Study of a Geothermal Space Heating and Domestic Hot Water Heating System at Holloman AFB, Alamogordo, NM

T. W. Lawford
EG&G Idaho, Inc.
Idaho Falls, ID

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Introduction and Summary

A brief study was made to evaluate the economics of a geothermal system for space heating and domestic hot water heating at Holloman Air Force Base near Alamogordo, NM. The study was based upon projected resource characteristics of 65°C (149°F) temperature water existing at 1 km (3200 ft) depth.[(1)] Using average production characteristics for geothermal wells in the United States, a single production well with a downhole pump would be expected to produce approximately 1000 gpm, sufficient to displace 90.6 x 10^6 CF of natural gas per year, while heating and supplying domestic hot water to approximately 40 buildings near the center of the base. The total geothermal system was estimated to have a capital cost of $4,240,700, which includes resource exploration, project feasibility studies, one production and one injection well, pumps, supply, injection, and distribution piping, heat exchangers, building retrofits and instruments and controls, as well as project indirect costs including a 10% contingency factor.

The payback period for this system is highly dependent upon the future escalation rates of the currently used fuel, natural gas. Recent rate increases have been large, and energy literature is projecting significant additional increases in the near future. One scenario, utilizing real escalation rates of 16%, 15%, and then continuing increases of 10% per year gives payback periods of 7.2 years (simple) and 9.4 years (7% discounted) for the geothermal system.

Area of Base Serviced

Initially, an area near the center of the base with a fairly high building density was selected in order to minimize distribution system costs. Specifically, this area was that bounded between West Sixth Street and West Fourth Street, and West Idaho Avenue and West Delaware Avenue. Nineteen buildings within this area were evaluated for heating loads. Twelve of these buildings are believed to be dormitories, one a gymnasium and one a dining hall, all of which have significant requirements for domestic hot water (DHW). The total heat load of all of these buildings, including DHW, was found to be less than one half of the expected capability of a single geothermal production well. The area serviced was therefore expanded to include approximately 20 additional buildings to the West, North and East. Heat loads were not specifically evaluated for these additional buildings, but are assumed to bring the total heat load up to approximately 95% of the projected production well capability. A new building, which serves as system distribution center and houses an isolation heat exchanger and distribution pumps, is assumed to be located in the open area Southeast of building 273.

Geothermal Supplying and Injection System

The production well is assumed to be capable of producing 1000 gpm of 149°F geothermal water via a lineshaft pump set in the well. The location of the production well is not defined but is assumed to be within one mile of the distribution center. Eight inch diameter insulated polybutylene pipe, buried in a two foot deep trench, is used to transmit the geothermal water from the production well to the distribution center. Polybutylene piping is relatively inexpensive to handle and install, is highly resistant to corrosion and scaling, and retains its pressure rating up to approximately 200°F. It has proven its serviceability in several geothermal district heating systems. The injection well is also assumed to be located within one mile of the distribution center, connected to it by buried, uninsulated polybutylene piping. The injection pump is located at the wellhead to minimize pressure loading on the injection piping. Both the production well and injection pump motors have variable speed drives to minimize electrical consumption during off peak operation.

Distribution Center

A distribution center is located immediately southeast of building 273. Here a plate type heat exchanger is used to isolate anticipated "dirty" geothermal water from inhibited clean water used to transmit heat to each of the buildings. Variable speed pumps are used to circulate the inhibited water through the distribution system. Pump speed is controlled on return water temperature. The building itself is anticipated to be a minimum cost pre-engineered steel building.

Distribution System

The distribution system also utilizes polybutylene piping. Both supply and return piping are layed in the same trench, which is routed to minimize crossings of streets and parking lots. The supply piping is insulated, while the return piping is not. Laterals run from the main piping trunklines to each building, and the trunklines are stepped down in size according to the maximum flow requirements of each line segment.

Building Retrofit

For simplicity of calculation, all buildings were assumed to have forced air heating systems. Heating system retrofit costs were based upon modification of existing ductwork to accept air handler coils and installation of additional valves and controls to regulate the geothermal flow to them. The Btu/h capacity of standard coils has been derated to account for the lower than standard water temperature supplied.

Cost of the DHW system retrofit is based upon solar hot water heating principles with a warm tank upstream of a hot tank. Recirculation flow from each tank is heated in series by the geothermally heated distribution water, using one heat exchanger for each tank. The heat exchangers are sized for a twelve hour recovery period. A typical 145 man dormitory uses two 1000 gallon tanks and two heat exchangers.

Indirect Costs

The exploration task, production well, injection well and production and injection pumps are considered Government Furnished Equipment (GFE). All other equipment and construction is subject to a 15% fee for contractor markup and construction management. Design of the system is estimated at $200,000 and a 10% contingency is applied to the total project, including GFE.

TABLE I

CAPITAL COST - INITIAL GEOTHERMAL SYSTEM FOR HOLLOMAN AFB

Resource Identification, Exploration and Project Feasibility	$ 752,000
Geothermal Supply System	
Production Well	596,200
Injection Well	248,400
Pumps	190,000
Wellhead Equipment	75,000
Supply & Injection Piping	296,500
Instruments & Controls	82,500
Subtotal Geothermal Supply System	$1,488,600
Distribution Center	
Building	$ 10,000
Heat Exchanger	132,400
Distribution Pumps	130,000
Piping inside building	20,000
Instruments & Controls	20,000
Subtotal Heat Exchanger Building	$ 312,400
Distribution System	
Distribution Piping	$ 205,000
Building Lateral Piping	53,000
Paving Tear-out and Replacement	28,000
Subtotal Distribution System	$ 286,000
Building Retrofit	
Space Heating	$ 349,500
Domestic Hot Water	238,800
Subtotal Building Retrofit	$ 588,300
Contractor Markup and Construction Management	$ 246,100
Design	200,000
Contingency	367,300
Project Total	$4,240,700

Project Economics

A breakdown of the project capital cost of \$4,240,700 is given in Table I, using 4th quarter 1982 dollars. Table II gives projected Operation and Maintenance costs for the goethermal system, excluding an operations crew, which is considered to consist of the same men currently operating the current individual systems. A yearly cost of \$130,700/year is projected. The geothermal system is expected to displace 90.6 x 10^6 CF of natural gas per year, currently costing approximately \$424,000. An additional savings of \$82,440/year for maintenance on existing heating systems is also anticipated.

The actual payback period of the proposed geothermal system is highly dependent upon future price escalation of the present fuel, natural gas. We have created one scenario, shown in Table III, with real escalation rates of 16% for 1983, 15% for 1984 and 10% per year for following years. This scenario gives a simple payback period of 7.2 years and a discounted payback period (at 7%)[2] of 9.4 years. Different assumptions of future escalation rates will, of course, yield different calculated payback periods.

Other Considerations

Factors other than pure economics should enter into a decision to construct a geothermal heating system. Among these factors is security of energy supply. Except for a small amount of electricity used to drive the system pumps, the energy source would be completely contained within the base boundaries, and hence nearly immune to interruptions from sabotage. The required electricity could be supplied by portable generators, if necessary. The system also saves a significant quantity of our nation's scarce hydrocarbon fuels. Perhaps the most important consideration from a base standpoint is a proposed Air Force policy which will limit base budgets for utilities to a fraction of the 1975 budget. This limitation will provide strong incentives for capital investment in conservation and alternate energy projects.

References: (1) Telecon - Dr. D. Foley, UURI to T. Lawford - 12/82
(2) The discount rate of 7% for federal projects was set by PL96-294.

TABLE II

HOLLOMAN AFB GEOTHERMAL SYSTEM O&M COSTS

Electrical Power	$ 54,700
Production Well Maintenance	20,000
Injection Well Maintenance	20,000
Piping Maintenance	11,500
Pump Maintenance	9,600
Building Equipment Maintenance	11,800
Instrument & Control Maintenance	3,100
Total O&M	$130,700

TABLE III

PROJECT ECONOMIC CALCULATIONS

HOLLOMAN AFB

	1982 $'S
SAVINGS	
-	0
NAT GAS	423960
OTHER	82440
TOTAL	506400
EXPENSES	
NAT GAS	0
ENERGY	0
OTHER	130700
TOTAL	130700
INITIAL INVESTMENT	4240700

02/03/83

HOLLOMAN AFB

	ENERGY @16&2% CUM ESC FACTOR	YEAR	SAVINGS	EXPENSES	NET REV
1	1.00	1983	506400	130700	375700
1	1.16	1984	574234	130700	443534
1	1.33	1985	648003	130700	517303
1	1.47	1986	704559	130700	573859
1	1.61	1987	766771	130700	636071
1	1.78	1988	835204	130700	704504
1	1.95	1989	910480	130700	779780
1	2.15	1990	993284	130700	862584
1	2.36	1991	1084369	130700	953669
1	2.60	1992	1184562	130700	1053862
1	2.86	1993	1294774	130700	1164074
1	3.15	1994	1416007	130700	1285307
1	3.46	1995	1549364	130700	1418664
1	3.81	1996	1696056	130700	1565356
1	4.19	1997	1857418	130700	1726718
1	4.61	1998	2034916	130700	1904216
1	5.07	1999	2230163	130700	2099463
1	5.57	2000	2444936	130700	2314236
1	6.13	2001	2681185	130700	2550485
1	6.74	2002	2941060	130700	2810360

NPV @ 7%= 6694124

NPV @ 7%	6694124
SIMPLE PAYBACK	7.24
D'CTD PAYBACK	9.40

EG&G Idaho, Inc.

FORM EG&G-561
(Rev. 1-77)

MEMO OF CONVERSATION

PERSON CALLING: J. M. Ramsthaler

REPRESENTING: EG&G

PERSON CALLED: John Barrutia

REPRESENTING: Mountain Home AFB

CITY:

DATE: 1/5/83

TIME:

PHONE NUMBER: 828-6344

SUBJECT: (1) Status Geothermal Proposal
(2) Organizational Responsibilities
John Green Tom White & Willis Barrow

DISTRIBUTION:
DiBello
Hilber
Domenico
Ranford
Lunis
(VORI) Duncan Roby

(1) John indicated the geothermal proposal was submitted to TAC/H.Q. about 2-3 weeks ago. He had not received a response but he was anticipating one soon. He suggested I call John Green at H.Q. to find out the status. I agreed to call J. Green and call him back.

(2) John Green Tom White and Willis Barrow were the three people from H.Q. who were at Mountain Home when we made the last geothermal presentation. John indicated they were all in the Utilities Operations Division and they had assumed responsibility for all energy work for TAC.

SIGNATURE

(CONTINUE ON REVERSE SIDE)

EG&G Idaho, Inc.

FORM EG&G-561
(Rev. 1-77)

MEMO OF CONVERSATION

PERSON CALLING: J. H. Ramsthaler DATE 1/18/83

REPRESENTING: TIME

PERSON CALLED: John Barrutia PHONE NUMBER 208-828-6344

REPRESENTING: Mountain Home AFB

CITY:

SUBJECT: Geothermal Project

DISTRIBUTION

DiBello	
Hilker	Domenico
Lawford	
Lunis	D. Foley (UURI)
Shane	

I called John to tell him the bad news from Washington (see Willis Barrow telecon). John was very disappointed and indicated he would follow up by calling Bob Green in Washington.

We discussed the potential for third party involvement at Mountain Home and I indicated the only potential was on the gunnery range. John indicated it would be no problem getting permission to build a power plant on the gunnery range if we could get third party interest. We agreed to the following:

(1) I would get UURI to recheck the probability of a power quality resource on the gunnery range.

(2) I would do some checking with Idaho Power on their interest in building a power plant if someone else developed the resource.

(3) Both John and myself would push TAC/HQ (Smith & Barrow) to fund phase #1 work as a basis for interesting a third party.

I subsequently called Duncan Foley and asked him to check into the potential for the gunnary range. Jon Zeisloft had previously said it had power quality potential. We also discussed Kingsly Field in Oregon. Willis Barrow had indicated there was a geothermal resource in the town adjacent to Kingsly.

John indicated Kingsly was a base the Air Force had tried to deactivate. Apparently because of general depression in Oregon, the Air Force is considering re-activating Kingsly as a base for over-the-horizon radar (an early warning system to replace the Dew Line). If it is about to be re-activated, it may be a good time to sell a geothermal system.

SIGNATURE [signature]

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