● Hydrothermal Industrialization: Direct Heat Development

Final Report

DOE/ID/12186--1

DE82 014874

May 1982

NOTICE
PORTIONS OF THIS REPORT ARE ILLEGIBLE.
It has been reproduced from the best
available copy to permit the broadest
possible availability. **MN ONLY**

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared by:
Engineering and Economics Research, Inc.
Vienna, Virginia 22180
Under Contract No. DE-AC-07-80-ID-12186

Prepared for:
U.S. Department of Energy
Assistant Secretary, Conservation and Renewable
Energy
Division of Geothermal Energy
Washington, DC 20585

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

leg

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Notice

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
List of Tables	v
List of Figures	vi
1.0 INTRODUCTION	1
1.1 Purpose	1
1.2 Overview and Structure	1
2.0 HYDROTHERMAL RESOURCE DESCRIPTION	7
2.1 Development Process - Federal Lands	7
2.2 Development Process - Non-Federal Lands	8
2.3 Development Sequence	8
3.0 DIRECT-HEAT INDUSTRIAL INFRASTRUCTURE	9
4.0 DEVELOPMENT STATUS	11
5.0 MARKET PENETRATION	16
5.1 Overview	16
5.2 NMEI Estimates	16
5.3 Hydrothermal Market Shares Estimation Task Force Study Estimates	16
5.4 Technical Research Analysis Co. Estimates	19
5.5 Comparison of Studies	19
APPENDIX A STATE-BY-STATE-SUMMARIES	A-1
Table of Contents: States with Significant Geothermal Development Activities	A-1
Table of Contents: States with Moderate Geothermal Development Activities	A-49
Table of Contents: States with Low or No Geothermal Development Activity	A-78

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1 States with Significant Geothermal Development Activity	3
2 States with Moderate Geothermal Development Activity	4
3 States with Low or No Geothermal Development Activity	5
4 Known Current Direct Applications By State and Type	13
5 Direct Applications By State and Type Planned Through 1985	14
6 Projected Directed Applications	15

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1 Comparison of Low Case Estimates	17
2 Comparison of High Case Estimates	18

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to provide detailed and comprehensive summaries of the status of hydrothermal direct-use applications on a state-by-state basis and industry's near and long term plans and prospects for future development. Since it is intended to be useful to equipment suppliers, financial institutions, developers, and other private sector groups seeking reliable projections of the future growth of this industry, it has been structured to allow maximum use by a diverse audience.

1.2 Overview and Structure

In order to evaluate geothermal energy's contribution to the nation's total energy supply one must understand the nature of geothermal resources, their development process, who is developing them, historical trends, current status, and the market potential for this energy source.

Geothermal energy is the internal heat of the earth and much of this energy is recoverable with current technology. Three types of geothermal resources (hydrothermal, geopressured, and hot dry rock) are capable of providing energy for direct use applications. Of these only hydrothermal energy is technically and economically feasible for exploitation at this time. Therefore, for the purposes of this report, only hydrothermal resources will be addressed.

Section 2.0 provides a description of hydrothermal resources suitable for direct applications, their associated temperatures, geographic distribution and developable capacity. The development of hydrothermal resources for direct-use is extremely application specific. Sections 2.1 and 2.2 examine this development process.

Section 3.0 presents an overview of the hydrothermal direct-heat development infrastructure. While the development of hydrothermal resources for electric power generation has been undertaken largely by the integrated oil companies, direct-use development has been much more segmented. Individual homeowners, cities, and large corporations have all been involved in this development.

Section 4.0 highlights development activity by examining known and planned geothermal direct-use applications. In the United States, geothermal energy has been used since 1900 to heat homes and offices in Boise, Idaho. Known applications include space/district heating systems, industrial processes, agriculture, and aquaculture.

Numerous studies have been undertaken to assess the market penetration of geothermal energy. Section 5.0 will discuss underlying assumptions and results for three studies conducted to determine direct-use market penetration. The three studies are:

- Projections for Hydrothermal Non-Electric Systems Market Shares conducted by the Market Shares Estimation Task Force established by DOE
- Market Penetration Analysis for Direct-Heat Geothermal Energy Applications conducted by Technical Research Analysis Company
- Geothermal Energy National Estimate for Direct-Use conducted by New Mexico Energy Institute.

The remainder of this report is devoted to the presentation of detailed direct-heat development information for all 50 states. This detailed information (presented in Appendix A) will assist the private sector in evaluating market activities.

The development information has been divided into the following three areas based upon the level of activity:

- Significant Development - all states that have geothermal direct-heat systems in operation or planned in the near-term (Table 1).
- Moderate Development - all states not included in significant development section but have active geothermal programs in progress (Table 2).
- Low or No Development - all remaining states (Table 3).

Within each of these sections the information is presented alphabetically by state. The information for each state is organized along the following outline:

- General summary about the state
- Energy use, potential, and penetration
- Organizations involved in geothermal direct-heat development
- State map detailing resources and population centers
- List of population centers colocated with hydrothermal resources
- Detailed list of operational, planned, and projected direct-use applications.

Numerous sources were used in obtaining the information presented in the state-by-state summaries. Sources that were utilized and information that was obtained is as follows:

- 1) Energy Use
 - a) Current geothermal energy use

TABLE 1

States With Significant Geothermal
Development Activity

Alaska
Arizona
California
Colorado
Hawaii
Idaho
Montana
Nevada
New Mexico
North Dakota
Oregon
South Dakota
Utah
Washington
Wyoming

TABLE 2

States With Moderate Geothermal
Development Activity

Arkansas
Connecticut
Deleware
Georgia
Maryland
Nebraska
New Jersey
New York
Texas
Virginia

TABLE 3

States With Low or No Geothermal
Development Activity

Alabama
Florida
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
New Hampshire
North Carolina
Ohio
Oklahoma
Pennsylvania
Rhode Island
South Carolina
Tennessee
Vermont
West Virginia
Wisconsin

- Geothermal Progress Monitor
 - State Teams
 - Various newspaper, magazine and journal articles
- b) Total Energy Use by Year 2000
- U.S. Dept. of Energy, State Energy Data Report
 - Energy Information Administration, 1980 Annual Report to Congress, Volume 3: Forecasts
- c) Geothermal Potential and Penetration by the Year 2000
- New Mexico Energy Institute for the states of Alaska, Arizona, Arkansas, California, Colorado, Delaware, Georgia, Idaho, Kansas, Maryland, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oregon, South Dakota, Texas, Utah, Virginia, West Virginia, and Wyoming
- d) Geothermal potential for states not listed above was obtained from Technical Research Analysis Company's report "Market Penetration Analysis for Direct-Heat Geothermal Development."

2) Direct Use Applications

- Geothermal Progress Monitor
- DOE
- State Teams
- Developers

3) Maps were obtained from the U.S. Department of Commerce. The plotting of the resource locations was based on information contained in USGS Circular 790 and supplemented by NOAA's Thermal Springs List for the United States, 1980.

4) Colocated Resources and Cities

- New Mexico Energy Institute

5) Development Organizations

- Geothermal Resources Council

2.0 HYDROTHERMAL RESOURCE DESCRIPTION

Hydrothermal resources are underground accumulations of hot water or steam with temperatures ranging up to 350°C. Water heated by contact with deep hot rock formations moves through fissures, faults, and fractures to porous reservoir rocks at shallower depths, within reach of modern drilling technology.

Hydrothermal resources with temperatures in the 60-150°C range are most suitable for direct-heat applications. In addition, resources with temperatures less than 60°C may be utilized through temperature augmentation techniques such as heat pumps.

Low to moderate temperature geothermal resources suitable for direct-heat applications are found in over 40 states. Most of the hydrothermal resources in the 90-150°C are located in western U.S. and are spread out over a large geographic area which encompasses eleven contiguous states and Alaska. In this region of the country the USGS has identified 218 sites with temperatures in the 90-150°C range and 142 sites with temperatures >90°C. USGS estimates that the total energy content of hydrothermal resources in the 90-150°C range amounts to $3800-5900 \times 10^{15}$ BTU. The National Oceanic and Atmospheric Administration has identified over 1,700 hydrothermal surface manifestations with temperatures >20°C. The resource potential is extremely large and availability is not a constraint to the expanded use of hydrothermal energy.

2.1 Development Process - Federal Lands

Once the specific site or geographic area to be developed has been identified, the would be developer gains access to the land. On Federal lands, surface access and the right to explore, develop and use geothermal resources is controlled by the Bureau of Land Management (BLM). If the area to be developed is designated as a Known Geothermal Resource Area (KGRA), all leases are by competitive bidding. Outside a designated KGRA, the developer submits an application to the surface land management agency on a non-competitive basis. Limited operations designed to provide a preliminary evaluation of resource potential may be carried out prior to leasing, under the supervision of the surface management agency (BLM, USFS, etc.). These operations are conducted under the provisions of a Notice-of-Intent (NOI) to conduct geothermal resource exploration.

Once land access and development rights to the geothermal resource have been secured, exploration/development activities begin. Most small scale projects involving on-site uses, which are typical for direct-heat applications, can be handled by a negative declaration. The declaration is an analysis showing that environmental impacts are adequately offset by the mitigating measures proposed. Public hearings are usually only necessary for more complicated projects. Formal Environmental Impact Statements (EIS) may be necessary for large scale operations, particularly those involving off-site facilities. A permit to construct small-scale direct-use facilities can be issued by the USGS Area Geothermal Supervisor. Larger facili-

ties will be licensed by the BLM with technical advice supplied by USGS. On Federal Lands, only one basic permit is required for facility siting, but any off-lease facilities involve separate land acquisitions and permitting processes.

2.2 Development Process - Non-Federal Lands

The development of geothermal resources on non-federal lands is governed by various state regulations and statutes. To determine processes and compliance thereof it will be necessary for the developer to check with the appropriate state land office.

2.3 Development Sequence

The development sequence for geothermal electric power production is relatively fixed. For direct-use applications the time required to commence operation is affected by several parameters:

- 1) Type of Project - depending on the intended end-use application, significant differences are discernible. A district-heating system may well take several years to develop, while an aquacultural application such as fish farming may require nothing more than a single, shallow well which provides warm water to stimulate breeding conditions.
- 2) Size of Project
- 3) Market Arrangements - the developer and user can be separate entities.

In general, project development can be as short as 1 or 2 years or as long as 7 or 8. A general development sequence, however, proceeds in the following manner:

- A) Preliminary Resource/Market Evaluation
- B) Funding Commitment
- C) Geophysical Evaluation
- D) Leasing
- E) Site Selection and Permitting for Exploratory Wells
- F) Well Testing, Environmental Monitoring, and Engineering and Economic Evaluation
- G) Preparation of Development and Operation Plan
- H) Final Design, Licensing, and Permitting where required
- I) Production Drilling and Testing/Facility Construction or Retrofit
- J) Start-up Testing and Regular Operation

3.0 DIRECT-HEAT INDUSTRIAL INFRASTRUCTURE

The development process and the particular entities involved in electric power production from geothermal resources are very defined. The two major entities are the field developer (producer) and the electric utility (consumer). This relationship is very straightforward and the number of firms involved is relatively small.

The development of geothermal resources for direct heat applications is not as well structured, primarily because of the wide variety of potential direct-heat applications. Geothermal energy can be used for space heating, industrial process heat, and agricultural/aquacultural applications. A potential direct-heat developer must first identify his market, while in electric power generation an immediate market (utilities) is available.

In many instances the geothermal developer and user are one and the same person. Many individual homeowners have drilled shallow geothermal wells and utilized a resource to provide space heating. In addition, a few large corporations have undertaken geothermal resource development to fulfill industrial process heat requirements.

The lack of a well defined direct-heat infrastructure has impeded the development process. Other factors have also contributed significantly to delaying full utilization of geothermal resources for direct-heat applications. Many potential users do not have access to risk capital needed for reservoir confirmation. Also, geographic separation between the resource and the demand center has made the development of many reservoirs uneconomic. Because the risk and costs associated with field development are high, field developers need the commitment of a number of users before development can be undertaken, which has delayed the utilization of many reservoirs. On the other hand, many large developers who have sufficient capital to undertake direct-heat projects have expressed minimal interest because the size of the project does not meet their investment criteria. Developers of large projects which will have multiple users have steered away from geothermal development due to the possibility of being regulated as a utility. Furthermore, utility companies which are logical entities for providing the interface between developer and users in large projects have shown little interest and have concentrated their efforts on electric power generation.

However, there have been many direct-heat projects successfully undertaken, especially on the local level in western parts of the U.S. The DOE has provided assistance to many of these projects through various programs. Loan guaranties and cost-shared financial assistance programs have eliminated many of the economic barriers impeding geothermal development. In addition, the establishment of regional technical and general assistance centers have stimulated development activity. These centers offer up to 100 hours of free assistance to potential geothermal users and developers by performing economic and engineering feasibility studies. State planning and commercialization teams have also provided general assistance to potential geothermal users and developers.

There are numerous entities involved in the development of geothermal direct-heat projects. The major players in the development of this energy source are as follows:

- Resource Developers
- Drilling Companies
- Architectural and Engineering Firms
- Federal Assistance Centers
- Hardware Firms
- State Commercialization/Planning Teams
- Geothermal Users
- Academic Institutions
- General Planning/Financial Consulting Firms

In order to assist potential users and/or developers in determining who is involved in geothermal development in their state, a detailed presentation of these entities is given within Appendix A - State-by-State Summaries. The listing of these firms should not be considered an endorsement of their services but merely a statement that they are involved in geothermal development.

4.0 DEVELOPMENT STATUS

Unlike the high temperature hydrothermal resources suitable for electric power generation, low-and-moderate temperature hydrothermal resources are widespread in the United States, and have been identified in 37 states. For this reason, direct applications of hydrothermal resources have the potential of making a favorable impact on energy supplies and industrial development throughout the nation. For the most part, individual direct-use projects are on a small scale, compared to electric generation, but collectively these users displace a significant amount of conventional fuel.

Resorts and spas have used naturally heated waters for balneology in the United States since the nineteenth century. Hydrothermal space heating has been employed in the United States since early 1900's, and hydrothermal district heating systems have been in place since the 1930's. During the era of cheap fossil fuel, little was done to develop hydrothermal space heating systems, but today's increased energy costs have once again stimulated interest in hydrothermal resources as a source of energy for space heating.

Hydrothermal resources are being used in agriculture to heat greenhouses and livestock shelters, to dry feedstocks and grains, and in hydroponic applications. These resources are also receiving extensive use in aquaculture: fish farms make use of both the hydrothermal waters and the heat energy contained in them.

Hydrothermal resources are also being used and considered for use in a variety of industrial applications. The food processing industry uses hydrothermal energy for sterilization, dehydration, drying, parboiling, and cooking. Ethanol and gasahol producers are rapidly becoming major users of the resource. The largest consumer, however, is enhanced oil recovery, which uses ten trillion BTU's of hydrothermal energy per year -- close to 80% of the national hydrothermal direct utilization.

The next largest consumer group is aquaculture, with fish farms using over one trillion BTU's annually. Industrial usage, excluding enhanced oil recovery, accounts for 635 billion BTU's per year, space heating and district heating use 246 billion BTU's annually, and agricultural applications use 201 billion BTU's each year. Multiple use or cascaded applications consume an additional 340 billion BTU's, bringing total annual direct utilization of hydrothermal resources in the United States to 12.5 trillion BTU's.

Direct-heat applications constitute the most rapidly growing segment of geothermal utilization in the United States. Ethanol and gasahol production facilities are rapidly being established. Hydrothermal utilization in ethanol production is expected to expand geometrically during the next few years. Other areas of hydrothermal direct-heat utilization expected to exhibit particularly rapid expansion in coming years are food processing and district heating. As heat pump technology progresses, a wide variety of industrial process heat applications for hydrothermal resources are also expected to develop.

Table 4 provides a state-by-state breakdown of direct applications of hydrothermal energy. Table 5 lists the expected annual hydrothermal energy utilization in facilities planned through 1985. Table 6 lists expected hydrothermal energy utilization in facilities that are currently projected to be built after 1985. It should be noted that these tables are based on current announced plans and projections and are subject to significant change. Indeed, these tables may reflect more about the planning processes in the different user groups than about the actual future of hydrothermal utilization by these groups.

Tables 5 and 6 show that the largest use of hydrothermal energy will continue to be in the western half of the country, with the state of Arizona, California, Idaho, Nevada, and South Dakota exhibiting the largest amount of growth.

Recent studies have identified a number of exploitable sites in the eastern half of the country. As indicated in Table B, new hydrothermal applications are planned by 1985 in several states that do not currently have hydrothermal development, including the eastern states of Connecticut, Maryland, New York, and Rhode Island. Additional eastern states for which direct applications are projected for after 1985 (cf. Table 6) are Georgia, New Jersey, and Virginia.

Tables 4, 5, and 6 indicate direct utilization of hydrothermal resources is expected to grow dramatically in the next few years. The projections show the most rapid expansion to be in the industrial and district heating user groups. The declining growth for agricultural and aquacultural applications shown in Tables 5 and 6 may, however, merely indicate that these user groups have a relatively short planning horizon. For this reason, growth in these areas may actually be significantly higher.

Current total annual utilization excluding enhanced oil recovery is 2.5 trillion BTU's. This figure is expected to increase six-fold by the end of 1985 to 14.8 trillion BTU's. Annual utilization after 1985, conservatively estimated from projections of development already being studied, is expected to exceed 25 trillion BTU's.

TABLE 4

KNOWN CURRENT DIRECT APPLICATIONS BY STATE AND TYPE

State	Type of Application/Energy Use (Billions BTU/YR)					
	Space/Dist. Heating	Industrial	Agricultural	Aquacultural	Multi-Use (1)	TOTAL
Alaska	2.0	8.0	9.0	-	19.0	38.0
Arkansas	0.5	-	-	-	-	0.5
California	60.0	10.0	18.0	117.0	229.0	434.0
Colorado	12.3	20.0	1.0	6.0	2.0	41.3
Florida	0.2	-	-	-	-	0.2
Idaho	47.2	-	13.5	893.0	1.5	955.2
Montana	7.4	-	-	-	-	7.4
Nevada	18.7	189.0	0.5	-	1.0	209.2
New Mexico	10.8	1.0	116.0	-	-	127.8
North Dakota	1.0	-	0.5	-	1.0	2.5
Oregon	40.1	286.0	17.3	102.8	8.4	454.6
South Dakota	32.6	100.0	-	-	78.7	211.3
Utah	11.0	-	17.8	-	-	28.8
Washington	1.5	10.0	2.0	-	-	13.5
Wyoming	0.6	10,011.0 (2)	5.5	0.5	-	10,017.6
TOTAL	245.9	10,635.0	201.1	1,119.3	340.6	12,541.9

(1) The resource is used for multiple primary or cascaded applications.

(2) Includes 10,000 billion BTU/YR for enhanced oil recovery.

TABLE 5

DIRECT APPLICATIONS BY STATE AND TYPE PLANNED THROUGH 1985

State	Type of Application/Energy Use (Billions BTU/YR)					
	Space/Dist. Heating	Industrial	Agricultural	Aquacultural	Multi-Use (1)	TOTAL
Arizona	2,001.0	200.0	0.5	-	100.0	2,301.5
California	68.2	1,300.0	140.0	311.0	182.0	2,001.2
Colorado	168.2	70.0	1.5	-	105.0	344.7
Connecticut	0.2	-	-	-	-	0.2
Hawaii	-	100.0	-	-	-	100.0
Idaho	414.9	1,192.0	44.4	200.0	680.0	2,531.3
Maryland	-	55.0	-	-	-	55.0
Michigan	-	-	0.5	-	-	0.5
Montana	34.5	60.0	0.5	3.0	605.0	703.0
Nevada	6.0	1,000.0	30.5	100.0	60.0	1,196.5
New Mexico	176.60	60.0	600.0	-	-	836.0
New York	-	50.0	-	-	-	50.0
North Dakota	20.6	60.0	-	-	-	80.6
Oregon	49.1	310.1	-	-	-	359.2
Rhode Island	0.2	-	-	-	-	0.2
South Dakota	56.2	-	1.5	-	1,014.0	1,071.7
Texas	46.0	-	-	-	-	46.0
Utah	112.0	-	0.5	-	-	112.5
Washington	10.0	-	-	-	-	10.0
Wyoming	12.9	360.0	2.0	-	101.0	475.9
TOTAL	3,176.0	4,817.1	821.9	614.0	2,847.0	12,276.0

(1) The resource is used for multiple primary or cascaded applications.

TABLE 6

PROJECTED DIRECT APPLICATIONS AFTER 1985 BASED ON STUDIES IN PROGRESS

State	Type of Application/Energy Use (Billions BTU/YR)					
	Space/Dist. Heating	Industrial	Agricultural	Aquacultural	Multi-Use (1)	TOTAL
Alaska	30.5	10.0	0.5	-	-	41.0
Arizona	11.0	-	-	-	-	11.0
California	26.2	4,300.0	0.5	-	100.0	4,426.7
Colorado	100.0	160.0	-	-	9.4	269.4
Georgia	1.0	-	-	-	-	1.0
Idaho	5.0	1,900.0	-	-	-	1,905.0
Indiana	-	100.0	-	-	-	100.0
Maryland	8.5	100.0	-	-	-	108.5
Montana	5.0	-	-	-	285.0	290.0
Nebraska	-	-	-	-	100.0	100.0
Nevada	1,201.0	900.0	-	-	-	2,101.0
New Jersey	40.0	-	-	-	-	40.0
New Mexico	770.0	6.0	-	-	36.5	812.5
New York	-	110.0	-	-	-	110.0
North Dakota	1.0	-	-	-	-	1.0
Oregon	1.0	320.0	-	-	-	321.0
Virginia	3.3	-	-	-	-	3.3
Washington	12.0	-	-	-	-	12.0
TOTAL	2,215.5	7,906.0	1.0	-	530.9	10,653.4

(1) The resource is used for multiple primary or cascaded applications.

5.0 MARKET PENETRATION

5.1 Overview

As previously noted in Section 2.0, the size of the resource base is extremely large, so accessibility and availability are not significant constraints to development. The market potential for utilizing hydrothermal resources is affected by a number of considerations such as: 1) ten percent of the U.S. population lives or works within twenty miles of some 225 known hydrothermal resource locations; 2) nearly 40 quads of the nation's energy requirements are below 150°C; 3) the use of heat pumps enables the utilization of low temperature (<60°C) geothermal resources. In recent years, the Department of Energy has funded three major market penetration studies to forecast the extent to which direct application of U.S. hydrothermal resources will be implemented. These studies were undertaken by the New Mexico Energy Institute (NMEI), the DOE Hydrothermal Market Shares Estimation Task Force, and Technical Research Analysis Company (TRA). Although all three models are based on logit functions and possess numerous other obvious similarities, variations in procedures, assumptions, and input data resulted in diverging forecasts. Figures 1 and 2 compare selected outputs from the three studies. Figure 1 presents the NMEI "No Federal Program" estimate, the Task Force ">50% likelihood, no Federal program" estimates, and the TRA "low case" estimates. Figure 2 presents the NMEI "with Federal program" estimates, Task Force ">50% likelihood, current Federal program" estimates, and the TRA "high case" estimates. The two figures illustrate that the estimates are reasonably consistent through 1990, but that the estimates for 2000 show dramatic differences.

5.2 NMEI Study

The NMEI study used a logit curve technology substitution model of the growth of geothermal direct-use. Decision behavior in this model is derived mainly by the relative price of geothermal energy compared to the price of conventional energy forms. The study further assumed that geothermal energy compared to conventional energy forms will show a small but continuing price advantage during the 1981-2000 time period. NMEI used its own resource data base which shows more than 4,000 colocated resource/user pairings. Explicit modeling of the economic feasibility for each potential user was undertaken to estimate the market potential. Potential impacts of the Federal hydrothermal program were factored into the relative cost estimates at each site.

5.3 Hydrothermal Market Shares Estimation Task Force Study

The Task Force study, also based on a logit probability analysis, emphasized the decision-making behavior of potential users of geothermal direct-heat. Interviews were conducted with approximately 250 potential users to determine the likelihood of geothermal energy utilization. The resource data base used in this study was a combination of the New Mexico Energy Institute (NMEI) data base and USGS

*NO ESTIMATE

Fig. 1 Comparison of Low Case Estimates

Fig. 2 Comparison of High Case Estimates

data. Resource characterization analyses were performed to estimate parameters such as well depth and flow rates for known but unconfirmed and undiscovered resources. A colocation variable (distance between reservoir and user) was established, based on the economics of transporting geothermal fluid to users. The potential impacts of federal hydrothermal programs were factored into the decision-making algorithm, resource discovery rates, and development schedules. Monte Carlo runs provided estimates at three levels of likelihood and allowed for fluctuations in independent variables of the model.

5.4 Technical Research Analysis Company

The TRA study takes a broad approach to geothermal market analysis by including a wider resource base, which considers known and anticipated geothermal resources based on USGS data and IGCC reports. The determination of the market available for penetration is determined by a state-by-state analysis of residential and industrial energy consumption systems. This model is also based on a logit function and includes an equilibrium market share equation and a market lag/adjustment equation. These expressions are designed to account for the relative attractiveness of geothermal energy compared to conventional energy sources and measure the degree of market adjustment to the introduction of cost-competitive geothermal energy. The results of the analysis were conducted for several different scenarios, but only two will be discussed here: the base, which is a conservative or most likely course; and a high case, which assumes an accelerated rate of cost escalation for conventional energy sources compared to geothermal.

5.5 Comparison of Studies

The three studies yielded fairly similar results through 1990, but in 1995 a significant gap appears between the predictions of NMEI and the Task Force, and in 2000 the three sets of predictions diverge widely. These differences, however, become less surprising if we examine some of the fundamental differences between these apparently similar studies.

In the first place, the scenarios are dissimilar. TRA's High Case versus Low Case distinction refers to a 5% versus 3% increase in conventional energy costs relative to geothermal energy costs -- not to the Federal Program versus No Federal Program distinction made in the NMEI and Task Force analyses. The NMEI and Task Force studies were performed about a year apart, and a number of significant developments occurred during that year. Indeed, preliminary Task Force estimates for 1995 and 2000 were more consistent with the NMEI estimates.

The studies were performed for different purposes. The TRA study deliberately did not consider transient market factors in an attempt to provide longer-term estimates, through the year 2020. The Task Force study involved an extensive survey procedure, interviewing potential investors and users throughout the U.S. to determine invest-

that the users' criteria for deciding whether or not to implement direct applications for hydrothermal energy will be important determinants of market penetration. Although all of the studies employed a logit function to account for the gradual entry of investors into the market place immediately as hydrothermal energy becomes economic, the Task Force study was the only project to factor in expressed investor preferences.

Additionally, the NMEI study involved a site-specific analysis, while the Task Force and TRA analysis were conducted on a state-by-state basis. The site-specific analysis provides an accurate reflection of short-term trends, but the state-by-state analysis provides a more flexible and broader basis for forecasting mid- and long-term trends.

Because of the broader bases, the inclusion of more recent data, and the more sophisticated modeling techniques, the longer-term estimates of the Task Force and of TRA appear to be more likely than the NMEI estimates. For the most part, these two sets of estimates are reasonably consistent. The most significant difference between the two sets of estimates is at the year 2000 on Figure 2, and this difference is understandable, given the difference between the scenarios resulting in those estimates.

APPENDIX A

STATE-BY-STATE SUMMARIES

TABLE OF CONTENTS

States With Significant Geothermal Development Activity

Alaska	A-2
Arizona	A-4
California	A-7
Colorado	A-11
Hawaii	A-15
Idaho	A-17
Montana	A-22
Nevada	A-26
New Mexico	A-29
North Dakota	A-32
Oregon	A-35
South Dakota	A-39
Utah	A-41
Washington	A-44
Wyoming	A-46

STATE: ALASKA

The recently adopted "Alaska Geothermal Steam Act" defines geothermal waters as being above 120°C and ground water below that temperature. The bill requires a water appropriation to develop geothermal resources; however for resources below 120°C drilling permits, environmental statements and leasing permits are not required.

The resource potential within the state is reasonably significant but geothermal occurrences are unfortunately not located in close proximity to population centers. Current applications of geothermal direct use are concentrated in individual residence space heating and recreational uses. There are a number of feasibility studies being conducted for district heating systems and if these prove successful, Alaska's utilization of geothermal energy could increase substantially.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0.038
Total Energy Use by Year 2000:	334.51
Geothermal Potential by Year 2000:	0.63
Geothermal Penetration by Year 2000:	0.37

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Commercialization & Planning Teams - Division of Energy & Power
Anchorage

General Planning/Finance - Stefano & Associates, Anchorage

- △ Hydrothermal Resources ≤ 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Area
- Places of 100,000 or More Inhabitant
- Places of 50,000 to 100,000 Inhabitant
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitant
- Places of 25,000 to 50,000 Inhabitant Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

(●) Places of 100,000 or More Inhabitants
 (●) Places of 50,000 to 100,000 Inhabitants
 (○) Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
 (○) Places of 25,000 to 50,000 Inhabitation Outside SMSA's
 Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collected Hydrothermal Resources and Refer to Numbers on Accompanying Table

SCALE
 0 50 100 MILES

ALEUTIAN ISLANDS (PART)

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Bell Island	Industrial	1900	8.0	Process Heat
Fairbanks	Multi-Use	1908	9.0	Resort & Greenhouse
	Recreational	1906	9.0	Pool Heating
	Agricultural	1900	9.0	Greenhouse
	Recreational	--	.5	Resort Area
Ophir Creek	Space Heating	--	.5	One Residence
Slicka	Space Heating	1920	1.0	Residence & Bath House
Teller Quad	Multi-Use	--	10.0	Resort Space Heating & Soil Warming
Tenakee	Space Heating	--	.5	Recreation Center
<u>Planned</u>				
None				
<u>Projected</u>				
Aleutian Chain	District Heating	--	5.0	Commercial Bldgs.
	Agricultural	--	.5	Greenhouses
Fairbanks	Space Heating	--	.5	Lodge
Tenakee	District Heating	--	25.0	Hot Water for 100 Residences
Aleutian Chain	Industrial	--	10.0	Food Processing for 10 Companies
5 Alaskan Towns (None)	Space Heating	--	--	Demo/PRDA

STATE: ARIZONA

Geothermal Resources in Arizona are in the low to moderate temperature range and many of the resources are colocated with large population centers. While there are no geothermal applications currently, there has been a great deal of activity in evaluating the resources. Of particular note are two projects, one investigating the use of geothermal energy to provide air conditioning to various buildings at Williams Air Force Base and a large district heating project near Phoenix. In addition, the towns of Wilcox and Stafford are investigating the potential for space conditioning applications (via heat pump augmentation) for commercial centers.

Public reaction to development seems very favorable and the state government is investigating ways to increase the use of this resource. The state legislature is currently working on defining geothermal resources; thus improving their legal status. In an effort to speed up geothermal development Arizona State land leasing regulations were modified to require public notice of lease bidding to be published twice each month.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2205.54
Geothermal Potential by Year 2000:	74.97
Geothermal Penetration by Year 2000:	48.18

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Architectural & Engineering - John F. Long Properties, Inc.,
Phoenix

Commercialization & Planning Teams - Dept. of Chemical Engineering, Tucson

General Planning/Finance - Int. Investment Services, Ltd.,
Phoenix

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Apache	Alpine, Eagar, Nutrioso, Springville
2. Cochise	Dragoon, Willcox
3. Graham	Soloman
4. Greenlee	Clifton, Morenci, Plantsite, Starzo
5. Maricopa	Aguila, Avondale, Beardsley, Buckeye, Cashion, Cave Creek, Chandler, Chandler Heights, El Mirage, Fountain Hills, Ft. McDowell, Gilbert, Glendale, Goodyear, Guadalupe, Higley, Laveen, Litchfield Park, Luke AFB, Mesa, Ocotillo, Paradise Valley, Peoria, Phoenix, Queen Creek, Rio Verde, Scottsdale, Sun City, Surprise, Tempe, Tolleson, Williams AFB, Wittmann, Youngtown
6. Mohave	Yucca
7. Pima	Big Field, Sells
8. Pinal	Apache Junction, Arizona City, Casa Grande, Coolidge, Eloy, Florence, Maricopa, Picacho, Sacaton, Stanfield
9. Yavapai	Agua Fria
10. Yuma	Crane, Gadsden, Roll, Salome, Somerton, Tacna, Welton, Wenden, West Yuma, Yuma, Yuma Proving Ground, Yuma Station

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Cochise	Multi-Use	--	100.0	Fish Farm, Food Processing, Crop Drying
Maricopa	Industrial	--	90.0	
	Space Heating	--	1.0	Air Force Base
Phoenix	District Heating	1981	2,000.0	10,000 Homes
Pima	Industrial	--	110.0	
Superior Farms	Agricultural	--	.5	Greenhouses
<u>Projected</u>				
Graham	Space Heating	--	1.0	Tech. Assistance Requested
Maricopa	Space Heating	--	1.0	Analysis for Hospital Laundry
Phoenix	Space Heating	--	9.0	LASL Evaluating Potential for 9 Bldg. Complex

STATE: CALIFORNIA

California leads the nation in geothermal energy development due to its abundance of geothermal resources and its commitment to developing alternative energy resources. Electric power development has dominated the scene due to the extreme success at the Geysers which is the world's largest geothermal energy complex. Recently, however, direct uses are receiving a great deal of attention. Direct use applications of geothermal energy currently stand at 434×10^9 BTU/YR which is indeed significant.

In the Imperial County the Board of Supervisors initiated a study to determine the potential and variety of direct use applications. Rohr Industries has drilled five 100-foot test wells (under a Ca. State Energy Commission Grant) in search of a supply of geothermal energy for industrial space and water heating. The California Energy Commission (CEC) has awarded two contracts to promote the use of geothermal energy in state and local government facilities. The County of Los Angeles has received funding to identify resources located in close proximity to county facilities and the City of Susanville has received funding to design a geothermal heating system for the state correctional facility. The Susanville City Council has awarded a contract for the retrofit of eleven buildings at Lassen Hot Springs for geothermal heating.

California has established, through legislation, a State Assistance Fund for Energy Business and Industrial Development Corporation (SAFE-BIDCO). The non-profit corporation provides financial assistance in the form of direct loans to small businesses established in the alternative energy industry and also provides assistance to small businesses seeking to convert to alternative energy systems.

The prospects appear extremely favorable for accelerated development of geothermal energy for direct applications. Conditions are such that over 265×10^{12} BTU/YR will be on-line by the year 2000.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.4340
Total Energy Use by Year 2000:	8976.04
Geothermal Potential by Year 2000:	404.50
Geothermal Penetration by Year 2000:	265.30

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Developers - Fredricksen, Kamini & Assoc., Sacramento;
Geo. Products Corp., Oakland; Geothermal Power Corp., Nouato;

Geothermal Services, Inc., San Diego; Geothermex, Inc., Berkeley; Hydrothermal Energy Corp., Los Angeles; Intl. Engineering Co., San Francisco; TSVI Meidav, Oakland

Resource Drillers - C&C Enloe Well Drilling, Dorris; Luhdorff & Scalmanini Consulting Engineers, Davis; Pulliam Drilling Co., Napa

Architectural & Engineering - Bechtel National, Inc., San Francisco; Ben Holt Co., Pasadena; Fredricksen, Kamine & Assoc., Sacramento; Intl. Engineering Co., San Francisco, Koepf & Lange, Inc., Lafayette; Lafco, Inc., Sacramento; PRC Toups, Orange; Rogers Engineering, San Francisco; Westec Services, San Diego

Academia - Univ. of Calif., Berkeley, Richmond; Univ. of Calif., Davis

Federal Technical & General Assistance Centers - U.S. Dept. of Energy, Oakland; Energy Tech. Engineering Ctr., Canoga Park; Lawrence-Berkeley Lab., Berkeley

Commercialization & Planning Teams - California Energy Commission, Sacramento

Hardware Firms - Lindsey Industries, Inc., Azusa; Mitsubishi Electric Products, Compton; Peabody Filoway, Fresno; Peerless Pump, Lafayette; Proctor-Schwartz, Inc., San Jose

General Planning/Finance - Aerojet Energy Conversion Co., Sacramento; Lahonton, Inc., Sacramento; Wedlusch, Noble, Cook, Riverside

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
Operational				
Colusa	Multi-Use	--	100.00	Space Heating and Agricultural
Imperial	Industrial Space Heating	1977	10.0	Community Water Supply
		--	.5	
Lake	Space Heating	1975	58.0	Residences
Lassen	Multi-Use	1978	29.0	30 Greenhouses, Veg. Drying
	Agricultural	1972	18.0	6 Greenhouses
Modoc	Space Heating	--	1.0	
Plumas	Multi-Use	--	UNK	Space Heating & Agricultural

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
Riverside	Aquacultural	1981	171.0	Raising Prawns, PON-79
San Diego	Space Heating	1981	1.0	Office Complex - Construction Started 8/80
<u>Projected</u>				
Imperial	Industrial		2,400.0	Ethanol Plant, 40 Million gal./yr.
	Industrial		600.0	Ethanol Plant, 10 Million gal./yr.
	Industrial		1,200.0	Ethanol Plant, 20 Million gal./yr.
Lassen	Agricultural		.5	Greenhouses, Bank of Montreal to Provide Loan
	Space Heating		1.0	Correctional Ctr.
	Industrial		100.0	Alfalfa Plant, 80 Tons per day
Modoc	Multi-Use		100.0	Space Heating and Greenhouses
San Diego	Space Heating		.2	Commercial Bldgs.
Oakridge	District Heating		5.0	13 Public Bldgs. & Industrial Park
Mono	District Heating		20.0	Residences & Commercial Bldgs.
San Luis Obispo	Aquacultural	--	117.0	Raising of Fingerlings
Sonoma	Space Heating	--	.5	
Little H. S.	Multi-Use	--	100.0	Process Heating & Irrigation
<u>Planned</u>				
Imperial	Industrial	1981	1,300.0	Pulp Drying Facility PON-79
	Multi-Use	1981	7.0	Cooling of Community Center, PON-79, City of El Centro
	Agricultural	1981	140.0	Greenhouses for Nakashima Nursery
Lake	Space Heating	1982	1.0	Wine Valley Inn
Lassen	District Heating	1981	41.0	City of Susanville PON-79
	Space Heating		25.2	126 Residences
Modoc	Multi-Use	1982	175.0	Space Heating & Agricultural, PON-79

STATE: COLORADO

Low to moderate temperature geothermal resources are located throughout much of the state. In addition to the abundance of resources, many are located in close proximity to population centers.

Numerous applications are currently on-line and include space heating, industrial process heating, and agricultural and aquacultural applications. Numerous other projects are currently underway. In the San Luis Valley the Alamosa Mushroom Farm has been chosen as the site for exploratory drilling. If the resource is confirmed a geothermal based industrial park will be developed. In addition to the mushroom farm other proposed users are a poultry farm, greenhouses, and aquacultural applications.

The geothermal potential of the state is extremely good and nearly 100×10^{12} BTU/YR could be on-line by the year 2000.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.0413
Total Energy Use by Year 2000:	1957.50
Geothermal Potential by Year 2000:	120.84
Geothermal Penetration by Year 2000:	99.24

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Research Developers - Chaffee Geothermal, Ltd., Denver; Micro Geophysics Corp., Golden

Resource Drillers - Excell Drilling, Arvay; B&B Drilling, Grand Junction; Beeman Brothers Drilling, Durango; James Drilling, Awada; Layne-Western Drilling, Denver; Louis Quirico, Alamosa; Terra Drill, Denver

Commercialization & Planning Teams - Ground Water Investigators, Denver

General Planning & Finance - Coury & Associates, Inc., Lakewood; Western Energy Planners, Ltd., Denver

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Adams	Eastlake, Federal Heights, North Glenn, Sherrelwood, Thornton, Westminster
2. Alamos	Alamosa, Hooper, Weisbart
3. Archuleta	Pagosa Springs
4. Boulder	Boulder, Broomfield, Hygiene, Jamestown, Lafayette, Longmont, Louisville, Lyons, Nederland, Superior, Ward
5. Chaffe	Buena Vista, Poncha Springs, Salida
6. Clear Creek	Empire, Georgetown, Idaho Springs, Silver Plume
7. Conejos	La Jara, Sanford
8. Costilla	Blanca
9. Delta	Austin, Cedaredge, Crawford, Hotchkiss, Orchard City, Paonia
10. Dolores	Rico
11. Eagle	Basalt
12. Fremont	Canon City, Coal Creek, Florence, Howard, Lincoln Park, Penrose, Portland, Rockvale, Williamsburg
13. Garfield	Carbondale, Glenwood Springs, New Castle, Silt
14. Gilpin	Black Hawk, Central City, Rollinsville
15. Grand	Fraser, Granby, Grand Lake, Hot Sulphur Springs, Kremmling, Winter Park

(1) Colocated means a city is within 5 miles of a resource.

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
16. Gunnison	Parlin, Pitkin
17. Hinsdale	Lake City
18. Jefferson	Applewood, Arvada, Evergreen, Golden, Lakewood, Morrison, Mountain View, Wheat Ridge
19. Larime	Berthood
20. Moffat	Craig
21. Ouray	Ouray, Ridgway
22. Pitkin	Basalt
23. Pueblo	Boone, Pueblo
24. Rio Grande	Del Norte, Monte Vista, South Fork
25. Routt	Clark, Hayden, Oak Creek, Steamboat Springs
26. Saguache	Baca Grande, Bonanza, Crestone, Industrial Park, Moffat, Center
27. San Juan	Silverton
28. San Miguel	Norwood, Ophir, Placerville, Saw Pit, Telluride
29. Teller	Cripple Creek, Victor
30. Weld	Dacono, Erie, Firestone, Frederick, Mead

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Alamosa	Space Heating	1980	5.0	Shopping Center
	Space Heating		.7	Residence
	Aquacultural		5.0	Fish Farm
Archuleta	Agricultural		1.0	
	Space Heating		2.0	10 Buildings
	Space Heating		1.0	Hub Dairy Creme
Boulder	Multi-Use		.5	Health Spa
Chaffee	Multi-Use		1.5	2 Residences & Agricultural
	Space Heating		.7	Residence
	Space Heating		.5	Resort Cabins
	Aquacultural		.5	Fish Farming & Algae Growing
Clear Creek	Space Heating		.7	7,000 ft. ² Bldg.
Conejos	Aquacultural		.5	Fish Farm
Grand	Industrial		10.0	Laundry
Gunnison	Space Heating		1.0	Ranch
Ouray	Space Heating		1.0	Two Motels
Pueblo	Industrial		10.0	Bottled Water
Saguache	Space Heating		.2	Residence

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Planned</u>				
Alamosa	Multi-Use	1981	5.0	Barley Malt Process Heat & Space Heating for Adams State College
	Space Heating		50.0	Shopping Mall
Archuleta	District Heating		32.0	PON-79, Wells Drilled, Final Design in Progress
	Space Heating		.5	Recreational Complex
Boulder	Agricultural		1.5	20 Acre Greenhouse
Chaffee	Space Heating		.2	Residence
	Multi-Use		100.0	Potato Processing & Mushroom Growing, Chaffee Geothermal
Clear Creek	District Heating		5.0	
Garfield	Industrial		10.0	Bridge Heating
	Space Heating		4.0	22 Unit Condominium
	Space Heating		UNK	25,000 ft. ² Office Buildings
Gunnison	Space Heating		5.0	
Hinsdale	Space Heating		1.0	Ski Resort
La Plata	Space Heating		1.0	Boarding School
	Space Heating		1.0	Timberline Academy
Ouray	Space Heating		1.0	Municipal Garage - Grant Proposal to DOE
Pueblo	Industrial		60.0	Ethanol Plant
San Miguel	Space Heating		1.0	Residence
	Space Heating		.5	Resort
<u>Projected</u>				
Alamosa	Industrial		60.0	Ethanol Plant, PRDA, 20-50 million gal./yr.
Chaffee	Industrial		100.0	PRDA, Waste Zinc Reprocessing Facility
Fremont	Space Heating		100.0	Prison Complex
Garfield	Multi-Use		9.4	PRDA, Heat Municipal Facility & Sewage Treatment Plant
Colorado State Univ.	Industrial		UNK	Alcohol from Lignocellulose, PRDA

STATE: HAWAII

Hawaii has been identified as having numerous geothermal resources which span the temperature range necessary for various applications. Resources with temperatures less than 100°F and a reservoir with a temperature greater than 600°F have been identified.

Most of the activity in Hawaii has centered on the development of geothermal energy for electric power production rather than direct applications. The Puna Sugar Company is investigating the viability of utilizing a geothermal resource for industrial process heat and agricultural applications. If projects of this type prove successful, direct applications of geothermal energy are certain to be pushed forward.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	348.93
Geothermal Potential by Year 2000:	4.00
Geothermal Penetration by Year 2000:	?

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Architectural & Engineering - Hawaiian Dredging & Construction Co., Honolulu

Commercialization & Planning Teams - Dept. of Planning & Economic Development, Honolulu

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Puna	Industrial Agricultural	100.0 UNK		Puna Sugar Company
<u>Projected</u>				
None				

STATE: IDAHO

The state of Idaho has been using geothermal energy since 1900 to provide space heating of residences and offices. The state is blessed with abundant geothermal resources and extensive direct-heat development has occurred state-wide. Current uses include both space and district heating, agricultural, and aquacultural applications. Geothermal energy currently accounts for over 900 billion BTU/YR of energy usage.

The prospect of continued development of geothermal energy is extremely bright. Numerous projects such as agricultural and industrial applications of geothermal resources along the Snake River Plain are already under construction; near Mountain Home the U.S. Air Force is investigating the possibility of a space heating project for the base.

Continued growth of geothermal direct-heat utilization is a certainty given the abundance of resources and the state's commitment to their development. By the year 2000 it is anticipated that geothermal energy for direct applications will amount to over 58×10^{12} BTU/YR.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.9552
Total Energy Use by Year 2000:	734.10
Geothermal Potential by Year 2000:	61.47
Geothermal Penetration by Year 2000:	58.75

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Developers - Energy Services, Inc., Idaho Falls

Resource Drillers - Gailey Drilling Co., Mountain Home

Architectural & Engineering - CH2M Hill, Boise; Energy Services, Idaho Falls; Morrison-Knudsen Co., Inc., Boise

Federal Technical & General Assistance Centers - U.S. DOE, Idaho Falls; EG&G, Inc., Idaho Falls

Commercialization & Planning Teams - Office of Energy, Boise

CITIES COLOCATED ⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Ada	Boise, Collister, Eagle, Garden City, Kuna, Meridian, Star
2. Adams	Council, New Meadows
3. Bannock	Arimo, Chubbuck, Downey, Inkom, Lava Hot Springs, McCammon, Pocatello
4. Bear Lake	Bennington, Bloomington, Dingle, Georgetown, Montpelier, Ovid, Paris, St. Charles
5. Bingham	Aberdeen, Basalt, Blackfoot, Firth, Fort Hall, Jr. Simplot Aberdeen, Moreland, Shelley, Springfield, Sterling
6. Blaine	Bellevue, Carey, Hailey, Ketchum, Picabo, Sun Valley
7. Boise	Crouch, Garden Valley, Horseshoe Bend, Idaho City, Lowman, Placerville
8. Bonneville	Ammon, Idaho Falls, Iona, Irwin, Swan Valley, U and I Sugar, Ucon
9. Butte	Arco, Butte City, Moore
10. Camas	Fairfield
11. Canyon	Amalgamated Sugar, Caldwell, Carnation Foods, Greenleaf, JR Simplot Caldwell, Melba, Middleton, Nampa, Notua, Parma, Wilder,

County	City
12. Caribou	Bancroft, Grace, Soda Springs
13. Cassia	Albion, Burley, Declo, Elba, Malia, Oakley, Ore-Ida, Strev
14. Custer	Challis, Clayton, Lost River, Stanley
15. Elmore	Glenns Ferry, Hammett, King Hill, Mountain W AFB, Mountain Home
16. Franklin	Clifton, Dayton, Franklin, Oxford, Preston, Thatcher, Weston
17. Fremont	Ashton, Drummond, Newdale, Parker, St. Anthony, Teton, Warm River
18. Gem	Emmett
19. Gooding	Bliss, Gooding, Hagerman, Tuttle, Wendell
20. Idaho	Pollock
21. Jefferson	Lewisville, Menan, Rigby, Ririe, Roberts
22. Jerome	Eden, Hazelton, Jerome,
23. Latah	Genesee, Juliaetta
24. Lemhi	Leadore, May
25. Lincoln	Richfield
26. Madison	Rexburg, Roger's Foods, Sugar City
27. Minidoka	Acequia, Heyburn, JR Simplot Heyburn, Minidoka, Paul, Rupert
28. Nez Perce	Culdesac, Lapwai, Lewiston
29. Oneida	Malad City
30. Owyhee	Bruneau, Grandview, Homedale, Marsing, Murphy
31. Payette	Fruitland, New Plymouth, Payette,
32. Power	American Falls, Lamb-Weston, Rockland
33. Shoshone	Pinehurst
34. Teton	Driggs, Teton, Victor
35. Twin Falls	Buhl, Castleford, Filer, Hansen, Hollister, Kimberly, Murtaugh, Rogerson, Twin Falls
36. Valley	Cascade, Donnelly, McCall
37. Washington	Cambridge, Midvale, Weiser

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Ada	Agricultural		2.0	Greenhouses
	Space Heating	1977	11.0	Health Dept.
	District Heating	1900	30.0	164 Units
	Space Heating		.2	Residence
Adams	Space Heating		1.5	Resorts
Bannock	Recreational		.5	
	Space Heating		UNK	Health Spa
Blaine	Space Heating		1.0	Motel
	Multi-Use	1920	UNK	
	Recreational		.5	Resort Area
Boise	Recreational		.2	Campground
	Agricultural		.5	Greenhouse
	Recreational		1.7	Resorts & Campgrounds
	Agricultural		7.0	Ward Greenhouses
	Space Heating		1.0	Several Residences
Butte	Space Heating		1.0	Several Residences
Camas	Space Heating		.3	2 Residences
Canyon	Space Heating		1.0	Warehouse
Cassia	Agricultural		.5	Greenhouse
	Aquacultural		5.0	Fish Farm
Custer	Recreational		3.2	Numerous Resorts & Campgrounds
Gooding	Agricultural		1.0	Greenhouse
Owyhee	Agricultural		.5	Greenhouse
	Agricultural		1.0	Stock Watering
Twin Falls	Space Heating		.2	Residence
	Agricultural		1.0	Greenhouse
	Aquacultural	1974	788.0	Fish Breeding (Fish Breeders of Idaho)
	Multi-Use		1.0	Several Residences for Space Heating/Tropical Fish Raising
	Aquacultural		100.0	Fish Farm
Washington	Multi-Use		.5	Fish Farm & Space Heating for Resort
<u>Planned</u>				
Ada	District Heating	1983		PON-79, Upgrade of Warm Springs System
	Space Heating	1983	63.0	7 State Buildings
	Agricultural		30.0	Feedlot
	Space Heating		10.0	Hospital (VA)
	District Heating	1987	67.0	1200 House Sub-division
	Space Heating		5.0	75,000 ft. ²
	Space Heating	1982	95.0	Admin. Building

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
Ada (Cont'd)	Space Heating	1981	2.0	Penitentiary
Boise	Space Heating	1985	17.0	50 Residences
Bonneville	Agricultural		UNK	Greenhouses
Butte	Agricultural		.5	Greenhouses
Camas	Space Heating		.2	Residence
	Space Heating		1.0	High School
	District Heating			
Madison	Multi-Use	1981	680.0	Space Heating
Blaine	Industrial		120.0	Ethanol Plant & Industrial Park
	District Heating		46.0	Residences & Businesses
Adams	Industrial		12.0	Ethanol Plant
	District Heating	1985	40.0	
Cassia	Industrial	1982	300.0	5 Million gal./yr. Ethanol Plant
	Aquacultural		100.0	Fish Farm
	Industrial		100.0	Potato Drying
	Agricultural		13.9	Greenhouses
Canyon	Space Heating		5.0	Hospital
Custer	District Heating		5.0	
Elmore	District Heating		5.0	HUD Grant Applied For
Gem	Industrial		60.0	Ethanol Plant
Gooding	Industrial		600.0	10 Million gal/yr. Ethanol Plant
Kootenai	Space Heating		.2	Heat Pump for Residence
	Space Heating		.5	Farragut St. Park Pumphouses
Shoshone	Aquacultural		100.0	Freshwater Prawns
Twin Falls	District Heating	1983	3.0	Campus Heating
<u>Projected</u>				
Ada	Industrial		60.0	Ethanol Plant
Bannock	Industrial		100.0	Malting of Barley
Canyon	Industrial		60.0	Ethanol Plant
Cassia	Industrial		60.0	Ethanol Plant
Custer	District Heating		5.0	
Teton	Industrial		60.0	Ethanol Plant
Twin Falls	Industrial		360.0	Ethanol Plant
Washington	Industrial		1,200.0	Ethanol Plant

STATE: MONTANA

Montana is blessed with an abundance of geothermal resources. Resources up to 140°C have been identified and a significant number of resources are colocated with population centers.

Numerous geothermal space heating projects are currently operational and account for approximately 7.0×10^9 BTU/YR of energy usage. Numerous agricultural, space heating and industrial geothermal applications are underway and should be completed within the next few years.

Geothermal energy can contribute significantly to Montana's total energy supply. By the year 2000 geothermal energy may contribute as much as 25×10^{12} BTU/YR which is roughly 3% of Montana's projected energy usage.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.0074
Total Energy Use by Year 2000:	911.91
Geothermal Potential by Year 2000:	29.69
Geothermal Penetration by Year 2000:	25.79

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Commercialization & Planning Teams - Montana Dept. of Natural Resources & Conservation, Helena

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Beaverhead	Jackson, Wisdom
2. Big Horn	Busby, Crow Agency, Fort Smith, Garryowen, Hardin, Lodge Grass, St. Xavier, Wyola
3. Blaine	Hays
4. Broadwater	Radersburg, Toston, Townsend
5. Carbon	Big Horn Calcium, Warren
6. Carter	Alzada, Ekalaka
7. Custer	Miles City
8. Daniels	Flaxville, Peerless, Scooby, Whitetail
9. Dawson	DTA Feed Plant, Glendive, Richey
10. Dear Lodge	Anaconda, Glean, Opportunity, Warm Springs
11. Fallon	Baker, Plevna
12. Fergus	Forestgrove, Hilger, Lewistown, Moore, U.S. Gypsum
13. Gallatin	Amsterdam, Belgrade, Bozeman, Bozeman Hot Spring, Cypress Industrial, Gallatin Gateway, Ideal Cement, Logan, Manhattan, Maudlow, Three Forks, Trident, Willow Creek
14. Garfield	Jordan
15. Hill	Box Elder, Havre, Kremlin, Vita Rich Dairy

(1) Colocated means a city is within 5 miles of a resource.

County	City
16. Jefferson	Alhambra, Basin, Boulder, Cardwell, Glancy, Jefferson City, Whitehall
17. Lake	Big Arm, Elmo, Polson
18. Lewis & Clark	Asarco, Canyon Ferry, East Helena, Helena, Kaiser Cement, Marysville, Montana City
19. Madison	Alder, Cameron, Ennis, Harrison, Norris, Pony, Sheridan, Silverstar, Twin Bridges, Virginia City, Waterloo
20. McCone	Brockway, Circle
21. Meagher	Ringling, White Sulphur Spring
22. Mineral	St. Regis, Superior
23. Park	Clyde Park, Gardiner, Livingston
24. Phillips	Dodson, Landusky, Malta, Saco, Whitewater, Zortman
25. Powder River	Bell Creek, Broadus,
26. Powell	Deer Lodge, Elliston
27. Prairie	Fallon, Terry
28. Richland	Crane, Fairview, Holly Sugar, Lambert, Savage, Sidney
29. Roosevelt	Bainville, Brockton, Culbertson, Froid, Poplar, Wolf Point
30. Rosebud	Ashland, Cartersville, Colstrip, Forsyth, Ingomar, Lane Deer, Rosebud
31. Sanders	Hot Springs, Paradise, Plains
32. Sheridan	Antelope, Homestead, Medicine Lake, Outlook, Plentywood, Reserve, Westby
33. Silver	Butte, Centerville Dublin, Elk River Concrete, Floral Park, McGlone Heights, McQueen, McQueen East Butte, Melrose, Silver Bow Park, Stauffer Chemical, Walkerville
34. Valley	Frazer, Ft. Peck, Glasgow, Glasgow AFB, Hinsdale, Nashua, Opheim, Park
35. Wibaux	Wibaux

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Beaverhead	Recreational		1.7	Spas
Gallatin	Space Heating		2.0	4 Residences
Jefferson	Space Heating		1.0	Nursing Home
Lewis & Clark	Space Heating	1978	.9	Residences & Club
Madison	Space Heating		.5	Laundry
	Space Heating		1.0	Cabins
Meagher	Space Heating	1980	.5	First National Bank
	Space Heating		.5	Motel
Sanders	Space Heating		.5	School
Silver Bow	Space Heating		.5	Resort
<u>Planned</u>				
Deer Lodge	Aquacultural		3.0	Fish Hatchery
Jefferson	Multi-Use		5.0	District Heating & Greenhouses
Lewis & Clark	Space Heating		30.0	Residential Sub-division
Madison	Space Heating		1.0	Office Complex
	Industrial		60.0	Ethanol Plant
	Multi-Use		600.0	Ethanol Plant & Greenhouses
Park	Space Heating		3.5	
Hunter	Agricultural		.5	Greenhouses
<u>Projected</u>				
Fallon	District Heating		5.0	
Roosevelt	Multi-Use		285.0	Ethanol Plant, Greenhouse, PRDA

STATE: NEVADA

The state of Nevada has an abundance of geothermal resources ranging in temperature from those less than 50°C up to numerous sites capable of supporting electric power generation. In addition to the abundance of geothermal resources, many of those sites are colocated with major population centers.

Direct application of geothermal energy occurred in the early 1900's when it was used for residential space heating purposes. Geothermal projects that are in operation account for 0.2×10^{12} BTU/YR and numerous other projects are under construction. By the year 2000 geothermal energy will account for 5% of Nevada's energy consumption.

The Nevada Department of Energy has recently awarded contracts for the preparation of site-specific development plans which will analyze the resource potential for the Hawthorne and Gabls Areas.

A comprehensive bill intended to define geothermal energy and encourage utilities to develop alternative energy sources has caused a controversy between utility companies and consumer advocates. The controversial section of the bill centers on notemaking policies which liberalize utility options in price setting policies.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.2092
Total Energy Use by Year 2000:	666.15
Geothermal Potential by Year 2000:	39.29
Geothermal Penetration by Year 2000:	36.90

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Developers - Elko Heat Co., C/O Chitton Engineering, Elko; Geothermal Development Assoc., Reno

Resource Drillers - Aqua Drilling & Well Service, Sparks; McKay Drilling, Inc., Reno; Polar Drilling Co., Elko; Sage Brothers Drilling Co., Inc., Reno

Federal Technical & General Assistance Centers - U.S. DOE, Las Vegas

State Commercialization & Planning - Nevada Dept. of Energy, Carson City

General Planning/Finance - Carson Hot Springs, Carson City

County	City
1. Clark	Arden, Blue Diamond, Boulder City, Bunkerville, East Las Vegas, Henderson, Indian Springs, Jean, Las Vegas, Logandale, Mesquite, Moapa, Nellis AFB, North Las Vegas, Overton, Paradise, Sunrise Manor, Vegas Creek, Winchester
2. Douglas	Gardnerville Minden, Genoa, Glenbrook, Minden
3. Elko	Carlin, Deeth, Elko City, Jackpot, Lamelle, Mountain City, Owyhee, Wells
4. Esmeralda	Silver Peak
5. Eureka	Beowawe
6. Humboldt	Golconda, Winnemucca
7. Lincoln	Caliente, Panaca, Pioche
8. Lyon	Dayton
9. Mineral	Babbitt, Hawthorne, Luning, Mina
10. Nye	Beatty
11. Ormsby	Carson City
12. Storey	Virginia City
13. Washoe	Black Springs, Crystal Bay, Reno, Sparks, Steamboat, Sun Valley, Verdi, Vya, Washoe City
14. White Pine	East Ely, Ely, McGill, Ruth

(1) Collocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Carson	Space Heating	1979	.5	Residences
	Space Heating		.2	
Churchill	Industrial	1979	160.0	Food Processing
	Space Heating	1912	1.0	6 Residences
Douglas	Space Heating		1.0	3 Small Buildings
Humboldt	Multi-Use		1.0	Space Heating of House & Barn, Hog Scalding
	Agricultural	1979	.5	Green House
Lincoln	Space Heating		.5	Trailer Park
Lyon	Industrial	1980	24.0	Ethanol Plant, TAD Enterprises
Washoe	District Heating		5.0	160 Residences
	Space Heating		15.0	66 Homes, 3 Community Buildings
	Industrial		5.0	Explosives
<u>Planned</u>				
Carson	Space Heating		1.0	Several Residences
Churchill	Space Heating		5.0	Fallon Air Station
Elko	Industrial		300.0	Ethanol Plant
	Agricultural		.5	Hydroponic Greenhouse
Eureka	Agricultural		30.0	Half Circle Ranch
	Industrial		300.0	Ethanol Plant
	Aquacultural		100.0	Prawn Raising
Humboldt	Industrial		300.0	Ethanol Plant
Lyon	Industrial		100.0	Process Heat for Dairy
	Multi-Use		60.0	Process Heat & Greenhouses
Mineral	District Heating		5.0	
Storey	District Heating		5.0	Post Office & Park Complex
Washoe	Space Heating		1.0	Pepper Mill Restaurant
<u>Projected</u>				
Churchill	Industrial	1982	300.0	5 Million gal/yr. Ethanol Plant
	Industrial	1982	600.0	10 Million gal/yr. Ethanol Plant
Lincoln	Space Heating		1.0	Dill Medical Ctr.
Washoe	District Heating		1,200.0	6000 Unit Sub-division

STATE: NEW MEXICO

Geothermal resources with temperatures $\leq 50^{\circ}\text{C}$, $> 50^{\circ}\text{C}$, and $> 150^{\circ}\text{C}$ are found throughout New Mexico. In addition, many of these resources are located in close proximity to population centers and potential industrial users.

New Mexico has several direct heat applications, principally commercial and residential space and water heating and greenhousing. Numerous other projects are under construction and include several residential heating projects. New Mexico legislature authorized over \$800,000 for the first phase of a demonstration project at New Mexico State University. The initial phase of the project involves the heat of domestic hot water for 12 buildings on the campus. In past years the state legislature has appropriated about \$2,000,000 a year to promote geothermal development in the state.

Given the abundance of geothermal resources in the state and New Mexico's commitment to geothermal energy use, the future of geothermal energy within New Mexico is extremely bright.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0.1278
Total Energy Use by Year 2000:	1399.62
Geothermal Potential by Year 2000:	38.93
Geothermal Penetration by Year 2000:	28.28

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Drillers - Stewart Brothers, Grants

Commercialization & Planning Teams - Energy Resource & Development Division, Santa Fe, N.M.

**CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS**

County	City
1. Bernalillo	Alameda, Albuquerque, Armijo, Cedar Crest, Isleta Pueblo, Los Ranchos De Albq, North Valley, South Valley, Tijeras
2. Dona Ana	Anthony, Berino, Garfield, Hatch, La Mesilla, La Union, La Cruces, Meadow Vista, Mesilla Park, Mesquite, Organ, Radium Springs, Rincon, Salem, San Miguel, University Park Tortuga., Vado, White Sanos
3. Grant	Bayard, Central, Hurley, Santa Rita, Silver City, Tyrone,
4. McKinley	Crownpoint, Gallup, Cameroo, Manuelito, Thoreau, Zuni
5. Mora	Watrous
6. Otero	McGregor Range
7. Rio Arriba	Dixon, Placitas
8. San Juan	Aztec, Bloomfield, Farmington, Flora Vista, Kirtland
9. San Miguel	Las Vegas, Sapello
10. Sandoval	Algodones, Bernalillo, Corrales, Jemez Pueblo, Jemez Springs, Ponderosa, Rio Rancho Estates, San Felipe Pueblo, San Ysidro, Sandia Pueblo, Santo Domingo Pueblo

County	City
11. Santa Fe	Pajarito
12. Sierra	Truth or Consequences, Williamsburg
13. Socorro	Lemitar, Magdalena, San Antonio, Socorro
14. Taos	Arroyo Hondo, Arroyoseco, Cerro, El Prado, Penasco, Questa, Ranches De Taos, Rio Pueblo, Taos, Taos Pueblo, Tres Piedras, Valdez
15. Valencia	Los Lunas, Peralta

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Bernalillo	Space Heating		5.0	10 Story Building
Catron	Industrial		1.0	Water Supply
Dona Ana	Space Heating	1964	.2	Residences
Grant	Agricultural	1980	1.0	Greenhouses
	Space Heating	1940	2.0	15 Buildings
Hildalgo	Agricultural	1978	12.0	100,000 ft. ² Greenhouse
	Agricultural	1967	.5	4,000 ft. ² Greenhouse
	Agricultural		101.0	2 Greenhouses
Sandoval	Space Heating		.5	
	Agricultural		.5	Greenhouse
Sierra	Space Heating	1980	1.6	Carrie Tingley Hospital
	Space Heating		1.0	Yucca Lodge
Taos	Space Heating		.5	Resort Building
	Agricultural	1980	1.0	7500 ft. ² Greenhouse, Solar America
<u>Planned</u>				
Bernalillo	Space Heating		1.0	High School Retro-fit
Bernalillo (Continued)	District Heating		5.0	Residential
	District Heating		52.0	Univ. of Albuquerque
	Space Heating		1.0	West Mesa Apts.
Dona Ana	Space Heating	1981	5.0	Candlelight Homes Subdivision
Grant	Industrial		60.0	Ethanol Plant
Hildalgo	Agricultural	1984	600.0	5,000 ft. ² Greenhouse Addition
Luna	Space Heating		100.0	Industrial Park
Taos	Space Heating		12.0	80 Unit Condo Complex
<u>Projected</u>				
Bernalillo	District Heating		770.0	Univ. of N.M., PRDA
Dona Ana	Multi-Use		36.5	Space & Process Heating, L'Eggs Products, PRDA
	Industrial		6.0	Ethanol Plant

STATE: NORTH DAKOTA

While no high temperature geothermal resources exist in North Dakota, there are several low temperature sites scattered throughout the state. There are approximately a dozen small-scale geothermal direct-use projects in operation. Most of those projects are private residences and are utilizing heat pump applications. Several projects are planned in the near future, most of them space heating applications.

The University of North Dakota under the sponsorship of the Old West Regional Council conducted a state-wide heat pump seminar. The use of heat pumps in conjunction with geothermal resources could significantly increase geothermal development in the state. It is estimated that by the year 2000 geothermal energy could provide approximately 5% of the state's energy needs.

Three bills aimed at furthering the development of geothermal energy were enacted during 1981. The first provides a 15% tax credit for geothermal capitalization. The second allows a five year property tax exception for geothermal devices and the third gives the State Industrial Commission the authority to regulate exploration, development and utilization of geothermal energy.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0.0025
Total Energy Use by Year 2000:	521.34
Geothermal Potential by Year 2000:	30.00
Geothermal Penetration by Year 2000:	28.78

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Commercialization & Planning Teams - Energy Management & Conservation, Bismarck

LEGEND

- △ Hydrothermal Resources ≤ 50°C
- ◆ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Adams	Hettinger, Reeder
2. Billings	Medora
3. Bottineau	Antler, Eckman, Kramer, Lansford, Maxbass, Russell, Willow City
4. Bowman	Bowman, Rhame
5. Burke	Bowbells, Columbus, Flaxton, Larson, Lignite, Portal, Powers Lake
6. Burleigh	Arena, Bismarck, Wing
7. Divide	Ambrose, Crosby, Fortuna, Noonan
8. Dunn	Dodge, Dunn Center, Halliday, Killdeer, Manning
9. Emmons	Hague, Hazelton, Linton, Strasburg
10. Golden	Beach, Colva,
11. Grant	Carson, Elgin, Leith, New Leipzig
12. Hettinger	Mott, New England, Regent
13. Kidder	Tuttle
14. McHenry	Anamoose, Balfour, Berwick, Deering, Drake, Granville, Karlsruhe, Kler, Towner, Upham, Velva
15. McIntosh	Zeeland

(1) Colocated means a city is within 5 miles of a resource.

County	City
16. McKenzie	Alexander, Arnegard, Mandaree, Watford City
17. McLean	Benedict, Butte, Coleharbor, Garrison, Max, Mercer, Riverdale, Turtle Lake, Underwood, Washburn, Wilton
18. Mercer	Beulah, Goldenvalley, Hazen, Stanton, Zap
19. Morton	Almont, Flasher, Glen Ullin, Hebron, Mandan, New Salem
20. Mountrail	New Town, Palermo, Parkshall, Plaza, Ross, Stanley, White Earth
21. Oliver	Center
22. Pierce	Rugby
23. Renville	Glenburn, Loraine, Mohall, Sherwood, Tolley
24. Sheridan	Martin, McClusky
25. Sioux	Fort Yates, Selfridge, Solen
26. Slope	Amidon, Marmarth
27. Stark	Belfield, Dickinson, Lefor, Richardton, South Heart City, Taylor
28. Ward	Berthold, Burlington, Donnybrook, Douglas, Kenmare, Makoti, Minot, Ruthville, Ryder, Sawyer, Surrey
29. Wells	Harvey
30. Williams	Alamo, Epping, Grenora, Ray, Tioga, Wildrose, Williston

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Emmons	Multi-Use		1.0	3,000 ft. ² Home, Stock Watering
Slope	Agricultural		.5	Stock Watering
Stutsman	Space Heating	1980	1.0	Heat Pump Demo Project
Larimore	Space Heating		UNK	3 Homes
Bismarck	Space Heating		UNK	5 Homes
<u>Planned</u>				
Barnes	Space Heating		UNK	Convent
Burley	Space Heating	1981	.4	Heat Pump Demo Project
	Space Heating		12.0	9 Story Building
	Space Heating		.2	Residence
Emmons	District Heating		1.0	
Hettinger	Space Heating		1.0	Slaughterhouse
LaMoure	Space Heating		1.0	Shopping Center
Morton	Space Heating		1.0	Residences & Offices
Stark	Space Heating		4.0	Carlson Homes, Inc.
Walsh	Industrial		60.0	Ethanol Plant
<u>Projected</u>				
Grand Fork	Space Heating		1.0	Heat Pump Study

STATE: OREGON

Oregon has a substantial number of moderate and high temperature resources throughout the state. Many of these resources are situated in close proximity to residential and commercial centers.

Geothermal energy has been used for space heating of residences in Oregon since 1900. There are numerous projects currently in operation which account for over $.4 \times 10^{12}$ BTU/YR of energy use. Several additional projects are in the planning and on construction phase. In Klamath Falls two projects currently under construction are an elementary school space heating endeavor and additional district heating to the city. In Lakeview, construction is underway on a space heating project for 71 downtown buildings.

In percentage terms, geothermal energy will never be a major contribution to overall energy supplies but will certainly alleviate total dependence on conventional fuel sources.

The state of Oregon is actively pursuing future development of this energy resource. Funding of \$1.4 million for geothermal exploration and \$25 million to help local governments create geothermal district heating systems has been allocated.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0.4546
Total Energy Use by Year 2000:	1260.48
Geothermal Potential by Year 2000:	8.84
Geothermal Penetration by Year 2000:	6.52

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Research Developers - Allen & Associates, Eugene; Elliot Zais & Associates, Corvallis

Drilling Companies - E.E Storey & Son Drilling, Inc., Klamath Falls; Hartley, Charles E. Well Drilling, Klamath Falls; Interstate Pump Co., Inc., Klamath Falls; Valley Pump & Equipment, Klamath Falls; Norm Sevey Well Drilling, Klamath Falls

Architectural & Engineering - Balzhiser, Hubbard & Associates, Eugene

Academia - Oregon Institute of Technology, Klamath Falls

Federal Technical & General Assistance Centers - Geo-Heat Center, Klamath Falls

Commercialization & Planning Teams - Oregon Dept. of Energy,
Salem

Hardware - Interstate Pump Co., Inc., Klamath Falls; Valley Pump
& Equipment Co., Klamath Falls

LEGEND

- △ Hydrothermal Resources ≤ 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's

Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources
and Refer to Numbers on Accompanying Table

SCALE
0 10 20 30 40 50 MILES
0 10 20 30 40 50 KILOMETERS

CITIES COLOCATED ⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Baker	Baker, Greenhorn, Haines, Huntington
2. Clackamas	Portland
3. Harney	Burns, Hines
4. Jackson	Ashland, Medford, Phoenix, Talent
5. Klamath	Bonanza, Klamath Falls, Merrill
6. Lake	Lakeview, Paisley,
7. Lane	Oakridge
8. Malheur	Adrian, Jordan Valley, Ontario, Vale
9. Multnomah	Troutdale
10. Umatilla	Hermiston, Milton-Freewater, Umatilla
11. Union	Cove, Imbler, Island City, La Grande, North Powder, Summerville, Union
12. Wasco	The Dalles

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Baker	Agricultural	1925	.5	Greenhouse
Cove	Agricultural	1977	10.0	Greenhouse (Boise Cascade)
Grant	Space Heating	1975	.7	Residences
	Space Heating	1900	2.3	Residences
Klamath	Multi-Use	1945	.7	Milk Pasteurization and Hot Water
	District Heating	1900	13.6	600 Residences
	Aquacultural	1979	1.8	Prawn Raising
	Space Heating		1.0	County Maintenance Shops
	Space Heating	1980	5.0	YMCA, PCN-79
	Space Heating	1974	9.1	School District
	Agricultural	1978	1.3	Liskey Farms

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
Klamath (Cont'd.)	Agricultural	1980	5.0	10 Greenhouses (Liskey Farms)
	Space Heating	1974	.5	Medical Center
	Multi-Use	1963	6.8	Space Heating & Aquacultural
	Aquacultural		1.0	Freshwater Prawns
	Industrial	1950	10.0	Snow Melting on Highways
Lake	Multi-Use Aquacultural	1970	.9 100.0	Desert Farms, Space Heating & Green- houses
Malheur	Industrial	1981	36.0	600,000 gal/yr. Ethanol Plant - Owyhee Energy
	Space Heating		.5	YMCA
	Space Heating	1940	1.1	Numerous Residences
	Industrial	1981	120.0	2 Million gal/yr. Ethanol Plant
Union	Space Heating	1960	1.1	Residence
	Industrial	1980	120.0	2 Million gal/yr. Ethanol Plant
	Space Heating	1930	.7	Residence
<u>Planned</u>				
Klamath	Space Heating		2.0	75 Unit Apartment Complex
	District Heating		25.0	125 Residences
	Space Heating		.5	Elementary School
	Space Heating		1.0	Office & Warehouse
	Space Heating		1.0	Church
	Space Heating		1.0	Pelican School
	Industrial		100.0	Process Heat for Sewage Plant
	Industrial	1982	60.0	Ethanol Plant
Lake	Space Heating		5.0	Industrial Park
	District Heating		5.0	20-30 Homes, Church, & Busi- nesses
Malheur	Industrial		.1	Process Heat for Mushroom Plant
Marion	Space Heating	1981	3.6	Residences
Modoc	Industrial		60.0	Ethanol Plant
Union	District Heating		5.0	Applied for HUD Grant
Treasure Valley	Industrial		90.0	Ethanol Plant
<u>Projected</u>				
Klamath	Industrial		100.0	Process Heat for Modoc Lumber Co.
Lake	Industrial		100.0	Wood Chip Drying for Pacific Wood Fuel Corp.
Malheur	Industrial	1982	120.0	4-5 Million gal/yr. Ethanol Plant
Union	Space Heating		1.0	Grand Ronde Hospital

STATE: SOUTH DAKOTA

Most of the geothermal resources in South Dakota are in the low to moderate temperature range. In addition to a reasonable number of resources, many are located close to population centers.

There are several space heating projects in operation including several residences, public schools, and St. Mary's Hospital. Many projects are in the planning stage. Of particular note is a multi-use project in the town of Lemmon which would encompass space and district heating, ethanol production, grain drying and greenhousing. If this project proves successful estimated annual energy use would exceed 1×10^{12} BTU/YR. By the year 2000 geothermal energy is likely to supply 3% of the state's energy requirements.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0.2113
Total Energy Use by Year 2000:	358.04
Geothermal Potential by Year 2000:	13.08
Geothermal Penetration by Year 2000:	12.13

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Commercialization & Planning Teams - South Dakota Office of Energy Policy, Pierre, South Dakota

LEGEND

- △ Hydrothermal Resources < 10°C
- ▲ Hydrothermal Resources > 10°C
- Known Geothermal Resource Areas
- Places of 100,000 or More Inhabitants
- Places of 10,000 to 100,000 Inhabitants
- Central Cities of SMSA's with fewer than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Butte	Belle Fourche, Fruitdale, Newell, Misland
2. Corson	McLaughlin, McIntosh, Morristown
3. Custer	Buffalo Gap, Custer, Pringle
4. Dewey	Eagle Butte, Isabel, North Eagle Butte, Timber Lake
5. Fall River	Ardmore, Edgemont, Hot Spring, Igloo
6. Haakon	Diamond Ring Ranch, Midland, Philip
7. Hardin	Buffalo, Camp Crook
8. Jackson	Belvidere, Cottonwood, Kadoka
9. Lawrence	Central City, Deadwood, Lead, Spearfish, Whitewood
10. Meade	Ellsworth, Faith, Piedmont, Sturgis
11. Pennington	Box Elder, New Underwood, Rapid City, Villa Ranchaero, Wall, Wasta
12. Perkin	Lemon
13. Washabaugh	Washlee
14. Ziebach	Dupree

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	STU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Haakon	Space Heating Multi-Use	1980	.5 78.7	Barns Diamond Ring Ranch, PCN-78, Barn Bldg., Space Heating, Grain Drying, and Warming Stock Water
	Space Heating	1968	5.0	Public School Buildings
	Space Heating	1970	5.0	Maintenance Sheds & Water Plant
	District & Space Heating	1980	9.5	PCN-78, 5 School Bldgs. & 8 Com- munity Bldgs.
	Space Heating		1.0	Heating Manufac- turing Plant (Scotchman In- dustry)
	Industrial	1965	100.0	Water Treatment Plant
	Space Heating	1980	11.4	PCN-78, St. Mary's Hospital
Lyman	Space Heating	1979	.2	Residence
<u>Planned</u>				
Carson	Multi-Use		1,014.0	Space Heating, Greenhouse, Grain Drying & Alcohol Plant
Fall River	Space Heating		4.0	School District
Haakon	Space Heating		7.0	9 Local Businesses
Hard	Space Heating		1.0	Polo High School (Seeking Funding)
Hughes	Space Heating Agricultural Space Heating		3.0 1.5 40.0	Capital Mall Greenhouse 200 Residences
Lyman	Space Heating	1981	.2	Highway Rest-stops
Minnekahta	Space Heating		1.0	Heat Pump Applic.
<u>Projected</u> <u>None</u>				

STATE: UTAH

Utah contains a substantial number of moderate temperature resources in addition to two high temperature KGRA's. There are several small direct-use projects, mainly residential space heating and agricultural applications. Various other projects are proposed and construction is underway on a space heating project for Utah prison and a residential district heating application for Monroe. By the year 2000 over 5% of Utah's energy requirements can be met by geothermal energy.

The resource potential is significant and recently enacted legislation is designed to enhance the use of geothermal resources.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0.0288
Total Energy Use by Year 2000:	1228.63
Geothermal Potential by Year 2000:	91.15
Geothermal Penetration by Year 2000:	64.33

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Drillers - K.O. Burt, Mapleton; Billings Drilling Co., Salt Lake City

Federal Technical & General Assistance Centers - Earth Science Lab., Salt Lake City

Commercialization Specialists - Division of Water Rights, Salt Lake City

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Beaver	Beaver, Milford, Minersville
2. Box Elder	Bear River City, Brigham City, Deweyville, Elwood, Garland, Honeyville, Mantua, Perry, Plymouth, Portage, Promontory Point, Tremonton, Willard
3. Cache	Amalga, Cache Junction, Clarkston, Cornish, Cove, Hydr Park, Hyrum, Lewiston, Logan, Mendon, Millville, Newton, North Logan, Paradise, Providence, Richmond, River Heights, Smithfield, Trenton, Wellsville
4. Davis	Bountiful, Centerville, Clearfield, Clinton, East Layton, Farmington, Fruit Heights, Kaysville, Layton, North Salt Lake, South Weber, Sunset, Syracuse, West Bountiful, West Point, Woods Cross
5. Duchesne	Hanna, Tabiona
6. Emery	Castle Dale, Clawson, Emery Ferron, Orangeville
7. Iron	Newcastle
8. Juab	Eureka, Nephi
9. Millard	Delta, Deseret, Fillmore, Hinckley, Kanosh, Leamington, Lynndyl, Meadow, Oak City, Oasis
10. Morgan	Devils Slide, Morgan, Porterville
11. Piute	Junction, Marysville

County	City
12. Salt Lake	Cottonwood, Draper, East Millcreek, Granger, Granger Hunter, Holladay, Kearns, Lark, Magna, Midvale, Mount Olympus, Murray, Riverton, Salt Lake City, Sandy, South Jordan, South Salt Lake, Taylorsville, West Jordan, White
13. San Juan	Bluff, Mexican Hat, Monticello
14. Sanpete	Centerfield, Ephraim, Fayette, Gunnison, Manti, Mayfield, Moroni, Spring City, Sterling, Wales
15. Sevier	Annabella, Aurora, Elsinore, Joseph, Koosharem, Monroe, Redmond, Richfield, Salina, Sigurd, Venice
16. Summit	Coalville, Francis, Henefer, Kamas, Oakley, Park City
17. Tooele	Corinne, Delle, Grantsville, Lakepoint, Stockton, Tooele, Wendover
18. Uintah	Jensen, Vernal
19. Utah	Alpine, American Fork, Cedar Fort, Genola, Goshen, Lehi, Linden, Mapleton, Orem, Payson, Pleasant Grove, Provo, Salem, Santaquin, Spanish Fork City, Springville
20. Wasatch	Charleston, Heber City, Midway, Wallsburg
21. Washington	Central, Enterprise, Hurricane, La Verkin, Rockville, Santa Clara, Springdale, St. George, Torquerville, Virgin, Washington
22. Weber	Harrisville, Hooper, Huntsville, Liberty, North Ogden, Ogden, Plain City, Pleasant View, Riverdale City, Roy, South Ogden, Washington Terrace

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Box Elder	Space Heating		.5	Resort Buildings
	Space Heating		7.5	Resort Buildings
	Agricultural		1.0	Greenhouse, Allen Plant Company
Iron	Agricultural	1980	.5	Christenson Bros. Greenhouse
Salt Lake	Aquacultural		UNK	Tropical Fish Raising
	Agricultural	1980	16.3	Utah Roses Inc., Greenhouses
	Space Heating		1.0	International Center
	Space Heating	1972	1.0	28 Story Bldg., Heat Pump Application
Sevier	Recreational		.5	
Utah	Recreational		.5	
Wasatch	Recreational		.5	Several Residences
	Space Heating		1.0	
<u>Planned</u>				
Cache	Space Heating		100.0	
Davis	Space Heating	1981	10.0	Hill AFB
Iron	Agricultural		.5	Greenhouses, Hydroponics Inc.
Piute	Space Heating		1.0	Convent
Utah	Space Heating		1.0	Utah Tech. College
<u>Projected</u>				
None				

STATE: WASHINGTON

A relatively small number of low to moderate geothermal resources are known to exist in Washington. The only known applications of geothermal energy in the state are a space heating project in Clallam County and an agricultural (crop irrigation) and industrialization (car wash) application in Yakima.

The city of North Bonnmerville has started well drilling operations for a planned district heating project and the city of Ephrata is proposing to use geothermally assisted heat pumps to heat 12 public housing units.

A bill passed by the state legislature requires that revenues received from geothermal leases be deposited in a state geothermal fund. The funds will be used to mitigate development impacts, continue resource assessment, and expand the State Energy Office's geothermal commercialization and development program.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0.0135
Total Energy Use by Year 2000:	2071.32
Geothermal Potential by Year 2000:	92.00
Geothermal Penetration by Year 2000:	?

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Drillers - Holman Drilling Corp., Spokane

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Clallam	Space Heating	1912	1.5	Park Service
Yakima	Agricultural	1940	2.0	Crop Irrigation
	Industrial	1930	10.0	Car Wash
<u>Planned</u>				
Grant	Space Heating		5.0	Heat Pumps
Skamania	District Heating		5.0	City of N. Bonneville
<u>Projected</u>				
Adams	District Heating		5.0	City of Othello
Yakima	Space Heating		1.0	Davis High School
	Space Heating		1.0	St. Elizabeth Hospital
	District Heating		5.0	

STATE: WYOMING

Low to moderate temperature geothermal resources are found throughout the state. There are a few direct heat applications currently operational and include a snow and ice melting operation on Interstate 80 near Cheyenne and at Salt Creek where Amoco has used geothermal water flooding to enhanced oil recovery since 1964.

At Salt Lake, Al-Agra Inc. has proposed using geothermal energy for an ethanol plant. In Natrona County a multi-use project which includes space heating of residence and an industrial park, greenhousing, and aquacultural applications is being investigated.

Recently enacted legislation declares geothermal energy to be of beneficial use and places it under the regulatory authority of the State Engineer.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	10.0176
Total Energy Use by Year 2000:	933.38
Geothermal Potential by Year 2000:	25.07
Geothermal Penetration by Year 2000:	21.74

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Drillers - Materi Exploration, Upton

LEGEND

- △ Hydrothermal Resources ≤ 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SHSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SHSA's
- Standard Metropolitan Statistical Areas (SHSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Big Horn	Byron, Cowley, Deaver, Frannie, Lovell
2. Campbell	Gillette, Lamont, Ryan Park, Saratoga
3. Converse	Douglas
4. Crook	Moorcroft
5. Fremont	C Ranch, Dubois, Fort Washakie, Hudson, Kinnear, Lander, Pavillion, Teton Village
6. Goshen	Fort Laramie
7. Hot Springs	East Thermopolis, Thermopolis
8. Johnson	Buffalo, Kaycee, Linch
9. Lincoln	Afton, Auburn, Etna, Fairview, Freedom, Grover, Smoot, Thayne
10. Natrona	Casper, Edgerton, Evansville, Midwest, Mills, Mountain View, Paradise Valley
11. Niobrara	Lance Creek, Lusk, Manville
12. Park	Cody, Powell, Ralston
13. Platte	Guernsey, Hartville, Sunrise, Wheatland
14. Sheridan	Acme, Big Horn, Clearmont, Dayton, Ranchester, Sheridan, Storey
15. Sweetwater	Bairoil

County	City
16. Teton	Jackson, Wilson
17. Weston	Newcastle, Osage, Opton

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Albany	Industrial	1964	10.0	Snow & Ice Melting
Fremont	Agricultural		.5	Countryman Ranch, Greenhouses
Hot Springs	Space Heating		.6	3 Residences
Natrona	Agricultural Industrial		5.0 10,000.0	Irrigation System Amoco, Enhanced Oil Recovery
Teton	Industrial Aquacultural		1.0 .5	Laundry Fish Farm
<u>Planned</u>				
Fremont	Agricultural		.5	Greenhouses
Hot Springs	Space Heating		1.0	Residences & Businesses
	Multi-Use		1.0	District Heating & Greenhouses
Natrona	Space Heating		1.0	Residences
	Multi-Use		100.0	Industrial Park, Greenhouses, Aquacultural
Park	Industrial		60.0	Ethanol Plant
	Industrial		300.0	Al-Agra Inc., Ethanol Plant
Park (Continued)	Agricultural		1.5	Greenhouses
Teton	Space Heating		7.9	Heat Pumps

TABLE OF CONTENTS

States With Moderate Geothermal Development Activity

Arkansas	A-50
Connecticut	A-52
Deleware	A-54
Georgia	A-56
Maryland	A-60
Nebraska	A-63
New Jersey	A-66
New York	A-69
Texas	A-72
Virginia	A-76

STATE: ARKANSAS

A number of hot springs with temperatures up to 143°F have been identified. At Hot Springs, Arkansas, the National Park Administration has been using a geothermal resource to provide space heating for administration buildings and bathhouses. The system has been in use since 1973 and provides about 5×10^9 BTU/YR. While the growth of geothermal energy usage is not expected to be significant in the near-term, this energy source may provide 2.0×10^{12} BTU/YR by the year 2000.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0.0005
Total Energy Use by Year 2000:	1266.88
Geothermal Potential by Year 2000:	3.07
Geothermal Penetration by Year 2000:	2.18

LEGEND

- △ Hydrothermal Resources $\leq 50^\circ\text{C}$
- ▲ Hydrothermal Resources $> 50^\circ\text{C}$
- Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitant
- ⊙ Places of 50,000 to 100,000 Inhabitant
- ⊙ Central Cities of SHSA's With Fewer Than 50,000 Inhabitant
- ⊙ Places of 25,000 to 50,000 Inhabitant Outside SHSA's
- Standard Metropolitan Statistical Areas (SHSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Garland	Fountain Lake, Hot Springs

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Garland	Space Heating	1973	.5	
<u>Planned</u>				
None				
<u>Projected</u>				
None				

STATE: CONNECTICUT

The potential for developing geothermal energy in Connecticut appears to be extremely limited. Geothermal resources are extremely scarce and are at the lower range end of the temperature spectrum ($<50^{\circ}\text{C}$). The town of Litchfield is investigating the use of geothermal energy for space cooling. The system would be a combination of geothermal energy augmented by heat pumps and passive solar techniques. Geothermal energy is not however expected to play a significant role in contributing to Connecticut's overall energy supply.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1068.89
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>	Space Cooling		.2	Combination with Passive Solar & Heat Pump
None				
<u>Planned</u>				
Litchfield				
<u>Projected</u>				
None				

STATE: DELAWARE

Geothermal energy has begun to receive more attention by government officials in Delaware. Some well drilling activity has occurred with five test wells drilled to depths of 900-1100 feet. The Delaware State Energy Office will drill a geothermal well at Lewis, Delaware to be used by the Bancroft Corporation. The existence of geothermal expressions in the state is somewhat limited but if testing proves successful, this energy source could supply approximately 1.8×10^{12} BTU/YR by the year 2000.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	293.51
Geothermal Potential by Year 2000:	1.87
Geothermal Penetration by Year 2000:	1.80

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

DELAWARE

County	City
1. Kent	Bowers, Camden, Cheswold, Clayton, Dover, Farmington, Felton, Frederica, Harrington, Hartly, Houston, Kenton, Leipsic, Little Creek, Magnolia, Milford, Smyrna, Viola, Woodside, Wyoming
2. Sussex	Bethany Beach, Bethel, Blades, Bridgeville, Dagsboro, Delmar, Ellendale, Fenwick Island, Frankford, Georgetown, Greenwood, Harbeson, Henlopen Acres, Laurel, Lewes, Millsboro, Millville, Milton, Oak Grove, Ocean View, Rehoboth Beach, Seaford, Selbyville, Slaughter Beach, South Bethany

(1) Colocated means a city is within 5 miles of a resource.

STATE: GEORGIA

A large number of low temperature geothermal expressions have been identified throughout the state. More importantly many of these potential resources are located in close proximity to small population centers. At Kings Bay Naval Base the Department of Energy and the Department of Defense are cooperating on a joint project to evaluate the use of a potential resource for space heating. An exploratory well has been drilled and if the resource proves viable a space heating system using geothermal fluids will be installed during FY 82.

Given the reasonable number of resources located within the state and their proximity to population centers, geothermal energy may contribute over 12×10^{12} BTU/YR by the year 2000.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2271.93
Geothermal Potential by Year 2000:	12.78
Geothermal Penetration by Year 2000:	12.29

CITIES COLOCATED ⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Appling	Baxley, Surrency
2. Atkinson	Pearson, Willacoochee
3. Bacon	Alma
4. Baker	Newton
5. Ben Hill	Fitzgerald
6. Berrien	Alapaha, Enigma, Nashville, Ray City
7. Bleckley	Cochran, Macon
8. Brantley	Hoboken, Nahunta
9. Brooks	Barwick, Morven, Pavo, Quitman
10. Bryan	Pembroke, Richmond Hill
11. Bulloch	Brooklet, Portal, Statesboro
12. Burke	Blythe, Girard, Midville, Sardis, Waynesboro
13. Calhoun	Arlington, Edison, Leary, Morgan

County	City
14. Camden	Kingsland, St. Marys, Woodbine
15. Candler	Metter, Pulaski
16. Charlton	Folkston, Homeland
17. Chatham	Bloomington, Garden City, Pooler, Port Wentworth, Savannah, Thunderbolt, Tybee Island, Vernonberg
18. Clinch	Argyle, Du Pont, Homerville
19. Coffee	Ambrose, Broxton, Douglas, Nichols
20. Colquitt	Berlin, Doerun, Ellenton, Funston, Moultrie, Norman Park, Riverside
21. Cook	Adel, Cecil, Lenox, Sparks
22. Crisp	Arabi, Cordele
23. Decatur	Attapulgus, Bainbridge, Brinson, Climax
24. Dodge	Chauncey, Chester, Eastman, Milan, Rhine,
25. Dooly	Byromville, Lilly, Pinehurst, Unadilla, Vienna
26. Dougherty	Albany
27. Early	Blakely, Damascus, Jakin
28. Effingham	Guyton, Rinoon, Springfield
29. Emanuel	Adrian, Garfield, Nunez, Oak Park, Stillmore, Summertown, Swainsboro, Twin City
30. Glynn	Brunswick
31. Grady	Cairo, Whigham
32. Houston	Centerville, Perry, Warner Robins
33. Irwin	Ocilla
34. Jeff Davis	Denton, Hazlehurst
35. Jefferson	Avera, Bartow, Louisville, Stapleton, Wadley, Wrens,
36. Jenkins	Millen
37. Johnson	Kite, Wrightsville,
38. Lanier	Lakeland
39. Laurens	Cadwell, Dexter, Dublin, Dudley, East Dublin, Montrose, Rentz
40. Lee	Leesburg, Smithville
41. Liberty	Allenhurst, Flemington, Hinesville, Midway, Riceboro, Walthourville
42. Long	Ludowici
43. Lowndes	Dasher, Hahira, Lake Park, Naylor, Remerton, Valdosta
44. McIntosh	Darien
45. Meriwether	Manchester
46. Miller	Colquitt
47. Mitchell	Baconton, Camilla, Meigs, Pelham, Sale City
48. Montgomery	Ailey, Alston, Higgston, Mount Vernon, Tarrytown, Uvalda
49. Pierce	Blackshear, Patterson
50. Pike	Meansville, Zebulon
51. Pulaski	Hawkinsville
52. Randolph	Coleman, Cuthbert, Shellman
53. Screven	Hilltonia, Newington, Oliver, Rocky Ford, Sylvania
54. Seminole	Donaldsonville, Iron City
55. Sumter	Americus, Andersonville, De Soto, Leslie, Plains

County	City
56. Tattnall	Cobbtown, Collins, Glennville, Manassas, Reidsville,
57. Telfair	Helena, Jacksonville, Lumber City, McRae, Scotland
58. Terrel	Bronwood, Dawson, Parrott, Sasser
59. Thomas	Boston, Coolidge, Ochlocknee, Omega, Thomasville
60. Tift	Tifton, Ty Ty
61. Toombs	Lyons, Santa Claus
62. Treutlen	Soperton
63. Turner	Ashburn, Rebecca, Sycamore
64. Twiggs	Danville, Jeffersonville
65. Ware	Waycross
66. Washington	Davisboro, Deepstep, Harrison, Oconee, Riddleville, Sandersville, Tennille
67. Wayne	Jesup, Odum, Screven
68. Wheeler	Alamo, Glenwood
69. Wilcox	Abbeville, Pineview, Pitts, Rochelle
70. Wilkinson	Gordon, Irwinton, Ivey, McIntyre, Toombsboro
71. Worth	Poulan, Sumner, Sylvester, Warwick

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
None				
<u>Projected</u>				
Kings Bay	Space Heating		1.0	Naval Facilities

STATE: MARYLAND

A large number of low-to-moderate temperature geothermal resources have been identified in southeastern Maryland. In addition, these resources are located near small population centers.

Although no geothermal applications are currently on-line, numerous projects are in the planning stages. In Calvert County, Columbia Gas is investigating using geothermal resources to gasify LNG. Two high schools are investigating geothermal space heating applications and Campbell Soup Co. is looking into geothermal industrial applications.

Five bills and resolutions were recently passed by the state legislature. Included in these actions are tax credits; a state team or advocate in the office of the State Director of Economic and Community Development.

The outlook for geothermal development in Maryland appears extremely favorable. By the year 2000 geothermal energy may provide approximately 55×10^{12} BTU/YR.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1631.18
Geothermal Potential by Year 2000:	57.78
Geothermal Penetration by Year 2000:	55.56

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Federal Technical & General Assistance Centers - U.S. DOE, Washington, D.C.; Johns Hopkins University, Laurel, Maryland

Hardware Firms - Brunswick Corp., Arlington; Westinghouse Corp., Staunton

General Planning/Finance - International Union of Operating Engineers, Washington, D.C.; Market-Facts, Washington, D.C.; MITRE Corporation, McLean, Virginia

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Caroline	Denton, Federalsburg, Goldsboro, Greensboro, Henderson, Hillsboro, Marydel, Preston, Ridgely, Templeville
2. Dorchester	Brookview, Cambridge, Church Creek, East New Market, Eldorado, Galestown, Hurlock, Secretary, Vienna
3. Queen Anne's	Barclay, Centreville, Church Hill, Queen Anne, Queenstown, Sudlersville
4. Somerset	Crisfield, Princess Anne
5. Talbot	Easton, Oxford, St. Michaels, Trappe
6. Wicomico	Delmar, Fruitland, Hebron, Mardela Springs, Pittsville, Salisbury, Sharptown, Willards
7. Worcester	Berlin, Ocean City, Pocomoke City, Snow Hill

(1) Collocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Calvert	Industrial		55.0	Gasify LNG for Columbia National Gas
<u>Projected</u>				
Somerset	Space Heating		4.0	High School at Crisfield
Wicomico	Space Heating Industrial		4.5 100.0	School Campbell Soup Co.

STATE: NEBRASKA

A significant number of low-to-moderate temperature geothermal occurrences have been noted statewide; many are located in close proximity to population centers.

Recently the Nebraska state resource team completed a 1,000 meter thermal gradient hole in the western part of the state. The hole confirmed the 70°C bottom hole prediction based on shallow thermal gradient data and indicates the presence of a low temperature geothermal resource.

There are no geothermal projects currently operational but the city of O'Neill is investigating the use of geothermal energy for a space heating and crop drying project. While geothermal energy will not make a significant energy contribution it will become a part of the state's total energy supply mix.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	889.88
Geothermal Potential by Year 2000:	4.44
Geothermal Penetration by Year 2000:	3.90

LEGEND

- Hydrothermal Resources > 10°C
- Hydrothermal Resources > 30°C
- Hydrothermal Resource Areas
- Places of 100,000 or more inhabitants
- Places of 10,000 to 100,000 inhabitants
- General Cities of SMSA's with fewer than 10,000 inhabitants
- Places of 25,000 to 100,000 inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Calculated Hydrothermal Production and Refer to Numbers on Accompanying Table

SCALE
0 10 20 30 40 50 Miles

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Adams	Ayr, Ayr Township, Halsey, Hastings, Holstein, Juniata Township, Kenesaw, Kenesaw Township, Prosser, Roseland Township
2. Antelope	Brunswick, Clearwater Township, Elgin, Neligh, Oakdale Township, Orchard, Royal Township, Tilden
3. Arthur	Arthur
4. Blaine	Brewster, Dunning, Trumbull
5. Box Butte	Alliance, Hemingford
6. Boyd	Anoka, Bristow Township, Butte Township, Gross, Lynch Township, Monowi, Naper, Spencer Township
7. Brown	Ainsworth, Johnstown, Long Pine
8. Buffalo	Amherst, Elm Creek, Elm Creek Township, Gibbon, Gibbon Township, Kearney, Miller, Pleasanton, Ravenna, Riverdale, Riverdale Township, Shelton, Shelton Township
9. Cedar	Belden, Coleridge, Fordyce, Hartington, Laurel, Magnet, Obert, Randolph, St. Helena, Wynot
10. Chase	Imperial, Lamar, Wauneta
11. Cherry	Cody, Crookston, Kilgore, Merriman, Nenzel, Valentine, Wood Lake
12. Cheyenne	Dalton, Gurley, Lodgepole, Potter, Sidney
13. Clay	Clay Center, Deweese, Edgar, Edgar Township, Fairfield, Fairfield Township, Glenville, Glenville Township, Harvard, Harvard Township, Ona, Saronville, Sutton
14. Custer	Anselmo, Ansley, Ansley Township, Arnold, Arnold Township, Berwyn, Berwyn Township, Broken Bow, Callaway, Comstock, Comstock Township, Mason City, Merha, Oconto, Sargent, Sargent Township
15. Dawes	Chadron, Crawford, Marsland, Whitney, Cozad, Darr, Eddyville, Farnam, Gothenburg, Lexington, Overton, Sumner, Willow Island
16. Deuel	Big Springs, Chappell
17. Dundy	Benkelman, Haigler
18. Franklin	Bloomington, Bloomington Township, Campbell, Franklin, Hildreth, Naponee, Riverton, Upland
19. Frontier	Arapahoe, Beaver City, Cambridge, Curtis, Edison, Eustis, Hendley, Holbrook, Maywood, Moorefield, Oxford, Stockville, Wilsonville
20. Furnas	Adams, Adams Township, Barneston, Barneston Township, Beatrice, Blue Springs, Blue Springs Township, Clatonia, Clatonia Township, Cortland, Filley, Filley Township, Odell, Pickrell, Virginia, Wymore, Wymore Township
21. Garden	Burwell
22. Garfield	Elmwood, Smithfield
23. Grant	Greeley Center, Scotia, Spalding, Wulbach
24. Hall	Aurora, Giltner, Hampton, Hurdville, Marquette, Phillips, Stockham
25. Hamilton	Alma, Huntley, Orleans, Orleans Township, Ragan, Republican City, Stamford, Hamlet, Hayes Center
26. Hitchcock	Atkinson, Atkinson Township, Chambers, Chambers Township, Emmet, Emmet Township, Inman, O'Neill, Page, Stuart, Tryon
27. Holt	Mullen
28. Hooker	Cotesfield, Cushing, Dannebrog, Elba, Farwell, Howard City, Boelus, Daykin, Diller, Endicott, Fairbury, Harbine, Hansen, Plymouth, Reynolds, Steele City
29. Kearney	Brule, Ogallala, Paxton
30. Keya Paha	Bushnell, Dix, Kimball.

County	City
31. Kimball	Bazile Mills, Bloomfield, Center, Creighton, Crofton, Niobrara, Santee, Verdel, Verdigre, Wausa, Winnetoon
32. Knox	Bennet, Davey, Denton, Hirth, Hallam, Hickman, Lincoln, Malcolm, Panama, Raymond, Roca, Sprague, Waverly
33. Lincoln	Gandy, Stapleton
34. Logan	Taylor
35. McPherson	Battle Creek, Madison, Meadow Grove, Newman Grove, Norfolk,
36. Morrill	Belgrade, Fullerton, Genoa
37. Nuckolls	Burr, Douglas, Dunbar, Lorton, Nebraska City, Otoe, Palmyra, Syracuse, Talmage, Unadilla
38. Perkins	Atlanta, Bertrand, Funk, Holdrege, Loomis
39. Phelps	Foster, Hadar, McLean, Osmond, Pierce, Plainview, Columbus, Cornlea, Creston, Duncan, Humphrey, Lindsay, Monroe, Platte Center, Tarnov
40. Red Willow	Barada, Dawson, Humboldt, Preston, Rulo, Salem, Shubert, Stella, Verdon,
41. Rock	Crete, De Witt, Dorchester, Friend, Swanton, Tobias, Western, Wilber
42. Scotts Bluff	Beaver Crossing, Bee, Cordova, Garland, Goehner, Milford, Pleasant Dale, Scotts Bluff, Seward, Staplehurst, Tamora, Utica
43. Sheridan	Ashton, Ellsworth, Hazard, Litchfield, Loop City, Rockville
44. Sherman	Harrison
45. Sioux	Pilger, Stanton
46. Thayer	Seneca, Thedford
47. Thomas	Pender, Rosalie, Thurston, Walthill, Winnebago
48. Webster	Bartlett, Ericson

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
None				
<u>Projected</u>				
O'Neill	Multi-Use		100.0	Crop Drying or Space Heating

STATE: NEW JERSEY

The existence and/or extent of geothermal resources in New Jersey is not well documented. Five wells have been drilled to a depth of approximately 1,000 ft. and are being measured for heat flow. There are indications that low temperature geothermal resources are likely to be found in the southeastern part of the state. If these resources can be identified and confirmed, there are numerous small population centers that could utilize them.

No geothermal applications are currently on-line but at McGuire Air Force Base investigations are underway to determine the feasibility of using geothermal energy for space heating of 200 residential units.

There seems to be an excellent potential for geothermal use in New Jersey but the rate of development will depend to a large extent on the level of aggressiveness of resource assessment and confirmation programs.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2759.63
Geothermal Potential by Year 2000:	125.52
Geothermal Penetration by Year 2000:	103.77

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

NEW JERSEY

County	City
1. Atlantic	Absecon, Atlantic City, Brigantine, Buena, Corbin City, Egg Harbor City, Elwood, Estell Manor, Folsom, Hammonton, Linwood, Longport, Margate, Mays Landing, Northfield, Pleasantville, Port Republic, Somers Point, Ventnor City
2. Burlington	Beverly, Bordentown, Bordentown Township, Burlington, Burlington Township, Chatsworth, Chesterfield, Cinnaminson, Columbus, Delanco, Delran, Edgewater Park, Evesham, Fieldsboro, Florence, Hainesport, Lumberton, Mansfield, Maple Shade, Marlton, Medford, Medford Lakes, Moorestown, Mount Holly, Mount Laurel, Palmyra, Pemberton, Pemberton Township, Rancocas, Rancocas Wood, Red Lion, Riverside, Riverton, Roebling, Vincentown, Willingboro, Woodland, Wrightstown
3. Camden	Atco, Audubon, Audubon Park, Barrington, Bellmawr, Berlin Township, Blackwood, Blue Anchor, Brooklawn, Camden, Cherry Hill, Chesilhurst, Clementon, Collingswood, Gibbsboro, Glendora, Gloucester City, Haddon Heights, Haddonfield, Hi-Nella, Laurel Springs, Lawnside, Lindenwood, Magnolia, Merchantville, Mount Ephraim, Oaklyn, Pennsauken, Pine Hill, Pine Valley, Runnemede, Somerdale, Stratford, Tavistock, West Berlin, Westmont, Winslow, Woodlynne
4. Cape May	Avalon, Cape May, Cape May Point, North Wildwood, Ocean City, Sea Isle City, Stone Harbor, West Cape May, West Wildwood, Wildwood, Wildwood Crest, Woodbine
5. Cumberland	Bridgeton, Cedarville, Millville, Port Norris, Shiloh, Vineland,
6. Gloucester	Clayton, Calssboro, National Park, Newfield, Paulsboro, Pitman, Swedesboro, Bridgeport, Deptford, Franklinville, Gibbstown, Hurffville, Kresson, Mantua, Mickelton, Mount Royal, Mullica Hill, Wenonah, Woodbury, Woodbury Heights

(1) Collocated means a city is within 5 miles of a resource.

County	City
7. Middlesex	Carteret, Dunellen, Helmetta, Highland Park, Jamesburg, Metuchen, Middlesex, Milltown, New Brunswick, Old Bridge Township, Perth Amboy, Sayreville, South Amboy, South Plainfield, South River, Spotswood
8. Monmouth	Allenhurst, Allentown, Asbury Park, Atlantic Highlands, Avon-By-The-Sea, Belmar, Bradley Beach, Brielle, Deal, Eatontown, Englishtown, Fair Haven, Farmingdale, Freehold Township, Highlands, Interlaken, Keansburg, Keyport, Little Silver, Loch Arbour, Long Branch, Manasquan, Matawan, Monmouth Beach, Neptune City, Oceanport, Red Bank, Roosevelt, Rumson, Sea Bright, Sea Girt, Shrewsbury, South Belmar, Spring Lake, Spring Lake Heights
9. Ocean	Barnegat, Barnegat Light, Bay Head, Beach Haven, Beachwood, Brick Town, Forked River, Harvey Cedars, Island Heights, Jackson, Lakehurst, Lakewood, Lavallette, Manchester, Mantoloking, Ocean, Ocean Gate, Pine Beach, Point Pleasant, Point Pleasant Beach, Seaside Heights, Seaside Park, Ship Bottom, South Toms River, Surf City, Toms River, Tuckerton
10. Salem	Carneys Point, Elmer, Pedricktown, Penns Grove, Salem, Woodstown

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
None				
<u>Projected</u>				
McQuire	Space Heating		40.0	200 Residential Unit at McQuire AFB

STATE: NEW YORK

A jointly funded program by the State Energy Research and Development Authority and the Department of Energy to define the geothermal resources in the capital area of New York is currently in progress. A few low temperature geothermal resources have been identified and are colocated with major population centers.

There are no geothermal direct applications currently on-line but 3 projects are under investigation. In Cayuga County a Starch Reduction Plant is examining the feasibility of using geothermal energy to perform the reduction process. In Alleghany County, Friendship Dairies is examining the use of geothermal energy in their cottage cheese processing operation; an ethanol plant is also being considered.

Even if these aforementioned projects prove successful, geothermal energy development will be relatively minor.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	6004.48
Geothermal Potential by Year 2000:	0.02
Geothermal Penetration by Year 2000:	0.00

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Developers - United States Geothermal Corp., New York City

General Planning/Finance - Geothermal Energy Corp., New York City; Jerome P. Rosenberg, New York City; Sterling, Grace & Co., New York City

**CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS**

County	City
1. Albany	Albany, Altamont, Cohoes, Colonie, Colonie Town, East Berne, Feura Bush, Green Island, Green Island Town, Guilderland, Latham, Menands, Ravena, Selkirk, South Bethlehem, Voorheesville, Watervliet, Westerlo
2. Cayuga	Auburn, Aurora, Cato, Cato Town, Cayuga, Fair Haven, Locke, Meridian, Moravia, Port Byron, Union Springs, Weedsport
3. Columbia	Lebanon Springs, New Lebanon, New Lebanon Central, North Chatham, Old Chatham, West Lebanon
4. Erie	Akron, Alden, Alden Town, Amherst, Angola, Blasdell, Buffalo, Cheektowaga, Colden, Depew, Derby, East Amherst, East Aurora, Eden, Elma, Farnham, Getzville, Hamburg, Holland, Kenmore, Lackawanna, Lancaster, Lancaster Town, North Collins, North Collins Town, Orchard Park, Orchard Park Town, Sloan, Springville, Tonawanda, Tonawanda Town, West Seneca, Williamsville
5. Onondaga	Baldwinsville, Camillus, De Witt, East Syracuse, Elbridge, Fabius, Fayetteville, Jamesville, Jordan, Liverpool, Manlius, Marcellus, Minoa, Nedrow, North Syracuse, Skaneateles, Solway, Syracuse, Tully
6. Rensselaer	Alps, Averill Park, Brainard, Castleton-on-Hudson, Center Berlin, Cherryplain, East Nassau, East Poestenkill, East Schodack, Carfield, Glass Lake, Hoag, Hoosick Falls, Millers Corners, Nassau, Nassau Town, North Stephentown, Peterburg, Rensselaer, Schaghticoke, Troy, Valley Falls
7. Saratoga	Ballston Spa, Clifton Park, Corinth, Galway, Mechanicville, Round Lake, Saratoga Springs, Schuylerville, South Glens Falls, Stillwater, Victory, Waterford
8. Schenectady	Delanson, Schenectady, Scotia

**CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS**

County	City
9. Tioga	Apalachin, Berkshire, Candor, Newark Valley, Nichols, Owego, Spencer, Waverly

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Cayuga	Industrial		50.0	Starch Reduction Process
<u>Projected</u>				
Alleghany	Industrial		50.0	Cottage Cheese Processing, Friendship Dairies
	Industrial		60.0	Ethanol Plant

STATE: TEXAS

Texas has extensive geothermal geopressured resources from which methane may be recovered in the next few years. Hydrothermal resources in the state are in the low-to-moderate temperature range.

There are no geothermal direct heat applications operational at this time but two space heating projects are currently under development. They are the Corbett-Hutchins-Smith Memorial Hospital and Navarro College.

Extensive use of geothermal resources is more likely to be from geopressured rather than hydrothermal.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	9810.35
Geothermal Potential by Year 2000:	255.57
Geothermal Penetration by Year 2000:	245.74

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Drillers - J.W. Operating Co., Dallas

**CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS**

County	City
1. Atascosa	Campbellton, Charlotte, Christine, Fashing, Jordantown, Lytle, Pleasanton, Poteet
2. Bandera	Bandera, Medina, Pipe Creek
3. Bastrop	Bastrop, Cedar Creek, Elgin, Paige, Rosanky, Sayersville, Smithville, String Prairie
4. Bell	Bartlett, Belfalls, Belton, Harker Heights, Holland, Killeen, Moffatt, Morgan's Point Resort, Nolanville, Rogers, Temple, Troy
5. Bexar	Alamo Heights, Balcones Heights, Castle Hills, China Grove, Converse, Elmendorf, Grey Forest, Hill Country Village, Hollywood Park, Kirby, Leon Valley, Live Oak, Olmos Park, San Antonio, Schertz, Selma, Shevano Park, Somerset, Terrell Hills, Universal City, Windcrest
6. Caldwell	Fentress, Lockhart, Luling, Maxwell, McNeill, Mendoza
7. Collin	Allen, Altoga, Anna, Blue Ridge, Celina, Fairview, Farmersville, Frisco, Josephine, Lavon, Lowery Crossing, Lucas, McKinney, Melissa, Murphy, Parker, Plano, Princeton, Prosper, Richardson, Royse City, Sachse, Saint Paul, Westminster, Weston, Wylie
8. Comal	Garden Ridge, New Braunfel
9. Dallas	Ackerly, Addison (Part), Balch Springs, Buckingham, Carrollton, Cedar Hill, Cockrell Hill, Combine, Coppell, Dallas, De Soto, Duncanville, Farmers Branch, Ferris, Garland, Glenn Heights, Grand Prairie, Grapevine, Highland Park, Hutchins, Irving, Lancaster, Mesquite, Rowlett, Seagoville, Sunnyvale, University Park, Wilmer

County	City
10. Edward	Rocksprings,
11. Ellis	Alma, Bardwell, Ennis, Garrett, India, Italy, Maypearl, Midlothian, Milford, Ovilla, Palmer, Red Oak, Trumbell, Waxahachie
12. Falls	Bruceville-Eddy, Chilton, Colinda, Lott, Marlin, Otto, Perry Rosebud, Satin
13. Fannin	Bailey, Bonham, Dodd City, Ector, Honey Grove, Ladonia, Leonard, Savoy, Trenton, Windom
14. Frio	Bigfoot, Derby, Dilley, Moore, Pearsall
15. Gonzales	Belmont, Gonzales, Nixon, Smiley, Waelder
16. Grayson	Bells, Clarksville City, Collinsville, Denison, Dorchester, Gunter, Howe, Pottsboro, Sadler, Sherman, Southmayd, Tioga, Tom Bean, Van Alstyne, Whitesboro
17. Guadalupe	Cibolo, Marion, New Berlin, Seguin
18. Hays	Buda, Dripping Springs, Kyle, San Marcos
19. Hill	Abbott, Aquilla, Blum, Bynum, Covington, Hillsboro, Hubbard, Itasca, Malone, Mertens, Mount Calm, Penelope, Whitney
20. Hunt	Caddo Mills, Campbell, Celeste, Commerce, Greenville, Lone Oak, Neylandville, Quinlan, West Tawakoni, Wolfe City
21. Johnson	Abilene, Alvarado, Briaroaks, Cleburne, Godley, Grandview, Joshua, Keene, Lillian, Rio Vista, Venus
22. Kaufman	Crandall, Forney, Heath, Kaufman, Kemp, Oak Grove, Terrell
23. Kendall	Boerne
24. Kerr	Kerrville
25. Kinney	Brackettville, Spofford
26. Limestone	Coolidge, Broesbeck, Kosse, Mexia, Tehuacana, Thornton
27. Maverick	Eagle Pass, El Indio, Normandy, Quemado
28. McLennan	Bellmead, Beverly Hills, Crawford, Gholson, Hallsburg, Hewitt, Lacy-Lakeview, Leroy, Lorena, Mart, McGregor, Moody, Northcrest, Riesel, Robinson, Ross, Waco, West, Woodway
29. Medina	Castroville, Devine, Hondo, La Coste, Natalie, Yancey
30. Milam	Buckholts, Cameron, Cause, Maysfield, Milano, Rockdale, Sharp, Thorndale
31. Navarro	Angus, Barry, Blooming Grove, Corsicana, Dawson, El Dorado, Emhouse, Frost, Kerens, Mustang, Powell, Purdon, Retreat, Rice, Richland
32. Real	Camp Wood, Leahey
33. Rockwall	Fate, McLendon-Chisholm, Rockwall
34. Tarrant	Arlington, Bedford, Benbrook, Blue Mound, Colleyville, Crowley, Dalworthington Garde, Edgecliff, Euless, Everman, Forest Hill, Fort Worth, Haltom City, Haslet, Hurst, Keller, Kennedale, Lake Worth, Lakeside, North Richland Hills, Pantego, Richland Hills, River Oaks, Saginaw, Sansom Park Village, Watauga, <u>Westover Hills</u> , <u>Westworth</u> , <u>White Settlement</u>
35. Travis	Austin, Lakeway, Littig, Manor, McDade, Pflugerville, Rollingwood, San Leanna, Sunset Valley, West Lake Hills
36. Uvalde	Concan, Sabinal, Utopia, Uvalde
37. Val Verde	Del Rio, Juno, Langtry, Loma Alta, Pumpville
38. Williamson	Cedar Park, Florence, Georgetown, Granger, Hutto, Leander, Round Rock, Taylor, Thrall, Weir,
39. Wilson	Floresville, La Vernia, Pandora, Poth, Stockdale
40. Zavala	Batesville, Crystal City, La Pryor

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Falls	Space Heating	1981	11.0	PON-79, T.H.S. Hospital
Navarro	Space Heating	1981	35.0	Navarro College
<u>Projected</u>				
None				

STATE: VIRGINIA

Numerous hot springs with temperatures between 20 and 40°C are found throughout the state. In the surrounding area of Norfolk over a dozen wells have been drilled to depths of up to 1800 feet to determine heat flow.

The naval air facility located in Norfolk is investigating the use of geothermal energy to provide space heating for the base.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2061.07
Geothermal Potential by Year 2000:	0.74
Geothermal Penetration by Year 2000:	0.06

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Federal Technical & General Assistance Centers - U.S. DOE, Washington, D.C.; Johns Hopkins University, Laurel, Maryland

Hardware Firms - Brunswick Corp., Arlington; Westinghouse Electric Corp., Staunton

General Planning/Finance - International Union of Operating Engineers, Washington, D.C.; Market-Facts, Washington, D.C.; MITRE Corporation, McLean, Virginia

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Accomack	Accomac, Belle Haven, Bloxom, Chincoteague, Hallwood, Keller, Melfa, Onancock, Onley, Painter, Parksley, Saxis, Tangier, Wachapreague
2. Alleghany	Clearwater Park, Falling Spring, Natural Well, Rivermont
3. Bath	Ashwood, Bacova, Bacova Junction, Bolar, Callison, Carlover, Healing Springs, Hot Springs, McClung, Mitchelltown, Shakerag, Warm Springs
4. Caroline	Bowling Green, Port Royal
5. Chesapeake	Chesapeake
6. Essex	Tappahannock
7. Greensville	Jarratt
8. Hanover	Ashland
9. Isle of Wight	Smithfield, Windsor
10. King William	West Point
11. Lancaster	Irvington, Kilmarnock, Whitestone
12. Middlesex	Urbanna
13. Northampton	Cape Charles, Cheriton, Eastville, Exmore, Nassawadox
14. Northumberland	Callao
15. Richmond	Warsaw
16. Southampton	Boykins, Branchville, Capron, Courtland, Ivor, Newsoms
17. Surry	Claremont, Dendron, Surry
18. Sussex	Stony Creek, Wakefield, Waverly
19. Virginia	Virginia Beach

(1) Colocated means a city is within 5 miles of a resource.

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
None				
<u>Projected</u>				
Norfolk	Space Heating		3.3	Naval Air Facility

TABLE OF CONTENTS

States With Low or No Geothermal Development Activity

Alabama	A-79
Florida	A-80
Illinois	A-82
Indiana	A-84
Iowa	A-86
Kansas	A-87
Kentucky	A-89
Louisiana	A-90
Maine	A-91
Massachusetts	A-92
Michigan	A-94
Minnesota	A-96
Mississippi	A-97
Missouri	A-98
New Hampshire	A-99
North Carolina	A-100
Ohio	A-102
Oklahoma	A-103
Pennsylvania	A-104
Rhode Island	A-106
South Carolina	A-108
Tennessee	A-110
Vermont	A-111
West Virginia	A-112
Wisconsin	A-114

STATE: ALABAMA

There has been virtually no geothermal development activity in Alabama. A few resource areas ($<50^{\circ}\text{C}$) have been identified but they are apart from any population centers which could utilize them. The potential for geothermal usage is almost non-existent.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2297.00
Geothermal Potential by Year 2000:	30.00
Geothermal Penetration by Year 2000:	?

STATE: FLORIDA

Within the state of Florida a few geothermal resources with temperatures $\leq 50^{\circ}\text{C}$ have been identified near Gadsden, Jacksonville, Fort Pierce, and Fort Lauderdale. The only geothermal application in the state is a private residence space heating project utilizing a heat pump. Due to the limited number of resources and their accompanying low temperature development of geothermal energy is very unlikely.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0.0002
Total Energy Use by Year 2000:	3036.78
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
Gadsen	Space Heating		.2	Heat Pump for Residences
<u>Planned</u>				
None				
<u>Projected</u>				
None				

STATE: ILLINOIS

Although no development activities have been undertaken in Illinois, geologic indications point to the possibility that a large portion of the state may contain low-to-moderate temperature resources.

Numerous manufacturing, industrial, and food processing companies are located within the state and many of them have process heat requirements which could be met by these potential resources. In the existence of these geothermal resources can be confirmed as well as their viability the potential for geothermal utilization certainly exists.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	5844.41
Geothermal Potential by Year 2000:	68.00
Geothermal Penetration by Year 2000:	?

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's

Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

STATE: INDIANA

The potential for the existence of low temperature geothermal resources is indicated. Very little development activity has occurred in Indiana and there are no current or near term geothermal projects underway. The town of Crystal is investigating using geothermal resources for an industrial application utilizing multi-flash evaporation. Geothermal development is not expected to occur except in the long term.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	3724.45
Geothermal Potential by Year 2000:	109.00
Geothermal Penetration by Year 2000:	?

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Hardware Firms - Arkla Industries, Inc., Evansville

LEGEND

- △ Hydrothermal Resources ≤ 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's

Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
None				
<u>Projected</u>				
Crystal	Industrial		100.0	Multi Flash Evaporation, PRDA

STATE: IOWA

There are no positive signs that geothermal resources exist within the state of Iowa. No development activity has taken place and it is extremely unlikely that any geothermal development will occur.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:
Total Energy Use by Year 2000:
Geothermal Potential by Year 2000:
Geothermal Penetration by Year 2000:

0
1587.76
?
?

LEGEND

- △ Hydrothermal Resources $\leq 30^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 30^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

STATE: KANSAS

A few low temperature geothermal resources have been identified throughout the state. While the resources are low temperature ($<50^{\circ}\text{C}$) they are located in close proximity to small population centers. The potential does exist for utilization of these resources for space heating. No development activity has been undertaken in the state but it is likely that 1.0×10^{12} BTU/YR will be supplied by geothermal energy sources by the year 2000.

ENERGY USE:

10^{12} BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1463.36
Geothermal Potential by Year 2000:	1.16
Geothermal Penetration by Year 2000:	1.06

SCALE
0 10 20 30 40 50 MILES

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Bourbon	Bronson, Fort Scott, Fulton, Mapleton, Redfield, Uniontown
2. Cherokee	Baxter Springs, Calena, Roseland, Scammon, Treece, Weir, West Mineral
3. Cheyenne	Bird City, St. Francis,
4. Crawford	Arcadia, Arma, Cherokee, Frontenac, Girard, Hepler, McCune, Mulberry, Pittsburg, Walnut, Walnut Township
5. Graham	Bogue, Hill City, Hill City Township, Morland
6. Labette	Altamont, Chetopa, Edna, Labette, Labette Township, Mound Valley, Mound Valley Township, Oswego, Parsons
7. Montgomery	Caney, Cherryvale, Coffeyville, Dearing, Elk City, Havanna, Independence, Liberty, Liberty Township, Sycamore, Tyro
8. Neosho	Chanute, Earlton, Erie, Galesburg, St. Paul, Stark, Thayer
9. Rawlins	Atwood, Herndon, Herndon Township, McDonald
10. Sheridan	Hoxie, Selden

(1) Colocated means a city is within 5 miles of a resource.

STATE: KENTUCKY

The existence of geothermal resources in Kentucky appears very unlikely. There has been no development activity whatsoever and any future investigation into this energy source is extremely doubtful.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1613.91
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

SCALE
0 10 20 30 40 50 MILES

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Area
- Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Area (SMSA's)

NOTE: Numbers on Map Indicate Collected Hydrothermal Resources and Refer to Numbers on Accompanying Table

STATE: LOUISIANA

Approximately a half dozen low temperature ($\leq 50^{\circ}\text{C}$) geothermal resources have been identified in Louisiana. A major constraint to the development of these resources is that they are not located in reasonable proximity to any population centers.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	3894.96
Geothermal Potential by Year 2000:	413.00
Geothermal Penetration by Year 2000:	?

STATE: MAINE

It is highly unlikely that any geothermal resources exist in Maine and no type of geothermal development is therefore anticipated.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	466.77
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

STATE: MASSACHUSETTS

The only geothermal resource that has been identified in Massachusetts is a low temperature site near Williamstown. No development activity has been undertaken and geothermal energy is not expected to provide any significant contribution.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2140.94
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Berkshire	Williamstown Town

(1) Colocated means a city is within 5 miles of a resource.

STATE: MICHIGAN

A few low temperature ($\leq 50^{\circ}\text{C}$) geothermal resources have been identified within the state. In Ingham County a resource is being investigated to provide space heating for greenhouses. While limited potential exists for geothermal resource development this energy source will not contribute significantly to overall energy supplies

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	4461.75
Geothermal Potential by Year 2000:	5.00
Geothermal Penetration by Year 2000:	?

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>	Agricultural		.5	Greenhouses
None				
<u>Planned</u>				
Ingham				
<u>Projected</u>				
None				

STATE: MINNESOTA

Up till this point in time no geothermal resources have been identified in Minnesota. No resource assessment on development activities have been undertaken and geothermal energy will not contribute to the state's overall energy supply.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1991.14
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

STATE: MISSISSIPPI

Low temperature geothermal occurrences have been noted throughout the state. Initial investigations indicate however that the resource locations are not near any population centers. No development activities have been undertaken in Mississippi but it appears there is potential for future geothermal development.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1191.28
Geothermal Potential by Year 2000:	36.00
Geothermal Penetration by Year 2000:	?

LEGEND

- △ Hydrothermal Resources < 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's with Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collected Hydrothermal Resources and Refer to Numbers on Accompanying Table

SCALE
0 10 20 30 40 50 MILES

STATE: MISSOURI

No geothermal resources have been identified in Missouri and it appears almost certain that this energy source will not become part of the state's overall energy mix.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2294.19
Geothermal Potential by Year 2000:	45.00
Geothermal Penetration by Year 2000:	?

STATE: NEW HAMPSHIRE

There are indications that extremely low temperature geothermal resources may exist within the state. It is extremely unlikely that geothermal energy will become a part of the state's energy mix.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	312.58
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

STATE: NORTH CAROLINA

Very little geothermal development activity has taken place in North Carolina. There are geologic indications that low temperature resources are likely to occur in the eastern region of the state. Even if these resources can be confirmed it is unlikely that geothermal energy will achieve any major role in the total energy supply of the state.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2258.66
Geothermal Potential by Year 2000:	0.38
Geothermal Penetration by Year 2000:	0.08

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's with Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Beaufort	Aurora, Bath, Belhaven, Chocowinity, Pantego, Washington, Washington Park
2. Bertie	Askewville, Aulander, Colerain, Kelford, Lewiston, Powellsville, Roxobel, Windsor, Woodville
3. Bladen	Bladenboro, Clarkton, Dublin, East Arcadia, Elizabethtown, Tar Heel, White Lake
4. Brunswick	Boiling Springs Lake, Bolivia, Calabash, Caswell Beach, Holden Beach, Ocean Isle Beach, Shallotte, Southport, Sunset Beach, Yaupon Beach
5. Carteret	Atlantic Beach, Beaufort, Cape Cartaret, Emerald Isle, Indian Beach, Morehead City, Newport, Pine Knoll
6. Chowan	Edenton
7. Columbus	Bolton, Brunswick, Cerro Gordo, Chadbourn, Fair Bluff, Lake Waccamaw, Tabor City, Whiteville
8. Craven	Bridgeton, Cove City, Dover, Havelock, New Bern, Trent Woods, Vanceboro
9. Dare	Kill Devel Hills, Manteo, Nags Head
10. Duplin	Beaulaville, Calypso, Faison, Greenevers, Harrells, Kenansville, Magnolia, Mount Olive (Part), Rose Hill, Teachey, Wallace, Warsaw
11. Edgecombe	Battleboro, Conetoe, Leggett, Macolesfield, Pinetops, Princeville, Rocky Mount (Part), Sharpsburg (Part), Speed, Tarboro, Whitakers (Part)
12. Gates	Gatesville
13. Greene	Hookerton, Snow Hill, Walstonburg
14. Halifax	Enfield, Halifax, Hobgood, Littleton, Roanoke Rapids, Scotland Neck, Weldon
15. Hertford	Ahaskie, Cofield, Como, Harrellsville, Murfreesboro, Winton
16. Jones	Maysville, Pollockville, Trenton
17. Lenoir	Grifton, Kinston, La Grange, Pink Hill
18. Madison	Antioch, Bluff, Hot Springs, Pain Rock, Stackhouse,
19. Martin	Beargrass, Everetts, Hamilton, Hassell, Jamesville, Oak City, Parmele, Robersonville, Williamston
20. New Hanover	Carolina Beach, Kure Beach, Wilmington, Wrightsville Beach,
21. Northampton	Conway, Carysburg, Gaston, Jackson, Lasker, High Square, Seaboard, Severn, Woodland
22. Onslow	Holly Ridge, Jacksonville, Richlands, Swansboro
23. Pamlico	Alliance, Arapahoe, Bayboro, Mesic, Minnesott Beach, Oriental, Stonewall, Vandemere
24. Pasquotank	Elizabeth City
25. Pender	Atkinson, Burgaw, Surf City, Top Sail Beach
26. Perquimans	Hertford, Winfall
27. Pitt	Ayden, Bethel, Falkland, Farmville, Fountain, Greenville, Grimesland, Simpson, Winterville
28. Robeson	Fairmont, Lumber Bridge, Lumberton, Maxton, McDonald, Orrum, Parkton, Pembroke, Proctorville, Raynham, Red Springs, Rennert, Rowland, St. Pauls
29. Sampson	Autryville, Clinton, Garland, Newton Grove, Roseboro, Salemburg, Turkey
30. Tyrrel	Columbia
31. Washington	Creswell, Plymouth, Roper
32. Wayne	Eureka, Fremont, Goldsboro, Mount Olive (Part), Pikeville, Seven Springs, Walnut Creek
33. Wilson	Black Creek, Elm City, Lucama, Saratoga, Sharpsburg (Part), Sims, Stantonburg, Wilson

(1) Colocated means a city is within 5 miles of a resource.

STATE: OHIO

A minimal amount of geothermal development activity has occurred in Ohio. Fifteen wells have been identified as suitable for testing and the state has regulated DOE assistance in the assessment of low-to-moderate temperature resources.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	6068.00
Geothermal Potential by Year 2000:	68.00
Geothermal Penetration by Year 2000:	?

STATE: OKLAHOMA

The state of Oklahoma has requested DOE assistance in low-to-moderate temperature geothermal resource assessment.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1677.74
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT:

Resource Developers - Earth Power Production Co., Tulsa

Hardware Firms - Centrillift, Inc., Tulsa

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Collocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

STATE: PENNSYLVANIA

At this time very little geothermal resource assessment activity has taken place. Near the town of Landisburg there are indications that a low temperature ($<50^{\circ}\text{C}$) geothermal resource may be present. Until further assessment of the resource potential can be carried out the future of geothermal energy in Pennsylvania cannot be determined.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	5960.87
Geothermal Potential by Year 2000:	87.00
Geothermal Penetration by Year 2000:	?

ORGANIZATIONS INVOLVED IN GEOTHERMAL DEVELOPMENT

Resource Developers - Delmarva Geothermal Assoc., Jenkintown

LEGEND

- △ Hydrothermal Resources $\leq 50^{\circ}\text{C}$
- ▲ Hydrothermal Resources $> 50^{\circ}\text{C}$
- Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitance
- ⊙ Places of 50,000 to 100,000 Inhabitance
- Central Cities of SMSA's with Fewer Than 50,000 Inhabitance
- Places of 25,000 to 50,000 Inhabitance Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Perry	Landisburg

(1) Colocated means a city is within 5 miles of a resource.

STATE: RHODE ISLAND

Very little geothermal development activity has occurred in Rhode Island. A potential low temperature geothermal resource has been identified in Washington County and investigations are underway to determine the feasibility of using the resource for a space heating project. It is likely that the heat extracted from the resource would have to be augmented via heat pumps.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	319.69
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

DIRECT-USE APPLICATIONS

LOCATION	TYPE OF APPLICATION	YEAR-ON LINE	BTU/YR (BILLIONS)	COMMENTS
<u>Operational</u>				
None				
<u>Planned</u>				
Washington	Space Heating		.2	Heat Pumps
<u>Projected</u>				
None				

STATE: SOUTH CAROLINA

Geothermal resource assessment activities were initiated in 1979. A few low temperature sites were identified but it appears that further testing was suspended.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1298.17
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Allendale	Allendale, Clemson, Sycamore, Ulmer
2. Bamberg	Bamberg, Denmark, Ehrhardt, Govan, Olar
3. Barnwell	Barnwell, Blackville, Elko, Hilda, Kline, Snelling, Williston
4. Beaufort	Beaufort, Bluffton, Port Royal, Yemassee
5. Berkeley	Bonneau, Goose Creek, Hanahan, Jamestown, Moncks Corner, St. Stephen
6. Calhoun	Cameron, St. Matthews
7. Charleston	Charleston, Folly Beach, Hollywood, Isle of Palms, Lincolnville, McClellanville, Megget, Mount Pleasant, North Charleston, Ravenel
8. Clarendon	Manning, Paxville, Summerton, Turbeville
9. Colleton	Cottageville, Lodge, Smoaks, Walterboro, Williams
10. Dillon	Dillon, Lake View, Latta, Sellers
11. Dorchester	Harleyville, Reevesville, Ridgeville, St. George, Summerville
12. Florence	Coward, Florence, Johnsonville, Lake City, Olanta, Pamplico, Quinby, Scranton, Timmons ville
13. Georgetown	Andrews, Georgetown
14. Hampton	Brunson, Estill, Furman, Gifford, Hampton, Luray, Scotia, Varnville
15. Horry	Atlantic Beach, Aynor, Briarcliffe Acres, Conway, Loris, Myrtle Beach, North Myrtle Beach, Surfside Beach
16. Jasper	Hardeeville, Ridgeland
17. Lee	Bishopville, Lynchburg
18. Marion	Marion, Mullins, Nichols
19. Orangeburg	Bowman, Branchville, Cope, Cordova, Elloree, Eutawville, Holly Hill, Livingston, Neeses, North, Norway, Orangeburg, Rowesville, Santee, Springfield, Vance, Woodford
20. Sumter	Mayesville, Pinewood, Sumter
21. Williamsburg	Greeleyville, Hemingway, Kingstree, Lane, Stuckey

(1) Colocated means a city is within 5 miles of a resource.

STATE: TENNESSEE

Very little geothermal assessment work has been conducted in the state. It appears that there may be a few low temperature sites near Memphis. No geothermal activity is being pursued at this time.

ENERGY USE:

10¹² BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	2448.97
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

LEGEND

- △ Hydrothermal Resources ≤ 50°C
- ▲ Hydrothermal Resources > 50°C
- ◆ Known Geothermal Resource Areas
- ⊙ Places of 100,000 or More Inhabitants
- Places of 50,000 to 100,000 Inhabitants
- Central Cities of SMSA's With Fewer Than 50,000 Inhabitants
- Places of 25,000 to 50,000 Inhabitants Outside SMSA's
- Standard Metropolitan Statistical Areas (SMSA's)

NOTE: Numbers on Map Indicate Colocated Hydrothermal Resources and Refer to Numbers on Accompanying Table

STATE: VERMONT

Geothermal development does not appear to be likely in Vermont. The only activity has been an assessment of the potential of using glacial fill along the Connecticut River as a storage median for warm river water. The water would be used with temperature augmentation via heat pumps to provide space heating for the downtown area of Bellows Falls.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	179.17
Geothermal Potential by Year 2000:	?
Geothermal Penetration by Year 2000:	?

STATE: WEST VIRGINIA

Numerous hot springs are found throughout the state. No resource assessment activities have been undertaken and significant geothermal development appears unlikely.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:	0
Total Energy Use by Year 2000:	1113.49
Geothermal Potential by Year 2000:	0.19
Geothermal Penetration by Year 2000:	0.01

CITIES COLOCATED⁽¹⁾ WITH A HYDROTHERMAL RESOURCE
SUITABLE FOR DIRECT APPLICATIONS

County	City
1. Morgan	Berkely Springs, Great Cacapon, Hancock

(1) Colocated means a city is within 5 miles of a resource.

STATE: WISCONSIN

No geothermal resources are believed to exist within the state.

ENERGY USE:

1012 BTU/YR.

Current Geothermal Energy Use:
Total Energy Use by Year 2000:
Geothermal Potential by Year 2000:
Geothermal Penetration by Year 2000:

0
2553.66
?
?