ECONOMICS OF ENERGY FROM GEOPRESSURED-GEOTHERMAL RESERVOIRS

O. C. Karkalits

McNeese State University

Lake Charles, LA 70609

ABSTRACT

Critical long-range (two-year) tests of Gulf Coast geopressured-geothermal reservoirs are scheduled to begin in 1981. If these tests demonstrate that the reservoirs can produce hot water for extended periods of time (15-20 years), then commercial exploitation of this resource could begin late in this decade. Since these geopressured reservoirs are much deeper than the hydrothermal reservoirs in the western states, more capital investment per well is required. This paper explores the boundaries within which commercial interest may be economically justified.

INTRODUCTION

Commercial exploitation of some of the hydrothermal reservoirs in western states of the U.S. has been successful for many years. In fact, commercial activity is being accelerated as the price of fossil fuels increases. By contrast, however, there has been no commercial attempt up to this time to exploit the geopressured-geothermal reservoirs of the Louisiana-Texas Gulf Coast. One reason is that the resource base has not yet been adequately explored. Another reason is that production wells are much deeper (and hence more costly) than in the western states. Until some long-term tests have been successfully demonstrated on at least one well to supply evidence of potentially long life, the resource will probably not be exploited commercially.

The principal purpose of this paper is to suggest the broad boundaries within which the resource might prove economically attractive to business investors.

STATUS OF RESOURCE DEVELOPMENT

The Department of Energy is currently pushing two programs for field evaluation of the geopressured-geothermal resource in the Gulf Coast. These programs are designated "Wells-of-Opportunity" and "Design Wells". The former is done in collaboration with an oil or gas operator who is about to abandon a well-site just drilled. Tests at these sites are usually short-term; about 10 - 20 days. The latter is done at sites carefully selected in advance which are presumed to be well-suited for geopressured-geothermal energy production over a long period of time; about 12 - 24 months.

The design wells are extremely important, for they will (if successful) give strong credence to the possibility of a 15 - 20 year reservoir life. The economics of the resource pretty well dictate a minimum of a 15 year life to attract industrial interest.

At least three design wells are due to come on stream for long-term tests during 1981. These are: (1) Sweet Lake No. 1 in Cameron Parish, Louisiana, (2) Pleasant Bayou No. 2 in Brazoria County, Texas, and (3) Sweezy No. 1 in Vermilion Parish, Louisiana.

ECONOMIC QUESTIONS

Until the probable lives of the geopressured-geothermal aquifers have been defined with reasonable limits, all attempts at economic study must be based on speculation about the probable life. Related technology from oil and gas production has made the following assumptions quite reasonable:

1. Drilling and completing wells into the geopressured zone is technically feasible.
2. Water production of 20,000 to 40,000 Barrels/Day can be expected.
3. Numerous aquifers of hot salt water do exist, containing dissolved natural gas essentially at saturation (1).

The following economic questions are addressed in this paper:

1. What are some reasonable boundaries for capital investment to realize satisfactory return on investment?

2. What range of consumer costs of energy can afford satisfactory return on investment?

It is well to point out that the resource is still insufficiently developed to warrant "sharp pencil" and highly refined economic study. Also it is worth noting that most of the prior studies have been done on the assumption that electrical power generation is the primary use for a given geothermal source. Typical of these is the study by Wilson et al.(2). A paper by Geer and Sharer was concerned with the economics of recovering the gas values only from the geopressured aquifers (4). This study is limited to non-electric applications, that is, low-level process heat, space heating and cooling, and similar applications, utilizing heat values from both gas and brine.

WHY NON-ELECTRIC APPLICATIONS ARE IMPORTANT TO GEOPRESSURED AQUIFERS

Preliminary field tests made by DOE to date have turned up very few aquifers with temperatures greater than 300 °F. The average temperature of geopressured aquifers in Louisiana between 10,000 and 20,000 feet is probably about 275 °F.

A "rule of thumb" breakpoint for generating electricity from geothermal fluids is about 300 °F minimum (3). Below 300 °F it is probably wise to forget electrical power generation and make plans to utilize the resource in non-electric applications, as is now being done extensively in Oregon, Idaho, and Nevada.

In general, temperatures increase in geopressured zones as one travels from the Mississippi River along the Gulf Coastline to the Mexican border. The deposits are older in South Texas than in the Mississippi Delta. Conversely, the permeability increases in the opposite direction. For this reason there are probably more sites of potential commercial interest in South Louisiana than in South Texas. The Louisiana aquifers will be more likely exploited by non-electric uses than by electrical power generation applications. If aquifers of sufficiently high permeability can be found in South Texas (i.e. greater than 100 millidarcies), it is probable that brine temperatures of about 350 °F can be located in some of those areas.

ASSUMPTIONS

The following assumptions were used as a basis for calculating sales revenue, operating costs, net income, cash flow, return on investment, and payout.

1. A geothermal site on dry land with 4 supply wells and 5 disposal wells.
2. Brine supply temperature is 270 °F.
3. Brine reject temperature is 130 °F.
4. Average brine flow is 30,000 B/D.
5. Average gas/water ratio is 30 SCF/Bbl. (No excess gas).
6. Life of supply wells is 18 years.
7. All sensible heat in the brine between 270 °F and 130 °F is utilized.
8. Value of energy in the brine is equal to the value of energy in the gas.
9. The supply wells produce from aquifers at 15,000 ft. depth.
10. The brine is disposed of in sands at 4000 ft. depth.
11. Density of brine is 8.8 lbs./gallon.
12. HHV of gas is 950 BTU/SCF.
13. Consumer price of heat energy is 1.45 times the well-head price.
14. Corporation tax on net income is 50%.
15. Severance tax on natural gas (well-head) is 10¢/1000 cubic feet.
16. Severance tax on sensible heat in brine (well-head) is 10¢/million BTU.
17. The venture acts as a seller of energy to customers.

RESULTS

Using the assumptions listed earlier, and the data from Tables 1, 2 and 3, return on investment can be calculated by well-known procedures. Payout is also calculated by standard procedures.

Figure 1 summarizes the after-tax return on investment (ROI) at values of energy in the range of 4 to 7 dollars per million BTU. The income, of course, includes the sale of both gas and brine heat. The consumer pays the same price for BTUs in either source. The parameter is capital investment in the range of 20 million to 40 million dollars.

Figure 2 summarizes the results of the calculations of payout for the same range of energy values and capital investment.

Based on the assumptions used here, the amount of heat energy in the hot brine is roughly twice as much as the heat energy in the dissolved natural gas.

CONCLUSIONS

1. For a total investment of 25 million dollars (base case), a 20% after-tax return on investment can be realized at energy values of $4.80 per million BTU, or higher.

2. Even if capital investment for the four-well plant is as high as 40 million dollars, the facility will show a payout in 5 years, or less, at all values of energy in excess of $5.00 per million BTU.

3. Entrepreneurs wishing to utilize the geopressured-geothermal resources of the Gulf Coast should probably think in terms of non-electric applications of the heat contained in the hot brine.

4. Assuming the brine is only saturated with natural gas (i.e., there is no excess gas above saturation), the geopressured-geothermal resource cannot be economically exploited if the brine is discarded and only the energy from the gas is utilized. This is true because there is roughly twice as much sensible heat energy in the brine as there is in the gas for typical aquifers.

REFERENCES

1. Karkalits, O.C. and Hankins, B.E., (1978). Chemical Analysis of Dissolved Natural Gas in Water from the World's First Geopressured Geothermal Well, Geothermal Resources Council, Transactions, Vol. 2, p. 351.

2. Wilson, J.S., Shepherd, B.P., and Kaufman,S. (1975). Economic Analysis of the Use of Texas Geopressured Geothermal Resources for the Production of Electrical Power, Proceedings First Geopressured Geothermal Energy Conference, p. 267.

3. DiPippo, Ronald, (1980). "Geothermal Energy as a Source of Electricity", DOE/RA/28320-1, p. 3.

4. Geer, E.C. and Sharer, J.C., (1980). Unconventional Geopressured Gas Recovery, Economics and Research, 7th Energy Technology Conference.

Table 1

BASE CASE CAPITAL, MILLIONS OF DOLLARS

4 Supply Wells at $5.6 MM each	$22.40
5 Disposal Wells at $0.25 MM each	1.25
Surface Separation Equipment	0.80
Brine Treating Equipment	0.55
Total Base Case Capital	$25.00

Table 2

FIXED COSTS

(Costs Unchanged by Sales or Capital)

Item	Dollars/Year
Direct Labor	600,000
Supervision	60,000
Payroll Burden (9%)	59,400
Laboratory	40,000
Utilities	22,000
Insurance	22,000
Office and Secretary	17,000
Travel Expenses	12,000
Sales and Administrative	200,000
Severance Tax	90,000
Total Annual Fixed Costs	$1,122,400

Table 3

VARIABLE COSTS

A. Tied to Capital
   1. Maintenance at 2.5% of capital investment
   2. Depreciation at 10% of capital investment

B. Tied to Sales Volume
   1. Royalty at 25% of well-head value (gas or brine)
   2. Well-head price of gas or brine is 69% of consumer price

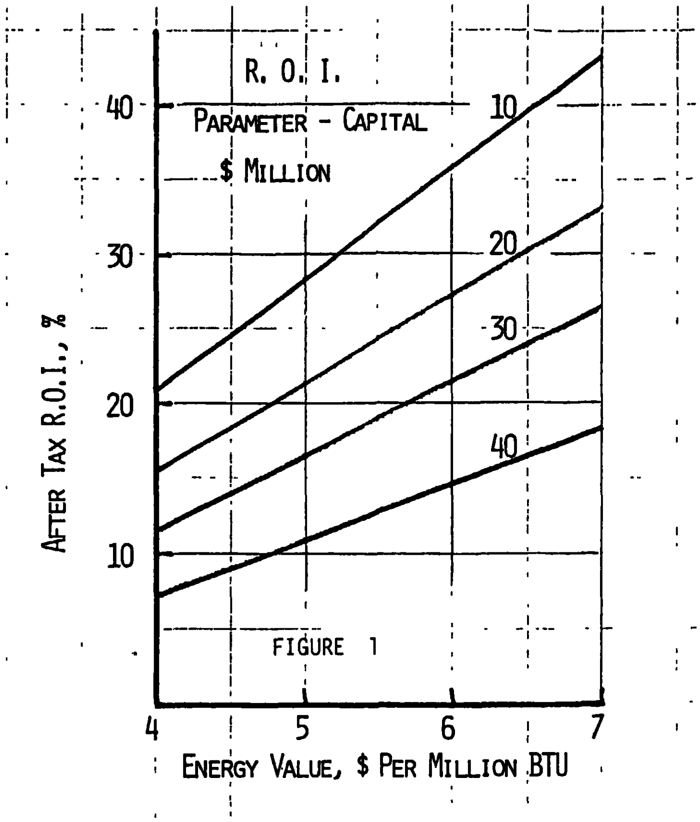

FIGURE 1

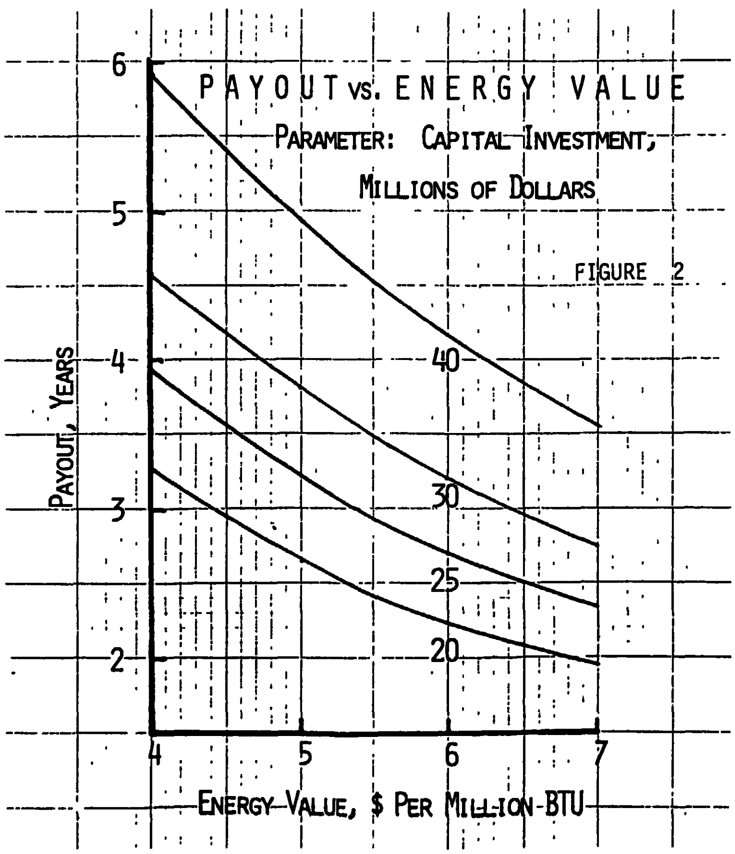

FIGURE 2