WYOMING GEOTHERMAL COMMERCIALIZATION PLANNING

SEMI-ANNUAL PROGRESS REPORT

January 1, 1979 - June 30, 1979

Prepared by:

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Wyoming Geothermal Commercialization Office
University of Wyoming
Laramie, Wyoming

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1.0 Introduction

The University of Wyoming in contract with the United States Department of Energy began the Wyoming Geothermal Commercialization and Utilization Program in December of 1978. The program evolved to become the Wyoming Geothermal Commercialization Program which is administered by the Wyoming Geothermal Commercialization Office, (GCO). The GCO is located in the Institute of Energy and Environment on the campus of the University of Wyoming in Laramie. The Office has a number of functions and activities which will be illuminated in this report.

1.1 Purpose

The purpose of the Wyoming Geothermal Commercialization Program is to match geothermal resources with potential users and applications. The program also is to be a clearing house of geothermal development information and a link to Wyoming geothermal resource data.

1.2 Objectives

1. Bring about a general understanding of geothermal energy and its potentials in Wyoming.
 - a. Through distribution of internally generated publications geared to a broad readership.
 - b. Through contacts with decision makers statewide.
 - c. Through a detailed outreach program.
 - d. Through a toll free incoming telephone line for information dissemination.
 - e. Through an ongoing media presentation about the purpose and goals of the GCO.
2. Create a working relationship with other agencies involved in geothermal development, both state and federal.
 - a. Through periodic telephone contact with agencies.
 - b. Through a general activities newsletter distributed regularly.
 - c. Through information exchange sessions with each agency regularly.
 - d. Through attending pertinent local, state, regional and national meetings.

3. Develop usable plans to predict geothermal development over the next 40 years.

- a. Develop several area development plans.
- b. Develop the methodology for the Site Specific Development Analysis (SSDA).
- c. Develop several SSDA.
- d. Develop if possible one time phased development plan.

4. Maintain regional ties with other states and contribute to the accomplishment of national geothermal energy goals of the United States Department of Energy.

- a. Through regular contact with adjoining state's geothermal commercialization teams.
- b. Through regular contact with DOE operations offices.
- c. Through a sharing of information with UURI, NMEI and the Wyoming Resource Assessment Team.

5. Assess the institutional barriers to development of geothermal energy.

- a. Through publication of a handbook of geothermal institutional factors affecting Wyoming.
- b. Through suggesting changes in legislation at federal, state, and local levels to enhance the geothermal development process.

1.3 Technical Approach and Team Members

1.3.1 Technical Approach

The technical approach of the GCO has been to evaluate and disseminate information on geothermal energy. The office finds that there are many interested parties in the state and that continued support and assistance has been helpful. Not all of the inquiries can be dealt with on a detailed site analysis basis but some have included several trips to the site and the use of E G & G technical staff. Often inquiries have been made through the Wyoming Energy Extension Service (WEES), with whom information is regularly shared. These inquiries are usually documented by WEES and then the GCO responds to them.

1.3.1 Technical Approach (Continued)

The intent is to be able to publish all plans, compilations and other generated information by the end of the 1979 calendar year. This could facilitate the outreach work and answer many of the questions about geothermal energy development.

1.3.2 Team Members

Dr. E. G. Meyer - Principle Investigator
Vice President for Research
University of Wyoming
Laramie, WY 82071
(307) 766-5353

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Wyoming Geothermal Commercialization Office
c/o Institute of Energy and Environment
Box 3965, University Station
Laramie, WY 82071
(307) 766-6760

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Laramie, WY 82071
(307) 766-6760

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Wyoming Geothermal Commercialization Office
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Box 3965, University Station
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(307) 766-6760

1.4 Benefits of Project to State and DOE

1. Raising the level of understanding regarding what geothermal energy is and how it can be useful to individuals, businesses and communities.
2. Developing a raport with actual and potential regulators within the state.
3. Developing useable plans which can predict the future of geothermal use in Wyoming.
4. Sharing of information with other states regarding GCO activities.
5. Clearly defining the framework of regulations which apply to geothermal development.

6. Further the potential of geothermal development in Wyoming by encouraging users, thus lessening the amount of fossil energy consumed.

2.0 Summary of State Project Tasks and Work Accomplished

Task 1

1. In cooperation with Dr. Edward Decker, Professor of Geology and director of the Wyoming geothermal energy resources identification program (coordinated through the University of Utah Research Institute), an appropriate number of substate geographical areas will be identified. These areas will have a good likelihood for development and utilization of geothermal energy between now and 2020. The potential industrial, commercial, municipal, and residential applications will be determined and analyzed. In each area geothermal prospects and energy applications will be correlated for the 42-year period, and technical, economic, environmental, and institutional factors will be examined qualitatively or semi-quantitatively so that the uses of geothermal energy may be prioritized. All information generated will be provided to the New Mexico Research Institute (NMEI) for collaborative preparation of state and regional geothermal prospect/utilization scenarios.

- The state of Wyoming is under a handicap when attempting to coordinate information between the Resource Assessment Team and the Commercialization Team. Theoretically the resource assessment would be approximately one year ahead of the commercialization effort, yet in this case the programs are operating in parallel. There has been no published information made available by the resource team to this office during the first six months of the contract year. It seems that the summer is the best time for gathering data in the field and, therefore, no compilation of that data has occurred to date.

- Ten substate geographical areas have been designated which include all 23 counties of the state, plus Yellowstone National Park. The original five areas identified during 1978 have been subdivided to make ten areas and are delineated on Map 1, Geothermal Regions of Wyoming. Also, the order in which area development plans will be produced is indicated by the circled number in the lower right of each area.

Map 1
GEOTHERMAL REGIONS OF WYOMING

SCALE
0 10 20 30 40 50 MILES

- The prioritized numbering system is indicative of the potential for development as determined by a general overview conducted during the spring of 1979. The overview considered geothermal energy potential from now to 2020 in light of technical, economic, environmental and institutional barriers to development. Industrial, commercial, municipal and residential applications were considered in the generalized overview.
- All generated information when compiled in draft form will be provided to NMEI.

Task 2

2. Two categories of site-specific development and commercialization plans utilizing proven reserves and applications will be prepared. The first, a site-specific development plan, will be prepared for all major site-specific geothermal prospects within the ten sub-state areas. Each such plan will be based largely upon the information gathered from the sub-state area development plans, but will examine the quantitative aspects of the technical, economic, environmental, and institutional factors influencing the rate of geothermal development and utilization. Each site-specific development plan will define the potential amount of useable geothermal energy as a function of time to 2020, and will describe the factors or actions which will influence, control, or accelerate the prescribed rate of development. The plan will be provided to NMEI to collaboratively construct state and regional aggregations of geothermal development activity and to identify public and private sector actions necessary to achieve state and regional geothermal development and commercialization.

The second plan category, a time phased commercialization project plan, will be prepared if one or more selected geothermal projects in the state can meet the following criteria: The site must be one for which (1) industrial, commercial, or municipal utilization is at an advanced stage of planning or commercialization; and (2) significant value may be derived from an independent and comprehensive evaluation of the technical, economic, environmental, institutional, and political factors which control the timing or energy magnitude of the project. A real-time description of such site-specific commercialization projects will be constructed and local, state, and federal government actions identified which would augment the

success of the project. Information generated will be provided to NMEI for the state and regional economic and energy analyses, and to the DOE/EG&C for the regional commercialization plan.

Specific sub-state areas that will be investigated in connection with this segment of the work include the Madison formation, Tensleep formation, Saratoga area, Agribusiness for Big Horn Basin, Gas Hills, Alcova Hotspring area, Auburn Hotspring area for power generation, Periphery of Yellowstone, Laramie, Goshen and Platte counties.

- The Site Specific Development Analysis was assigned to the Wyoming team for development of a methodology and for developing an example of the plan. At the time of the production of this report the methodology is available and follows in outline form.

- The second plan category, a Time Phased Project Plan, is not yet feasible according to the criteria set forth in the cooperative agreement.

- Thus far investigations in this work segment have involved the Madison Formation (in a general information gathering sense), work with the town of Saratoga on its potential geothermally heated recreation center, and Agribusiness applications in the Big Horn Basin, specifically the potentials for a geothermally powered gasohol plant or barley malting plant.

Task 3

3. Local and state legislative and regulatory procedures and practices associated with geothermal leasing, exploration, field development, plant construction, energy transmission, utilization, etc., will be examined to ascertain interactions and overlaps with those of the state. The information will be utilized in preparation of sub-state area development plans, site-specific development plans, and the selected time phased commercialization project plans.

A state handbook will be prepared describing institutional procedures and time factors for evolving a geothermal resource from the leasing stage through the utilization stage for both electric and direct thermal applications.

Significant economic factors which affect the sub-state area and site-specific development plans will be identified and evaluated. Identification and quantification of geothermal economic factors and performance of

SITE SPECIFIC DEVELOPMENT ANALYSIS - METHODOLOGY

1.0 Introduction

- 1.1 Description of Methodology
- 1.2 General Overview of Geothermal Use Potentials
- 1.3 General Overview of Economic Markets

2.0 Site Description

2.1 Geography - Maps

- 2.1.1 Location of County in State
- 2.1.2 Location of City in County
- 2.1.3 Location of Site in City
- 2.1.4 Site Map

2.2 Demographics

- 2.2.1 Labor Force
- 2.2.2 Population Statistics

2.3 Economy of Site Area

- 2.3.1 Economic Base
- 2.3.2 Elements of the Economy by % Contribution

2.4 Public Considerations

- 2.4.1 Previously Established Development or Business Prejudices
- 2.4.2 Land Use Patterns
 - 2.4.2.1 Federal
 - 2.4.2.2 State
 - 2.4.2.3 Local Municipal
 - 2.4.2.4 Private
- 2.4.3 Usable and Available Land

3.0 Resource Evaluation

3.1 Springs

3.2 Wells

3.3 Reservoir Description

- 3.3.1 Apparent Surface Extent
- 3.3.2 Apparent Volume
- 3.3.3 Energy Content

3.4 Exploration Results

- 3.4.1 Drilling
- 3.4.2 Geochemistry
- 3.4.3 Geophysics

3.5 Potential Applications of the Resource

Site Specific Development Analysis - Methodology

- 4.0 Site Specific Application
 - 4.1 Process/Application
 - 4.2 Available Resource Compatability
 - 4.3 Eco System Evaluation
 - 4.3.1 Intra Application
 - 4.3.2 Extra Application
 - 4.4 Economics of Application
 - 4.4.1 Market Analysis
 - 4.4.1.1 Raw Material Market Area
 - 4.4.1.2 Area to which Product is Marketed
 - 4.4.1.3 Transportation of Finished Product
 - 4.4.2 Process Analysis (Economics)
 - 4.5 Outside and Special Factors
 - 4.5.1 Reservoir Use Allocations and Rights
 - 4.5.2 Government Assistance, i.e., tax incentives
- 5.0 Development Process
 - 5.1 Financial Factors
 - 5.1.1 Private
 - 5.1.2 Public (GLGP etc.)
 - 5.2 Leasing and Permitting
 - 5.2.1 Delineation of All Needed Permits
 - 5.2.2 Timeline for Permitting Process
 - 5.2.3 Obtain Leases
 - 5.3 Technological Factors
 - 5.3.1 State of the Arts Discoveries
 - 5.3.2 New Technologies Needed for Project Feasibility
 - 5.4 Barriers to Development
 - 5.4.1 Institutional
 - 5.4.2 Environmental
 - 5.4.3 Financial
 - 5.4.4 Others
- 6.0 Conceptual Timeline for Project Development
- 7.0 Summary and Recommendations

economic analyses for specific geothermal sites and uses will be done collaboratively with NMEI.

All geothermal data, information, plans, and findings or conclusions will be made available to state agencies and offices (executive and legislative) and to the Old West Regional Economic Development Commission. The services of NMEI, EG&G, and DOE will be called on to assist State and regional offices with energy and economic data pertinent to geothermal energy utilization.

- Local and State legislative and regulatory procedures and practices associated with geothermal development have been examined and interactions and overlaps identified. This information has been utilized in the preparation of the Big Horn Basin Area Development Plan and is currently being used as an important element in the Site Specific Development Analysis.
- A handbook describing this information, The Wyoming Geothermal Development Handbook, is in the final stages of preparation and is expected to be published in early October.
- Economic factors with significant informational value have been identified for areas where extensive work has been done.
- A distribution list has been developed as part of the GCO's outreach effort. This will include regular mailings to appropriate state officials and, funds permitting, a monthly newsletter.

Task 4

4. An outreach program will be organized and conducted to promote the utilization of geothermal energy by industry, utilities, commerce, agriculture, and governmental units. This effort will be made in cooperation with the on-going Wyoming Energy Extension Service, thus producing a synergistic benefit. The basis for the outreach program will be the sub-state area development plans, and the DOE/EG&G regional commercialization plan. Outreach will consist of the following elements:

- (a) interaction with community, business, industrial, labor, and governmental leaders concerning geothermal;
- (b) information dissemination;
- and (c) regional support coordination for limited assistance to potential geothermal developers and users.

- The initial element of outreach as delineated in part (a) has been accomplished thus far by contacting the following:

State Agencies

Larry Bouret, Commissioner
Agricultural Planning and Development
Cheyenne, WY

John Niland, Director, John T.
Goodier, and Dale S. Hoffman
Department of Economic Planning
and Development
Cheyenne, WY

George L. Christopulos, State Engineer
State Engineer's Office
Cheyenne, WY

Earl M. Thomas, Director
Wyoming Game and Fish Department
Cheyenne, WY

Dr. Blaine E. Dinger, Director
Industrial Siting Administration
Cheyenne, WY

*Don Basko, Supervisor
Wyoming Gas and Oil Commission
Casper, WY

Director
Wyoming Office of Recreation
Cheyenne, WY

*Oscar Swan, Director
Wyoming Public Lands Commission
Cheyenne, WY

*Esther M. Smith
Institute of Energy and Environment
Laramie, WY

Steve Genz
Conservation Commission
Cheyenne, WY

*Pam Able, Director
Wyoming Energy Conservation Office
Cheyenne, WY

Lance Stewart, Land Division and
*Bill Garland, Water Division
Department of Environmental Quality
Cheyenne, WY

*W. Don Nelson, Director
Wyoming Health and Social Services
Cheyenne, WY

Executive Director
Land Use Administration
Cheyenne, WY

Randall Wagner, Director
Wyoming Travel Commission
Cheyenne, WY

Director
Public Service Commission
Cheyenne, WY

*Dan Miller, State Geologist
Wyoming Geological Survey
Laramie, WY

Wyoming Community Development
Authority
Casper, WY

*Contact involved face to face discussions

Interest Groups

*Robert "Terry" Martain
Rocky Mountain Oil and Gas Association
Casper, WY

*Bob Cantine, Director
Wyoming Association of Municipalities
Cheyenne, WY

Mr. Doug Gibosn
Wyoming Farm Bureau Federation
Laramie, WY

Wyoming Coal Information Committees
Casper and Gillette, WY

*Ms. Jessie Baker
Wyoming Woolgrowers Association
Casper, WY

Ken Wonstolen
National Conference of State Legislatures
Denver, CO

Political Interests

*Richard Cheney, U.S. Representative
Washington, D.C.

*Alan Simpson, U.S. Senator
Washington, D.C.

*Sheila Arnold, Wyoming Senator
Laramie, WY

*Mathilda Hansen, Wyoming Representative
Laramie, WY

Bob Burnett, Wyoming Representative
Laramie, WY

*Craig Thomas
Rural Electrification Association
Casper, WY

Wyoming Real Estate Commission
Cheyenne, WY

Wyoming Geological Association
Casper, WY

Wyoming Chambers of Commerce
Cheyenne, WY

*Dean Prosser
Wyoming Stockgrowers Association
Cheyenne, WY

*Malcolm Wallop, U.S. Senator
Washington, D.C.

*Dave Nicholas, Wyoming Senator
Laramie, WY

*Patti McMillan, Wyoming Representative
Laramie, WY

T.A. Larson, Wyoming Representative
Laramie, WY

- Element (b) of the outreach task is to some extent in the planning stages. It is expected that regular information will be extended to the State through a monthly news letter. Also distribution to the State of various in-house publications will begin. These efforts will enhance the toll free incoming telephone line and the efforts of the Wyoming Energy Extension Service.

*contact involved face to face discussions

- Element (c) is now underway by the Wyoming Energy Extension Service although more support of its efforts is needed for it to fulfill the needs of the GCO.

Task 5

5. Mr. Rick James has been directing the work plan since December 19, 1978.

3.0 Specific Task Descriptions and Products

As indicated previously in this report, a number of Area Development Plans will be produced. Thus far one has been developed, The Big Horn Basin Area Development Plan. Also the beginning of a number of other tasks has been accomplished.

The reader is referred to the 1978 project report for much of the data upon which the present activity has been based. Included as Appendix A is the published form of the report produced, Geothermal Energy in Wyoming: Site Data and Development Status, by Richard W. James, published by the Oregon Institute of Technology. Also an additional publication is noted here for informational reference, Hydrothermal Commercialization Baseline for the State of Wyoming, published by EG&G Idaho, Inc. and DOE.

3.1 Geothermal Prospect Identification

As there are currently no possibilities for electrical generation by geothermal means in Wyoming, the following will be a presentation of geothermal prospects for direct thermal ($20^{\circ}\text{C.} < T < 150^{\circ}\text{C.}$).

- Geothermal Resources

Confirmed Reservoirs $> 150^{\circ}\text{C.}$: None

Prospects $> 150^{\circ}\text{C.}$: Two

Confirmed Reservoirs ($20^{\circ}\text{C.} < T < 150^{\circ}\text{C.}$): 6

Prospects ($20^{\circ}\text{C.} < T < 150^{\circ}\text{C.}$): 4

Identified Warm Springs and Wells $> 40^{\circ}\text{C.}$: 25

- Low- and Moderate-Temperature Resources ($< 150^{\circ}\text{C.}$)

Confirmed Reservoirs: Auburn Hot Springs, Countryman Well (near Lander), Huckleberry Hot Springs, Saratoga, Thermopolis, Cody.

Prospects: City of Glenrock; Madison and Minnelusa Formation (Campbell, Crook, Niobrara, Sheridan and Weston Counties), North of Douglas and the Gas Hills.

- Hydrothermal Springs and Wells

A listing of hydrothermal springs and wells with measured temperatures in excess of 40°C. is given in Table 1 for Wyoming.

TABLE 1

HYDROTHERMAL SPRINGS AND WELLS - WYOMING
(Source: USGS File GEOTHERM)

COUNTY, NAME, AND TYPE	LOCATION	TEMP (°C)	FLOW (L/min)	TOTAL DISSOLVED SOLIDS (ppm)
<u>CARBON</u>				
Saratoga Hot Springs (S) ^[a]	T17N, R84W	48	454	1920
<u>FREMONT</u>				
Fort Washakie Hot Springs (S)	T1S, R1W	44	568	832
Fort Washakie Hot Springs (S)	T1S, R1W	47		801
Fort Washakie Hot Springs (S)	T1S, R1W	45		1006
<u>HOT SPRINGS</u>				
Bathtub Spring (S)	T43N, R95W	53	7.6	2330
Big Spring (S)	T43N, R94W	56	11008	2190
Maytag Well (W) ^[b]	T43N, R95W	54	2040	
McCarthy Well (W)	T43N, R94W	54	2207	2380
Sacajawea Well (W)	T43N, R95W	52	4618	2390
Van Norman Well (W)	T43N, R95W	51		
White Sulphur Spring (W)	T43N, R94W	53	780	2350
<u>LINCOLN</u>				
Auburn Hot Springs (S)	T33N, R119W	62	140	5250
Auburn Hot Springs (S)	T33N, R119W	62		
Johnson Springs (S)	T33N, R119W	46	7.6	
<u>NATRONA</u>				
Alcova Hot Springs (S)	T30N, R83W	54	379	1260
Alcova Hot Springs (S)	T30N, R83W	59		1381

[a] (S) = Spring

[b] (W) = Well

TABLE 1
(Continued)

COUNTY, NAME, AND TYPE	LOCATION	TEMP (°C)	FLOW (L/min)	TOTAL DISSOLVED SOLIDS (ppm)
<u>TETON</u>				
Granite Falls Hot Springs (S)	T39N, R113W	45	454	
Granite Hot Spring (S)	T39N, R113W	41	1136	670
Huckleberry (S)	T48N, R113W	71		
Huckleberry Hot Springs (S)	T48N, R115W	45	1136	688
Huckleberry Hot Springs (S)	T48N, R115W	61		613
Huckleberry Hot Springs (S)	T48N, R115W	61		837
Huckleberry Hot Springs (S)	T48N, R115W	71		
Jackson Lake Hot Springs (S)	T45N, R115W	72		
North Buffalo Fork Springs (S)	T45N, R113W	45	757	

[a] (S) = Spring
[b] (W) = Well

• Geothermal Leases

Federal: 7,448 acres

State: 1,150 acres

Private: None

State of Wyoming:

2 year Exploration Permits:

0-36026*	Sec 13, T. 33 N., R. 119 W. E $\frac{1}{2}$ NE $\frac{1}{4}$, NE $\frac{1}{4}$ SE $\frac{1}{4}$.	120 acres
0-36027*	Sec 16, T. 34 N., R. 119 W. Lots 1-4, E $\frac{1}{2}$.	389.6 acres
0-36028*	Sec 36, T. 34 N., R. 119 W. All.	640 acres

Permitted to: Intercontinental Energy
Corporation
7503 Marin Drive
Suite 1-C
Englewood, CO 80110

There have been no state leases to this point.

U.S. Bureau of Land Management:

Leases:

1) W-44532 Sec 2, T. 33 N., R. 119 W.
All but Lot 1.

Sec 3, T. 33 N., R. 119 W.
Lot 1-4, S $\frac{1}{2}$ N $\frac{1}{2}$, S $\frac{1}{2}$.

Sec 4, T. 33 N., R. 119 W.
Lots 1-6, SE $\frac{1}{4}$, S $\frac{1}{2}$ NE $\frac{1}{4}$.

Sec 9, T. 33 N., R. 119 W.
Lots 1-4, E $\frac{1}{2}$.

Sec 16, T. 33 N., R. 119 W.
Lots 1-4, E $\frac{1}{2}$.

Leased to: U.S. Geothermal
39 Broadway
Suite 3100
New York, NY 10006

2) W-44533

Sec 10, T. 33 N., R. 119 W.
All.

Sec 11, T. 33 N., R. 119 W.
All.

Sec 14, T. 33 N., R. 119 W.
 $N\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $NE\frac{1}{4}$, $E\frac{1}{2}SE\frac{1}{4}$.

Sec 15, T. 33 N., R. 119 W.
All.

Leased to: U.S. Geothermal
39 Broadway
Suite 3100
New York, NY 10006

3) W-47940

Sec 33, T. 34 N., R. 119 W.
Lots 1-6, $NE\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$.

Sec 34, T. 34 N., R. 119 W.
Lots 1-7, $S\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}$, $SW\frac{1}{4}NE\frac{1}{4}$, $W\frac{1}{2}SE\frac{1}{4}$.

Sec 35, T. 34 N., R. 119 W.
Lots 1-3, 8, 9, $NE\frac{1}{4}SW\frac{1}{4}$.

Leased to: Thermex Company
1600 Broadway, Suite 1560
Denver, CO 80202

4) W-47741

Sec 15, T. 34 N., R. 119 W.
 $SW\frac{1}{4}SW\frac{1}{4}$.

Sec 21, T. 34 N., R. 119 W.
Lots 1-6, $S\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}$.

Sec 22, T. 34 N., R. 119 W.
Lots 3-5.

Sec 27, T. 34 N., R. 119 W.
Lots 2-4, $W\frac{1}{2}E\frac{1}{2}$, $W\frac{1}{2}$.

Sec 28, T. 34 N., R. 119 W.
Lots 1-4, $E\frac{1}{2}$.

Leased to: Thermex Company
1600 Broadway
Suite 1560
Denver, CO 80202

Lease Applications:

W-49770

Sec 21, T. 33 N., R. 119 W.
Lots 1, 2, NE $\frac{1}{4}$, NE $\frac{1}{4}$ SE $\frac{1}{4}$.

Sec 22, T. 33 N., R. 119 W.
NW $\frac{1}{4}$ SW $\frac{1}{4}$.

Applicant: Thermex Company
1600 Broadway
Suite 1560
Denver, CO 80202

3.2 Area Development Plans

3.2.1 State Geothermal Planning Areas

Planning Districts (identified in 1978)

1. Big Horn Basin
2. Powder River Basin
3. Platte River
4. Green River
5. Yellowstone

Planning Regions (identified in 1979)

Candidates for ADPs

- 1-A Big Horn Basin Region
- 1-B Fremont County Region
- 2-A Sheridan Region
- 2-B Midwest Region
- 2-C Black Hills Region
- 3-A Cheyenne Region
- 3-B Laramie Region
- 4-A Sweetwater Region
- 4-B Bridger Region
- 5 Yellowstone

3.2.2 ADP- Big Horn Basin Area

The Big Horn Basin Area Development Plan covers the counties of Big Horn, Hot Springs, Park and Washakie in northcentral Wyoming. The primary geothermal resource areas which have been identified by the Wyoming Geothermal Commercialization Office in cooperation with the University of Wyoming Department of Geology are Cody, Thermopolis and Little Sheep Mountain Spring in Big Horn County (see Map 2). Little resource

Map 2

The Big Horn Basin

data is available for the Big Horn County site but there is distinct reason for further study there.

The principal work has been conducted on inferred resource information for Cody and Thermopolis. The proposed application in each case is for geothermal district heating. The two communities are quite similar economically and in size; therefore, in the broad context of this plan they are considered as equal with the exception of specific energy demands by specific industries in each community.

The GCO surveyed growth trends in the Big Horn Basin to enable prediction of energy consumption within the area, and discovered that the population was growing at about one-half the growth rate for the state of Wyoming as a whole. Population growth rate for the state of Wyoming is 2.9 percent per year, while growth rate for the Big Horn Basin is 1.4 percent per year. (Table 2). Employment and energy consumption rates in the Basin indicate that the mineral industry and its related service industries account for 12 percent of employment and 92 percent of energy consumption (Table 3). Predictions of future resident and work populations were also made for the area and indicated in Table 2.

Drilling and distribution costs have been estimated and are given in Table 4. The costs were estimated on the basis of eight miles of pipeline and two production wells with one re-injection well. Transportation pipe is a double-insulated asbestos-concrete variety.

In Table 5 the completed system cost is projected and an amortization is applied. The total cost of the delivered heat is an amazingly competitive \$3.30/MMBTU.

There have been no wells drilled for geothermal purposes in Cody; therefore, there is no site data available. However, there is data available from the nearby DeMaris Hot Springs (Table 6). These springs may be associated with the system which would be tapped by drilling in Cody.

The Thermopolis district heating potential has been considered

TABLE 2
POPULATION TRENDS

TABLE 3

REGIONAL EMPLOYMENT AND ENERGY CONSUMPTION

<u>SIC</u>	<u>INDUSTRY</u>	<u>EMP.</u>	<u>MILLIONS OF BTU/CAPITA CONSUMPTION</u>	<u>MILLIONS OF BTU TOTAL</u>
0	Ag Services	28	.0309	.9
1	Mining	109	.927	101.0
13	Oil and Gas	813	6000	4,878,000.0
138	O & G Field Svcs.	266	.927	246.6
1452	Bentonite	239	5300	1,266,700.0
1	Contract Const.	373	3.0	1,119.0
15	Gen. Const.	110	3.0	330.0
17	Spec. Const.	109	3.0	327.0
2	Manufacturing	803	2.08	1,670.2
200	Food	54	100.0	5,400.0
2063	Beet Sugar	200	79.0	15,800.0
29	Petro. & Coal Prod.	200	3.0	600.0
4	Trans. & Util.	429	3.0	1,287.0
42	Trucking & Whsle.	121	1.0	121.0
4211	Trucking wio Storage	98	1.0	98.0
5	Wholesale Trade	397	28.0	11,116.0
508	Machinery & Equip.	28	28.0	784.0
5	Retail Trade	507	95.0	48,165.0
52	Bldg. Materials	164	100.0	16,400.0
53	General Mchdse.	125	95.0	11,875.0
54	Food Stores	105	100.0	10,500.0
541	Grocery Stores	4	100.0	400.0
55	Automotive Dealers	309	76.0	23,484.0
554	Gas Stations	152	100.0	15,200.0
56	Apparel Stores	46	20.0	920.0
58	Eating & Drinking	515	38.0	19,570.0
59	Misc. Stores	180	55.0	9,900.0
6	F.I.R.E.	377	95.0	35,815.0
7/8	Services	564	200.0	112,800.0
70	Hotels	233	270.0	62,910.0
72	Personal Services	63	200.0	12,600.0
80	Medical & Health	305	195.0	59,475.0
81	Legal	25	100.0	2,500.0
86	Non-Profit Org.	226	100.0	22,600.0
869	Non-Profit Org. NEC	140	100.0	14,000.0
89	Misc. Organizations	43	100.0	4,300.0
TOTALS		8460		6,667,104.7

TABLE 4

DRILLING AND DISTRIBUTION COSTS FOR DISTRICT HEATING
IN CODY OR THERMOPOLIS

Distribution		<u>\$2,000,000</u>
Drilling		
Wells	\$82,500	
Casing	<u>28,350</u>	
		110,850
Turbine Submersible Pump (2)	80,000	
Reinjection Pump (2)	36,000	
Recirculation Pump (2)	<u>32,000</u>	
		148,000
Resource to User Cost		\$2,258,850
Retrofit 20 Municipal Buildings		<u>200,000</u>
		\$2,458,850

TABLE 5

Estimated Cost Per MMBTU Delivered
Cody and/or Thermopolis (1978 Dollars)

Plant and Start Up	\$2,500,000
Cost of Financing \$2,500,000 for 25 years at 8%	788,619
Yearly Operations Cost of \$50,000 per year for 25 years	<u>1,250,000</u>
Total Estimated Cost	\$4,538,619

Total Estimated Cost \$4,538,619/25 years = \$181,545/year

Estimated Yearly Cost \$181,545/year x 1 year/55,000 MMBTU
Delivered - \$3.30/MMBTU

TABLE 6

DEMARIS HOT SPRING

Location: Sec. 3bc, T.52N., R102W.
Quadrangle: Cody
Temperature: 27-36°C.
County: Park
Ownership: Private; Kit Cody, Wyoming
Flow: 1700 GPM

Description: The site is two miles west of Cody, Wyoming, off U.S. highway 14-20. The area is approximately 75 yards long, near the river level, on the north bank of the Shoshone River. There are 7 vents with the likelihood of more issuing through the river bottom. Needle Hot Spring issues approximately 2 miles upstream from DeMaris; the site was covered by earth fill during construction of the present highway.

Geology: The DeMaris springs issue from the Permian Phosphoria Formation, an interbedded sequence of massive limestone beds and thin shaly layers. On the northeast limb of the Rattlesnake anticline the strata dip 16° off of the mountain. There are many fractures: the hottest spring flows from a crack 2 feet wide and 15 feet deep. Native sulphur can be found associated with travertine deposits at the spring site.

Socio-economics: Primarily used for recreational purposes.

Potential Uses: No use suggested. The springs, per se, are now abandoned, and the owner uses the access road to stage commercial float trips. A commercial pond, located on the terrace across from the springs, pumps 208 gpm from a 168 foot deep well.

Environment: On the Shoshone River, the area has significant travertine deposits and has produced an abundance of sulphur.

for years, but some problems are associated with its development. Hot Springs State Park in Thermopolis is the most famous thermal area in Wyoming outside of Yellowstone. Some of the springs in the area are part of the Park and based on original ownership restrictions cannot be developed except for recreational uses.

However, the privately owned wells in the Thermopolis area offer significant space heating potential. The three wells have been used to heat the homes and swimming pools of the owners in the past. If one were to apply a reasonable ΔT (amount of heat which can be extracted) such as 30°F., a significant space heating potential can be realized, as indicated in Table 7.

TABLE 7

<u>Well</u>	<u>Ownership</u>	<u>°F.</u> <u>Temp.</u>	<u>ΔT</u>	<u>BTU/hr</u>	<u>Flow</u> <u>gpm</u>	<u>Number*</u> <u>of Homes</u> <u>Heated</u>
Maytag	Private	129°	30	8,085,000	539	231
Sacajawea	Private	125°	30	18,300,000	1,220	523
McCarthy	Private	129°	30	8,745,000	583	250

*Estimated number of homes which could be heated by direct use given an area of approximately 100 square feet per home. No consideration has been given in the estimation for other contributing factors such as a distribution system, etc.

(Some information gathered from Breckenridge, 1978).

It seems likely that if reasonable district heating temperatures are encountered in drilling in the Thermopolis or Cody area that geothermal district heating will be a reality in the near future. When natural gas costs are compared with those of geothermal district heating by delivered BTU as in Table 8, it is clear that the future will bring geothermal energy use to the Big Horn Basin.

• Additional ADPs that will be completed in the coming months are:

- 1-B Fremont County
- 2-B Midwest Region
- 3-A Cheyenne Region

TABLE 8

COST COMPARISON FOR CODY AND/OR
THERMOPOLIS DISTRICT HEATING PER MM BTU

3.3 Site Specific Development Analysis

3.3.1 Candidate Geothermal Sites/Applications

(See Table 9)

3.3.2 Site Specific Development Analysis - In Preparation

Currently, the Wyoming Geothermal Commercialization Office (GCO) is developing a Site Specific Development Analysis for the Cody, Wyoming area. The City of Cody is located in Park County and in the Big Horn Basin area of Wyoming--the subject of a past GCO Area Development Plan. The geothermal resource is to be tapped at a location southwest of Cody on private lands.

Park County is not undergoing the energy growth which plagues many other areas in Wyoming. Therefore, population levels have shown consistent but not overwhelming growth. An historical population increase of 1.4% per year will probably continue indefinitely. Currently, Park County is experiencing more unemployment than most of the rest of Wyoming. But the Park County unemployment rate is still far lower than the national average.

The Cody economy is dominated by its proximity to Yellowstone Park. Tourist trade as a service industry is important to the local economy. Other important "export" industries are agriculture and mining. In fact, the local economy is dominated by the cash flows from government, agriculture, mining, and tourism.

Cody is central to a system of national parks and forests, particularly Yellowstone. Park County is dominated by federal land ownership. About 70% of the land area is federally owned; 20% is privately owned; and 10% is owned by state or local government.

At this time, the geothermal resource has not been described. Once the resource description is complete, site specific development potentials will be better understood.

The GCO is assisting a Cody resident to develop a geothermal powered alcohol extraction plant. The plant uses barley (a local agricultural product currently under transportation cost

TABLE 9

CANDIDATE SSDAs

Site	Proposed Application	Year Analysis Completed	Resource Data				Energy use data
			Surface Temp	Flow (gpm)	Reservoir Vol.	Surface Extent	
1. Cody	Agribusiness gasohol plant	1979	33°C (71°C)	1700	unknown	unknown	unavailable at this time
2. Cody	District Heating	1980	33°C (71°C)	1700	unknown	unknown	unavailable at this time
3. Thermopolis	District Heating	1980	56°C	2908	unknown	unknown	to be determined
4. Midwest	District Heating	1979	(100°C)	14,583	unknown	unknown	to be determined
5. Midwest	Industrial Park	1980	(100°C)	14,583	unknown	unknown	to be determined
6. Countryman Well	Greenhouse Operation	1979	38°C	500	unknown	unknown	to be determined
7. Saratoga	Phased District Heating	1980	48°C	120	unknown	unknown	to be determined
8. Auburn	Agribusiness gasohol plant	1980	62°C (100°C)	37	unknown	unknown	to be determined

() inferred temperature - an estimate

pressure) as the basic raw material. The barley is malted (as in beer making) and the alcohol is extracted. The alcohol is then mixed with gasoline to form gasohol.

The mix of gasoline and alcohol to make gasohol is in such demand that the developers have been approached by Sinclair Oil Company to sell their total production henceforth. The product will instead be marketed Wyoming-wide through local independent oil and gasoline jobbers. Rail transportation will be utilized wherever practical.

The gasohol/alcohol market is so good that the developers expect to recoup their initial investment in less than three years. The geothermal energy source enhances this investment potential. Financing for development is well along in the private sector.

At this time, the Cody gasohol developers have not begun the permitting process. GCO anticipates that permitting will be complete for the opening of the plant in two years. Fortunately, the technology needed for plant development is well known and no technological barriers are anticipated.

3.4 Time Phased Project Plans

3.4.1 Active Demonstration/Commercialization Projects

None have been funded.

3.4.2 Time Phased Project Plans

None.

3.5 State Aggregation of Prospective Geothermal Utilization

(See Tables 10 and 11)

3.6 Institutional Analysis

3.6.1 Overview of State Laws and Regulations

Development of geothermal resources in Wyoming is regulated by federal, state, and local regulations and agencies.

Because approximately half of Wyoming's lands are federally owned, federal leasing agencies play an important role in geothermal development. Primarily concerned are the U.S. Bureau of Land Management, the U.S. Forest Service, and the U.S. Park Service. The U.S. Geological Survey processes all applications.

TABLE 10

Thermal Energy on Line/year/ADP

Site	Type of Plan	Projected Energy Supply/Demand				
		1979	1980	1990	2000	2020
1-A Big Horn Basin		--	50 B11 BTU/yr	75 B11 BTU/yr	100 B11 BTU/yr	165 B11 BTU/yr
1-B Fremont County		--	25 "	40 "	60 "	100 "
2-A Sheridan		--	15 "	30 "	60 "	88 "
2-B Midwest		?	2,000 "	2,500 "	3,000 "	5,000 "
2-C Black Hills		--	15 "	30 "	40 "	50 "
3-A Cheyenne		--	--	5 "	10 "	10 "
3-B Laramie		--	15 "	30 "	45 "	60 "
4-A Sweetwater		--	--	--	5 "	10 "
4-B Bridger			15 "	30 "	50 "	75 "
5 Yellowstone	--	--	--	--	--	--
Total			335 "	2,740 "	3,370 "	5,558 "

TABLE 11

Thermal Energy on Line/year/SSDA

Site	Type of Plan	Projected Energy Supply/Demand			
		1980	1990	2000	2020
Cody Gasohol	SSDA	15 B11 BTU/yr	50 B11 BTU/yr	55 B11 BTU/yr	55 B11 BTU/yr
Cody District Heating	"	10 "	15 "	30 "	55 "
Thermopolis District Heating	"	25 "	25 "	50 "	55 "
Midwest District Heating	"	10 "	50 "	70 "	100 "
Midwest Industrial Park	"	200 "	1,450 "	2,930 "	4,900 "
Countryman Well	"	15 "	25 "	40 "	40 "
Saratoga District Heating	"	15 "	30 "	45 "	60 "
Auburn agribusiness Gasohol	"	10 "	50 "	60 "	75 "
Totals	"	300 "	1,695 "	3,210 "	5,340 "

The developer leases geothermal rights from the federal government but is additionally regulated by state and local agencies. Estimated timelines involved with obtaining permits from federal agencies range from 30 days to as much as eight years.

Most of the Wyoming laws which affect geothermal development apply only broadly to the developer. For instance, the Department of Environmental Quality regulates all environmentally affected activities in Wyoming. The State Engineer issues permits to drill all water wells, not only those with hot water.

Few Wyoming laws deal directly with geothermal development. Wyoming Statute 41-3-901, "Definition of 'underground water,'" reads "'underground water' means any water, including hot water or geothermal steam, under the surface of the land or the bed of any stream, lake, reservoir, or other body of surface water, including water that has been exposed to the surface by any excavation such as a pit." Another law requires the State Engineer to take any actions necessary to safeguard "geothermal springs." State agency requirements can involve timelines from one day to 18 months.

Proposed legislation has been developed by the Wyoming Geothermal Commercialization Office for introduction in the 1980 session of the Wyoming legislature. Primary concern is in six areas: definitions of geothermal, regulatory agencies, "grandfather" clause, delineation of small use or large use, bonding and taxation powers, and quality and quantity protection of Wyoming waters.

Local agencies and regulations in Wyoming become involved in development of geothermal resources according to local land use controls, i.e., zoning laws, building codes, and construction permits. Primarily involved are County Commissioners and City Councils. These two bodies generally delegate authority to such boards as the County Planning Commissions, County Boards of Adjustments, and City Planning Commissions. Of primary

concern to the developer of geothermal resources is the direction of development influenced or controlled by local politics and politicians. The timeline involved with local agencies and permits varies from a few days to several weeks.

3.7 Public Outreach Program

3.7.1 Outreach Mechanisms

- Existing

1. Regular contact with State and Federal Lawmakers regarding geothermal legislation.
2. Wyoming Energy Extension Service contacts through the 7 Regional Directors to the people of the state.
3. Incoming toll free telephone line on which anyone in the state can call the GCO free of charge.
4. University of Wyoming Communications Services which provides news coverage of all pertinent issues and arranges interviews on Radio and T.V. Also the service provides a service of arranging public talks to civic groups and schools, etc.

- Proposed

1. Newsletter to be circulated once per month to interested parties in the State.
2. More extensive acceptances of invitations to speak at civic clubs and schools.
3. Use of T.V. and Radio as is possible.
4. Development of an advisory committee whose members would come from government, industry, education, and the common citizen.

3.7.2 Summary Listing of Contacts and Results

<u>Contact</u>	<u>Interest</u>	<u>Affiliation</u>
1. Pam Abel Wyoming Energy Cons. Office	General	State Government
2. Fred Abel US DOE/RA	Wyo Resources	Fed. Government

<u>Contact</u>	<u>Interest</u>	<u>Affiliation</u>
3. Ed Bates U.S. DOE Region VIII	Appropriate Technology	Fed. Government
4. Gerald Brophy U.S. DOE/DGE	Resource Assessment	Fed. Government
5. Mr. Ken Bull USGS - Salt Lake City	Leasing and Permitting	Fed. Government
6. Karin Boutain Big Horn County Planner	ADP Progress	County Government
7. Charles Collins Wyoming DEQ	Regulations	Wyo. Government
8. Richard Cheney U.S. Congressman	Fed. Legis.	Fed. Government
9. Randy Wood Wyoming DEQ	Regulations	State Government
10. Walter Ackerman Wyoming DEQ	Regulations	State Government
11. Dr. Robert Dorn Wyoming DEQ	Regulations	State Government
12. Dolence and Frullo Rock Springs, WY	Architects	Consultants
13. Roger Elkins Hot Springs County Planner	PRDA interest	County Government
14. Al Galbraith Fish and Wildlife Service	Agriculture	U.S. Government
15. John T. Goodier Wyo. DEPAD	Industrial & Mineral Devel.	State Government
16. Richard Hartman State Planning Coordina- tor	Fed. & State Legis.	Office of Wyo. Governor
17. Dale Hoffman Geologist - DEPAD	Geo. Devel.	State Government

<u>Contact</u>	<u>Interest</u>	<u>Affiliation</u>
18. Fred Longyear Geo. Agribusiness	PRDA Appl.	Agribusiness
19. Richard McGuire Ecologist	Environmental Issues	Consultant
20. Tomas Turner Ecologist	Environmental Issues	Consultant
21. Dan Miller State Geologist	Geo. Devel.	State Government
22. Russell Miller Drilling Contractor	General Data	Industry
23. Marilyn Norman Town Manager	Financing Information	Local Government
24. Martin Nielson Rancher	Gasohol	Agribusiness
25. Alan Simpson U.S. Senator	Fed. Legis.	Fed. Government
26. Fred J. Sipe Town of Saratoga	Recreation Center Information	Local Government
27. Andrew Tarshis BLM	Leasing	Fed. Government
28. Malcolm Wallop U.S. Senator	Fed. Legis.	Fed. Government
29. Ken Wonstolen NCSL	State Legis.	NCSL
30. Larry Bouret Agriculture Planning and Development	State Legis.	State Government
31. John Niland DEPAD	State Legis.	State Government
32. George Christopoulos State Engineer	State Legis.	State Government
33. Earl M. Thomas Wyo. Fish and Game	State Legis.	State Government

<u>Contact</u>	<u>Interest</u>	<u>Affiliation</u>
34. Dr. Blaine Dinger Industrial Siting Admin.	State Legis.	State Government
35. Donald Basko Wyo. Oil & Gas Comm.	State Legis.	State Government
36. Oscar Swan Wyo. Public Lands Comm.	State Legis.	State Government
37. Esther Smith Institute of Energy and Environment	State Legis.	University
38. Steve Genz Conservation Commission	State Legis.	State Government
39. Lance Stewart Carbon County Planner	State Legis. & Saratoga	County Government
40. W. Don Nelson Department of Health & Social Services	State Legis.	State Government
41. Randall Wagner Wyo. Travel Commission	State Legis.	State Government
42. Public Service Comm.	State Legis.	State Government
43. Wyo. Community Devel. Authority	State Legis.	State Government
44. Robert "Terry" Martin Oil & Gas Association	State Legis.	Industry
45. Bob Cantine Wyo. Association of Municipalities	State Legis.	Municipalities
46. Doug Gibson Farm Bureau	Wyo. Legis.	Agriculture
47. Wyo. Coal Information Committees	Wyo. Legis.	Mining Industry
48. Jessie Baker Woolgrowers Assoc.	Wyo. Legis.	Agribusiness
49. Craig Thomas R.E.A.	Wyo. Legis.	Power Industry
50. Wyo. Real Estate Comm.	Wyo. Legis.	Business

<u>Contact</u>	<u>Interest</u>	<u>Affiliation</u>
51. Wyo. Geological Assoc.	Wyo. Legis.	Professional Assoc. Industry
52. Wyo. Chambers of Commerce	Wyo. Legis.	Business
53. Dean Prosser Wyo. Stockgrowers Association	Wyo. Legis.	Agriculture
54. Shiela Arnold Wyoming Senator	Wyo. Legis.	State Government
55. Mathilda Hansen Wyo. Representative	Wyo. Legis.	State Government
56. Bob Burnett Wyo. Representative	Wyo. Legis.	State Government
57. Dave Nicholas Wyoming Senator	State Legis.	State Government
58. Patti McMillan Wyo. Representative	State Legis.	State Government
59. T.A. Larson Wyo. Representative	State Legis.	State Government

3.7.3 Overall Prospectus for Future Geothermal Activity

During the last year the awareness of geothermal energy and its uses in Wyoming has greatly increased. The interest in developing it as an alternate has also increased. But there are problems with bringing a new energy alternative to an energy exporting state.

Geothermal energy brings with it the opportunity for new businesses such as agriculture and large scale greenhouse operations which were not possible with conventional systems. These industries can move in and establish themselves and last far beyond the current energy boom.

But there are significant obstacles to be overcome, state regulation and statutory development incentives are all but lacking in Wyoming today. With adequate legislative control and incentives there would be an ever increasing

3.7.3 Overall Prospectus for Future Geothermal Activity (Continued)

number of geothermal developers coming to Wyoming. The other major constraint is soon to disappear, that of cheaper competitive fuels. Coal, oil, natural gas and uranium are all exported from Wyoming. They currently help to make up the strong economy of the state. But even now as we have seen in the Big Horn Basin Area Development Plan geothermal energy for space heating is competitive with the costs of natural gas. Soon it will be less expensive in all areas and more and more homes will use it.

4.0 Summary of Major Findings

o Major or conclusive results are different to pinpoint as all of the planning activity performed by the GCO to date has been based on speculation. The resource assessment data has not been available and, therefore, the GCO has been severely limited in matching prospective geothermal energy applications. Allowing for the many assumptions made, the prospect for an important contribution from geothermal to the energy requirements of Wyoming is real.

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