700,000 years ago and filled with up to 12,000 feet of rhyolite flows, tuffs and volcaniclastic sediments (1). The Casa Diablo site is adjacent to K.G.R.A. lands currently being considered by the Department of Interior for geothermal leasing in 1977.

Nine geothermal wells have been drilled on the Casa Diablo property, four in 1959 and 1960 and an additional five in 1961 and 1962. The wells are relatively shallow, ranging in depth from 500 to 1100 feet. The wells are cased to a maximum depth of about 400 feet, with open hole (i.e. no casing) for the remainder of well depth.

B. USGS ASSESSMENT

The U.S. Geological Survey has made assessments of the geothermal heat storage and recoverable energy in the Long Valley area (2). They report maximum surface temperatures from springs and fumaroles of 94°C (201F) and geochemically inferred reservoir temperatures of 219C - 238C (426F - 460F). Based on the above, geologic data they have collected and analysed, and data from the Casa Diablo geothermal wells, they have published the following reservoir assumptions for Long Valley.

TABLE 1

Reservoir Assumptions-Long Valley

(From USGS Circular 726)

Subsurface Temperature	220 C (428 F)
Subsurface Area	225 km^2 (87 mi^2)
Thickness	2 km (1.2 mi)
Heat Content	5.5×10^{19} cal (2.2×10^{17} Btu)

Given the reservoir assumptions of Table 1, the USGS calculated the electrical energy generation potential of Long Valley after deriving a ratio of recoverable electrical energy to stored energy of 0.025

for a hot-water reservoir with 200 - 250C subsurface temperature. This calculation yields an estimated electrical energy production potential of 1825 megawatt (electric) - centuries (MW_e - cent) for Long Valley.

For purposes of comparison, USGS's recoverable energy estimates for other geothermal reservoirs are tabulated below.

TABLE 2

Recoverable Energy Estimates

(From USGS Circular 726)

Long Valley	1825 MW_e - cent.
The Geysers	477
Salton Sea	836
All Identified Reservoirs*	7966

*All U.S. geothermal resources with reservoir temperature above 150 C (302 F).

From Table 2, it becomes clear that the Long Valley geothermal resources compose a very large percentage of the total high-temperature geothermal resource base of the U.S. By additional comparison, the recoverable electrical energy estimate for Long Valley of 1825 MW_e - cent. would be sufficient to supply 9 times the entire 1975 electric energy consumption of the State of California (3).

Assuming all portions of the Long Valley K.G.R.A. are homogeneous with respect to recoverable energy, the 90 acre Casa Diablo geothermal area would have a recoverable electrical energy potential of about 300 MW_e -years. Based on a typical conversion efficiency of 15% for geothermal to electrical energy, the Casa Diablo geothermal area may contain about 2000 megawatt (thermal) - years (MW_t - yr) of recoverable thermal energy. Preliminary estimates indicate that 2000 MW_t - yr. is sufficient energy to heat all space and domestic water in the town of Mammoth Lakes for over 200 years at the current usage rate.

C. WELL FLOW TESTING

In addition to reservoir estimates by the USGS, well test data exist for seven of the nine wells which have been drilled at Casa Diablo (4,5). In 1960, well flow and temperature testing was conducted by Middleton for Endogenous Well Nos. 1 to 3 and Mammoth Well No. 1. Although the flow testing was only run for a short time, less than 1 day per well, an indication of the maximum capabilities of wells was determined as tabulated below.

TABLE 3

1960 Well Test Results

(Data from Middleton)

WELL	MAXIMUM FLOW RATE	MAXIMUM WELLHEAD TEMPERATURE
Endogenous No. 1	531,000 lb/hr	364F
Endogenous No. 2	287,000 lb/hr	357F
Endogenous No. 3	349,000 lb/hr	314F
Mammoth No. 1	495,000 lb/hr	270F

Subsequent well testing, performed in 1962, provided additional flow and temperature data for Endogenous Well Nos. 1,2,4,5 and 7. A summary of the data obtained during the six week testing period follows.

TABLE 4

1962 WELL TEST RESULTS

(Data from Middleton)

	Wellhead Conditions		Well Flow Rates		Total
	Pressure	Temperature*	Water	Total	Flow Time
Well	(Psig)	(^{o}F)	(lb/hr)	(lb/hr)	(wks)
Endogenous 1	70	343	123,500	---	3
Endogenous 2	56	341	206,500	---	3
Endogenous 4	52	331	250,000	330,000	1 1/2
Endogenous 5	70	324	524,000	550,000	1 1/2
Endogenous 7	50	(Only one measurement taken, data questionable)			1

*Static conditions, maximum temperature

Based on the data gathered in 1960 and 1962, Middleton concluded that the flow and temperatures which could be expected from the Endogenous Wells are as follows.

TABLE 5

PREDICTED WELL CAPACITIES

(From Middleton)

Well	Flow Rate @ 50 psig (lb/hr)	Producing Temperature (^{o}F)
Endogenous 1	450,000	360
Endogenous 2	450,000	360
Endogenous 3	300,000	320
Endogenous 4	400,000	300
Endogenous 5	700,000	340
Total	2,300,000	Average 340

A producing rate of 1,000,000kg/hr (2,300,000 lb/hr) with a temperature of 171C (340^{o}F) yields an instantaneous production rate of between 200 MW_t and 800 MW_t, depending upon the quality of the well flow. If all the well flow were liquid, 200 MW_t would be produced; if all steam, 800 MW_t would be the production rate. This compares to a projected peak space and water heating demand for all of Mammoth Lakes of about 50 MW_t for the year 1980.

D. HETU Testing

One additional set of tests was conducted on the Casa Diablo wells in 1974. Magma Power Company pumped geothermal waters from Endogenous Well No. 2, through a Heat Exchanger Test Unit (HETU) and injected the cooled geothermal water into Endogenous Well No. 3. The purpose of these tests was to determine the scaling properties of the geothermal water. However, temperature measurements recorded during testing provide an indication of reservoir temperature.

The HETU tests took place between August 8, and October 13, 1974. Two runs of 23 and 25 days were undertaken. The geothermal liquid temperature at the wellhead as monitored throughout the testing varied between 165C (330F) and 171C (340F). The geothermal liquid was being pumped at a rate of about 1100kg/hr (2500 lb/hr).

E. CONCLUSIONS

1. The USGS estimates of reservoir capability and the well test results presented above indicate that the Casa Diablo geothermal area has the capacity to provide for the space and water heating needs of the town of Mammoth Lakes. USGS estimates suggest the potential of a 200 year supply of heating energy beneath the 90 acre Casa Diablo site. Well and heat exchanger testing have provided flow and temperature data for a number of the existing Casa Diablo Wells. Well head temperatures of 165-171C (330-340F) and flow rates of 140,000 to 230,000 kg/hr (300,000 to 500,000 lb/hr.) per well have been measured during short-term testing. These temperatures and flows are well in excess of peak space and water heating demand for the entire town of Mammoth Lakes.

2. While the USGS estimates and flow test results are encouraging, they are by no means conclusive as to the Casa Diablo geothermal area's capacity or longevity. Additional long-term reservoir data need to be provided before a large scale district heating facility can be built on the site.

F. RECOMMENDATION

The following actions are necessary to provide the data necessary for a complete reservoir evaluation (6):

a. Drilling a deep production test well with appropriate logging.

b. Instrumenting the deep production well, an existing injection well and one or more existing production wells for pressure, temperature and flow measurement.

c. Logging of some of the existing wells.

d. Running a full production test on the new well for a period of time required to obtain steady state data.

e. Measurement of pressure drawdown during deep well production, pressure build-up during shut-in following flow tests, and injection pressures throughout the testing.

The Magma Power Company made application on August 20, 1976 to the Mono County Department of Planning and Building for permits to drill a 4000 foot deep production well on the Casa Diablo property. Magma anticipates completing the well by the summer of 1977 (7). The reservoir information gained as a result of this deep well and associated testing should provide sufficient information for going ahead with a large district heating installation on the site, assuming the technical, economic and engineering feasibility of the heating system itself has been proven.

G. REFERENCES

(1) Final Environmental Statement of the Geothermal Leasing Program, United States Department of Interior, 1973, Volume II.

(2) White, D.E. and D.L. Williams, "Assessment of Geothermal Resources of the United States - 1975", Geological Survey Circular 726.

(3) Electrical World, "1976 Annual Statistical Report", Volume 185, Number 6, March 15, 1976.

(4) Middleton, W.H., "Engineering Report on Casa Diablo Geothermal Steam Wells", January, 1961.

(5) Middleton, W.H., "Technical Report", January, 1963.

(6) Private communication with Mono Power Company.

(7) Private communication with Mr. Richard Foss of Magma Power Company.

V. LOCAL CONTACTS

In order to increase the probability that the geothermal heating system designed for Mammoth Lakes Village meets the community's needs, an effort is being made to obtain input from Village residents and business people during this feasibility study. The effort includes informing the local people of our efforts as well as obtaining their input to the work.

The Southern California Edison Company (SCE) maintains a local Customer Service Center in Mammoth Lakes Village which is under the direction of their Bishop District Manager. The District Manager interacts with numerous local residents and business people on a regular basis. Therefore, he has been used as liaison between project personnel and Village residents.

As of December 12, 1976 project personnel have met with representatives of the U.S. Forest Service, which maintains a Visitor's Center in Mammoth Lakes, and the Mammoth County Water District which provides water services for the Village. The cooperation of both of the above agencies will be necessary in order to implement a geothermal space and water heating system in the Village. In addition, their knowledge of local conditions will be of great value in the feasibility study.

During the saturation survey of current methods of space and water heating in Mammoth Lakes Village, many additional business people and residents will be contacted by SCE personnel. Some local people will also be asked to allow metering of their electrical heating loads and energy consumption as part of the feasibility study. These contacts and subsequent metering arrangements will promote two way communication between project personnel and local citizens.

One additional local contact was made through a press release which appeared in the Bishop Inyo Registar on November 15, 1976 announcing initiation of the feasibility study under ERDA's sponsorship. The text of the article appears below.

USE OF GEOTHERMAL ENERGY
AT MAMMOTH TO BE STUDIED

"The Ben Holt Co., a Pasadena based engineering and construction firm, has been awarded a $120,000 contract by the U.S. Energy Research and Development Administration to perform a 12-month study to determine the feasibility of utilizing geothermal energy for supplying space and water heating to Mammoth Lakes which presently utilizes electricity for most of its space-water heating needs. It is proposed that energy from the nearby Casa Diablo geothermal reservoir would be utilized, thus offering an alternative to electric energy generated by burning fuel oil.

Southern California Edison Company and Magma Energy, Inc. will assist Holt as subcontractors. SCE supplies and distributes electrical energy to Mammoth Lakes and Magma is the owner of the land of which Casa Diablo is located.

At the conclusion of the study the technical, economic, and environmental feasibility of the project will have been evaluated. In the event the project proves feasible, The Ben Holt Co. will recommend the installation of a pilot facility."

VI. FUTURE PLANS

During the next quarter (December 13, 1976 to March 12, 1977), the following activities are planned.

A) The saturation survey of numbers and types of space and water heating systems currently in use in Mammoth Lakes Village will be completed.

B) All demand, energy and temperature meters will be installed and data collection procedures will be initiated.

C) Designs for residential and commercial hydronic heating systems will be prepared and evaluated.

D) Design of the district heating system will be begun; including the geothermal/city water heat exchange system, heat storage, and distribution and discharge piping.

The attached Progress Chart summarized progress to date, and anticipated future activities on the project.

PROGRESS CHART - MAMMOTH GEOTHERMAL HEATING STUDY