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SYSTEMS ANALYSIS OF THE TEXAS
GULF COAST GEOPRESSURED RESOURCES³¹

by

Dr. C. Dale Zinn

950 2459

Center for Energy Studies
The University of Texas at Austin

FINAL REPORT

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EXECUTIVE SUMMARY

This report describes the work performed by the Geothermal group within the Center for Energy Studies on the Texas Energy Advisory Council (TEAC) funded portion of the development planning scenario for the Gulf Coast Geothermal/Geopressured Resource.

An integral part of formulating a detailed development strategy was the determination of the prospective users of the resource. In addition, the issues concerning the resources as related to the users had to be identified as well as identifying any possible alternative methods for the commercial development of the resource.

The initial step in identifying the prospective users was to formulate a list of incentives to distribute to interested parties. Following the distribution of the possible incentives, a series of individual meetings between the geothermal team and prospective users were conducted to seek out the individual issues that concern the prospective users. The culmination of this phase of the project came on November 6, 1978 when a group discussion was held in Houston, Texas.

The most important immediate issues affecting the involvement of private industry in the development of geopressured resources are uncertainties regarding the physical characteristics of the resource. The most prominent of these factors are: 1) the size of the zone that is producible from a single well; 2) the sustainable production flow rates; and 3) the methane content of the fluids.

Until more information about these physical factors is available, private industry is not likely to be involved in commercialization activities. This type of information will have to come from a test well

drilling program which will probably have to be financed primarily by the federal government.

Regulatory and legal issues will have a considerable effect upon resource development if the physical characteristics appear to be promising. The most important of these are: 1) resource ownership; 2) allowable use of dissolved methane; 3) allowing multiple completion of production zones; and 4) regulation of the disposal of geopressed fluids.

Economic incentives that are most likely to encourage resource development are tax incentives that can be offered by the federal government. These include: 1) production tax credits; 2) expensing of intangible drilling costs; and 3) depletion allowance for geopressed methane and thermal energy.

The development planning portion of the work was accomplished after assimilation of the latest data concerning the Texas Gulf Coast Geothermal/Geopressed Resource. This information was principally obtained from the Texas Bureau of Economic Geology (BEG). The BEG reports identified thirteen potential Geothermal/Geopressed fairways in Texas. Eight of these fairways are located in the Wilcox Formation. The remaining five are in the Frio Formation.

The physical characteristics of the Wilcox Formation Fairways have not been adequately assessed at this time. The primary parameter missing in the early studies is the sandstones' permeability. If the permeability of the Wilcox Fairways approach that of the Brazoria Fairway in the Frio Formation, the Wilcox Fairways may be produceable.

The Frio Formation Fairways are located closer to the coast than the Wilcox Fairways. The Frio Fairways have been extensively studied,

with most of the attention given to the Brazoria Fairway southwest of Houston. The Brazoria Fairway is the site of the General Crude Oil/Department of Energy (GCO/DOE) Geothermal/Geopressured well. With the exception of the Brazoria Fairway, the physical characteristics of the Frio Fairways appear to be below the minimum criterion established for production. In particular, the permeability often ranges less than 5.0 md for the four fairways.

Computer codes have been created to evaluate the various fairways in both the Wilcox and Frio Formations based upon the latest available data. Using this data, all the fairways with the exception of Brazoria fail to satisfy production requirements. The Brazoria Fairway meets all production requirements and the fairway development has been outlined in a followup code. The accuracy of such planning scenarios is dependent on the validity of reservoir physical characteristics incorporated into the codes. When this information becomes available during the testing of the Brazoria well, it will be incorporated into the existing codes.

In conclusion, the various economic and regulatory factors controlling whether the Geothermal/Geopressured resource will become a viable source of energy are secondary to the question of whether the reservoir will be able to produce at all. Preliminary results indicate that only the Brazoria Fairway can meet the minimum physical requirements for production.

The detailed development plan and economic analysis is being prepared as a part of a report to the Division of Geothermal Energy of DOE. This plan will be forwarded to TEAC upon its completion which is estimated to be early fall 1979.

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The geopressured energy resources of the Texas Gulf Coast have been the subject of considerable research at The University of Texas since 1974. Because of the potential of these resources for making a significant contribution to the energy supply for the State of Texas and for the nation, a systems analysis for the development of these resources was initiated by the U.S. Department of Energy (DOE).

The overall objective of this systems analysis was to produce a coordinated plan for the development of these geopressured resources. An important part of this development planning activity was the determination of 1) who are the likely developers and users of this resource; 2) what issues are important to the industry, users, and governmental agencies that are involved; and 3) what are the viable alternative methods for commercial development of these resources.

In April 1978, the Center for Energy Studies (CES) of The University of Texas at Austin submitted a proposal to the Texas Energy Advisory Council (TEAC) for the support of this resource development planning work. The overall project was funded in the amount of \$50,000 by the TEAC and \$154,919 by DOE. The TEAC part of the project was directed toward the determination of those activities that could have a significant effect upon the commercial development of the Texas geopressured resources. This information was then to be factored into the overall development planning project which was being sponsored by DOE. The final product of these efforts is a detailed plan for the development of the Texas Gulf Coast geopressured resources.

This report describes the work accomplished by the Center for Energy Studies on the TEAC funded portion of the development planning

project. Specifically, emphasis was placed upon the determination of those factors that were most important to the likely developers, users, and regulators of the geopressed energy resources of Texas. This information was utilized in constructing the basic guidelines under which the alternative development plans were constructed. These detailed plans will be described in the final report to DOE which will be published in Fall 1979.

II. DETERMINATION OF INFORMATION AND ACTIVITIES NEEDED FOR DEVELOPMENT OF THE TEXAS GULF COAST GEOPRESSURED RESOURCES

The first step in determining those activities that were likely to have a significant impact upon geopressured resource development was the preparation of a list of possible incentives to be used in initial discussions. This list was compiled from the results of a previous planning study that was sponsored by DOE in 1977. This list was mailed to selected members of the oil and gas industry, electric utility industry, and state agencies during the late summer of 1978. A series of individual meetings was then conducted between this group and Dr. Zinn and Dr. Lesso of the CES research team. At the conclusion of these individual meetings, in early Fall 1978, the research team prepared a document summarizing the comments that had been obtained from these meetings. This summary was circulated to the contributors for their review. A group discussion meeting was held in Houston, Texas on November 6, 1978. This meeting produced a lively interchange of ideas regarding the development of the Texas geopressured resources.

Copies of the initial discussion list and the summary document mentioned earlier are included as Appendices C and D to this report.

III. PROCESSING, ANALYSIS, AND DISSEMINATION OF INFORMATION RELEVANT TO GEOPRESSURED RESOURCE DEVELOPMENT

Using the information obtained from the individual and group meetings described previously, a summary of incentive actions and possible problem areas that could affect geopressured resource development in Texas was compiled by the CES research group. This summary (Appendix D) was circulated to industry and governmental agencies for their review and comment.

The principal result of this activity was the determination that uncertainties regarding the physical characteristics of the geopressured resource are the principal deterrents to private industry participating in the commercial development of the geopressured resource. The most prominent of these physical factors are 1) the size of the reservoir that can be produced from a single well; 2) the production flow rates that can be sustained; and 3) the methane content of the geopressured fluids.

Some information describing these factors can be obtained from geological studies and laboratory investigations; however, the quality of information that is needed to attract direct industry participation probably can be obtained only by a test well drilling program. This type of program is expensive in terms of capital investment requirements, and risky in terms of the results that may be obtained. Therefore, it is the conclusion of the CES research group that private industry is extremely unlikely to participate in the initial test well drilling activity. This effort appears to be an appropriate function of the U.S. Department of Energy which is in fact conducting a drilling program in both Texas and Louisiana for the purpose of obtaining basic data describing the geopressured energy resource.

The test well program can be expected to have a significant impact upon the rate at which geopressured resource development will proceed. If the test results indicate that the resource has the physical characteristics, i.e., sufficient reservoir size, producibility, and methane content, that make commercial development attractive, then private industry is likely to become an active participant in resource evaluation and development activities.

If the geopressured resource does have attractive physical characteristics, then a variety of items that could have significant impact upon commercial development come into play. One of the most prominent of these items is the disposal of the geopressured fluids. Since these fluids are likely to be saline, approximately 20,000-60,000 ppm, disposal will probably have to be accomplished by subsurface injection. This situation could be troublesome from both a physical and regulatory point of view. Physically, acceptable disposal zones will have to be found in close geographical proximity to the production wells, or the spent fluids will have to be returned to the producing zones. If this deep reinjection is required, it will require a considerable amount of energy. From the regulatory standpoint, federal and state laws and regulations will influence the injection process. Because of this it is important to note that federal laws and regulations have been subject to severe changes which produce a great deal of uncertainty in the regulatory environment. As an illustration of this situation, it is possible that the Environmental Protection Agency (EPA) will impose requirements for the location of disposal facilities that will not be compatible with the physical realities of geopressured resource development. The Texas Railroad Commission and the Texas Department of Water Resources are the

Texas agencies that will be involved with this aspect of geopressured resource development.

The possibility that the production of geopressured fluids may cause subsidence is a major factor to be considered. At the present time there does not appear to be a clear consensus as to whether or not subsidence will occur when the geopressured fluids are removed from the production zones. Subsidence monitoring during the test well program should give some insights into the magnitude of this problem.

If subsidence does prove to be a substantial problem, then some form of protection for the potential resource developers and the property owners will probably be required. This may take the form of an "insurance policy" that is provided by the federal government.

The possibility that multiple completions of production zones in a single well may be required to achieve an effective total production volume is another regulatory matter for consideration by the Texas Railroad Commission. In general, for oil and gas wells, the rules of the Texas Railroad Commission allow for multi-completions but prohibit production from different horizons via a single production string. This factor has been discussed with the Commission staff and they have agreed to take this matter under consideration in future commission decisions.

The question of ownership of the geopressured/geothermal resource is a legal issue that may affect resource development. A clarification of this issue via an amendment to the Geothermal Resources Act has been discussed with the staff of the Texas Railroad Commission. A recommendation that this resource be classified as a part of the mineral estate was made law by the Texas legislature during the 1979 session.

The involvement of electrical utilities in geopressured resource development will likely be significantly influenced by regulatory factors. One of the most important of these relates to the use of natural gas as a boiler fuel. The Texas Railroad Commission had held in Docket 600, that the use of natural gas as a boiler fuel would be phased out. A motion was made to reconsider this situation, and during the Spring of 1979 this restriction on using natural gas as a boiler fuel was repealed. This could be a powerful incentive for the involvement of the electrical utilities and for large industrial co-generators.

An additional item affecting electric utility involvement with geopressured resource development is how the costs of geopressured wells and power plant equipment will be allowed to be treated. In general, power plant equipment is depreciated over a long time period while the cost of geopressured wells will likely be treated as a part of the fuel expense. This situation can be both good and bad from the point of view of the utilities and the consumer. Items that can be included in the utility's rate base such as power plant capital costs are generally desirable to the utility because of the long term revenue production. This may not be true in the case of geopressured resource development since uncertainties associated with the life of the resource tend to make an early pay back of capital investment desirable.

On the other hand, the cost of the geopressured production and disposal wells is likely to be a considerable part of the cost of the project. In this event, if the Texas Public Utility Commission allows this expense to be recovered quickly, this will also be a positive incentive for involvement by the electric utilities. This situation may not be too likely since public utility commissions generally tend to

classify costs so that recovery will be over a long period of time in order to create current rates that are as low as possible. The regulatory handling of reservoir drilling and production costs is likely to be a major factor in determining the future structure of the geopressured resource development industry.

IV.

SUMMARY OF ACTION ITEMS

This section summarizes those items that are most likely to have an impact on development of the geopressed resources of the Texas Gulf Coast and indicates those entities that will probably be directly involved.

Action Item 1

Complete drilling and testing of first geopressed test well currently being drilled in Brazoria County, Texas. Agencies involved: DOE, General Crude Oil Company, Texas Railroad Commission, University of Texas geothermal research team. The information obtained from this test well will have a direct influence on the degree of interest of a large segment of the potential commercial developers. If the test results indicate reasonably good values for reservoir volume, fluid production rate, and methane content, then interest on the part of the private sector can be expected to show a significant increase. However, if these initial test results are not favorable, then additional geopressed test well activity in the near future will probably be sponsored exclusively by the federal government.

Action Item 2

Presentation of testing results from first test well. Agencies involved: UT geothermal research team, USGS researchers, other DOE funded research projects. Note: a conference for this purpose is scheduled for Fall 1979.

Action Item 3

Arrange for drilling of additional test wells in Texas resource areas. Agencies involved: DOE, UT geothermal research team, Texas

Railroad Commission, Texas Department of Water Resources, General Land Office (depending upon location). Arrangements for drilling additional test wells can be somewhat complex. Locating sites that are geologically attractive and then obtaining the necessary drilling rights can be a time consuming process. Additionally, finding an operating company that is willing and able to contract with DOE for the drilling of a geopressured test well is not a trivial exercise.

Action Item 4

Resolution of the regulations required for subsurface disposal of used geopressured fluids and the allowable locations for facilities handling geopressured fluids. Agencies involved: Texas Railroad Commission, Texas Department of Water Resources, Federal Environmental Protection Agency, DOE. Proposed regulations by EPA regarding the classification of facilities handling geopressured fluids as hazardous materials handling facilities and a ban on the location of such facilities in wet land areas could pose a significant impediment to the commercial development of the geopressured resource. Since subsurface injection is the most probable method for disposal of the used geopressured fluids, this is a critical item to be resolved for commercial development to occur.

Action Item 5

Resolution of issue of ownership of geopressured resources. Agencies involved: Texas legislature, Texas and Federal Courts. During the Spring of 1979, the Texas legislature acted through an amendment to the Geothermal Resources Act to establish geothermal resources as a part of the mineral estate. This should be a useful development; however, it is certainly possible that in some specific cases a resolution of the ownership issue may have to be decided by the courts.

Action Item 6

Resolution of the allowable use of the methane issue. Agencies involved: DOE, U.S. Congress. The action of the Texas Railroad Commission to abandon the phaseout schedule and ban on the use of natural gas as a boiler fuel is likely to have a positive influence on the participation of the electric utilities and large industrial co-generators in geopressured resource development. A similar restriction on the use of natural gas is contained in federal energy legislation. Gas produced from geopressured brine from wells spudded prior to January 1, 1990 is currently excluded from classification as natural gas. The continuation of this situation should have a positive effect on the interest of private industry in the commercial development of the geopressured resource.

Action Item 7

Resolution of the situation concerning the recovery of geopressured energy development costs by the electric utility industry. Agencies involved: Texas Public Utility Commission.

Action Item 8

Resolution of the requirement that different producing horizons must be produced via separate conduits. Agency involved: Texas Railroad Commission. In the case of conventional oil and gas production, the Texas Railroad Commission has generally prohibited the production of separate horizons through the same conduit. Because of the nature of the geopressured formations and the requirement for high flow rates it will probably be necessary to produce fluid from more than one horizon through the same production string. If this is not allowed, then economical production rates may not be attainable.

The important items associated with the development of the geopressed energy resources appear to fall into three principal categories. These are 1) physical characteristics of the resource; 2) economic incentives; and 3) regulatory factors.

The physical characteristics that appear to be the most important are the size of the reservoir that can be drained by a single production well and the rate of production that can be sustained. Closely associated with these are the methane content of the fluids and the ability to dispose of the fluids by subsurface injection.

Determination of these physical characteristics requires an intensive research and development activity including a test well drilling program. Programs of this type are extremely costly and thus will likely require funding by the U.S. Government or from private sources such as the oil and gas industry.

Because of the dilute nature of this resource in terms of energy concentration, some form of economic incentives are likely to be required to promote development by private industry. Most of these incentives are likely to come in the form of tax provisions. Since the State of Texas does not impose an income tax on corporations, state tax incentives for geopressed resource development may have only a limited effect. Again, more direct forms of incentives such as research and development grants and matching funds for federal government programs may be an effective means for the State of Texas to encourage geopressed resource development.

On the other hand, a variety of tax incentives that could be offered by the federal government could prove to be effective in stimulating

private industry involvement in developing geopressured resources. Among these are: 1) investment tax credits for fuel plant and power plant equipment; 2) intangible drilling expense allowances; 3) depletion allowance for both geopressured methane and thermal energy; and 4) production tax credits.

In the regulatory environment, agencies of the State of Texas have a primary involvement. The Texas Railroad Commission through its regulatory authority over drilling and production is directly involved with geopressured resource development. In a similar fashion, the Texas Department of Water Resources, the Texas Public Utilities Commission, and the General Land Office may be involved through their permitting authority.

The federal government will probably continue to play the major role in research and development activities associated with the geopressured resources. Funding of test well drilling programs and other basic research activities will probably be provided primarily by DOE with some limited support from private industry. If these research and development activities indicate that further development of the resource is attractive, then commercialization activities will probably be carried out by private industry.

In summary, the State of Texas has a long history as a producer of energy. Its regulatory agencies have extensive experience in working with industry so that energy resource development is encouraged while the state and its citizens rights and welfare are protected. If there is no severe disturbance of this situation by federal government action, then the regulatory environment in Texas is such that geopressured energy resource development will not be hindered.

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APPENDIX A

LIKELY DEVELOPERS AND USERS OF GEOPRESSURED ENERGY RESOURCES

LIKELY DEVELOPERS AND USERS OF GEOPRESSURED ENERGY RESOURCES

In Texas, the geopressured resource is located along the Gulf Coast from approximately 150 miles inland to the near offshore. This fact coupled with the relative difficulty and expense of transporting the geopressured fluid means that direct use of the resource will likely be confined to the Gulf Coastal area. The transportable part of this energy source is created by transforming the thermal energy into electrical energy and by separating the methane gas from the fluids.

These factors together with the physical factors of resource exploration and production mean that the likely developers are probably limited to 1) the oil and gas industry, 2) the electric and natural gas utility industries, and 3) large industrial users of process heat and electricity. In the case of the electric utility industry and large industry, the users of the resource are most likely to be located in Texas. However, for gas utility customers, their location will depend upon governmental rulings affecting the markets into which the geopressured methane will be allowed to be sold.

APPENDIX B

ALTERNATIVE DEVELOPMENT METHODS

ALTERNATIVE DEVELOPMENT METHODS

At the present time, two methods for commercial development seem to be reasonable. These methods are highly dependent upon the location of the resource and the proximity of the producing reservoirs.

If individual reservoirs that are capable of sustaining a production rate of from 20,000 bbls to 40,000 bbls per day for 20 to 30 years are found in reasonable proximity to each other, then a central plant concept can be envisioned. In this sense, reasonable distance means well locations approximately 2 to 3 miles from a central plant site. This central plant would have an electrical generating capacity of approximately 25 to 50 MW and a gas production capacity of approximately 10,000,000 cubic feet per day. This situation would provide some benefit through the economies of scale in the construction of the electric generating and gas processing facilities. In addition, such a facility would probably be of sufficient size to attract a reasonably large industrial plant if the energy resource from the geopressed plant could be made available to it.

On the other hand, if individual reservoirs are not found to be reasonably close together, then a single well development concept will likely be required. In this event, a portable generating unit of approximately 5 MW capacity and a portable gas processing plant will be required. Because of the relatively small amount of energy per well, the utilization of the resource under this scheme will be very site specific. If such sites are located near to existing electric and gas transmission systems, then these products could be distributed fairly easily. However, if these sites are remotely located, then the effective use of these resources is much more difficult.

Other schemes for development of the geopressed resource have been considered. One of these schemes is to produce the fluids for the sole purpose of extracting the methane. Some of the problems associated with this method are: 1) energy conservation laws of the states of Texas and Louisiana, 2) approximately 50% of the energy content of the geopressed fluids is in the temperature and pressure of the fluids, and 3) the energy requirements of fluid disposal by reinjection will probably make this scheme uneconomical.

Another development method centers on the use of the thermal energy in the fluids to provide direct heating or process heat for industry. This is probably a viable alternative only in a few site specific cases. The economics of transporting the thermal energy seem to preclude this option unless the well location happens to be very near to an existing consumer. Also, the amount of thermal energy available from a single well, together with other transportation and logistics problems, makes it unlikely that an industry would relocate to be near the well site.

APPENDIX C

DISCUSSION LIST

LIST OF POSSIBLE INCENTIVES FOR
DEVELOPMENT OF GEOPRESSURED RESOURCES

Electric Utilities:

1. Guarantee by state utility regulatory agencies that cost of geothermal geopressured facilities can be included in the rate base.
2. Guarantee program backed by federal government that funds spent on geopressured exploration can be recovered either by special tax considerations or by alternative fuel allocations.
3. Special tax credits for investing in geothermal electric generating equipment.
4. Accelerated depreciation of geothermal electric generating equipment.
5. Allocation of a portion of the gas produced for the use of the electric utilities in existing gas fueled generating stations.
6. Research and Development Programs to be funded by federal government or by private research organizations such as EPRI or GRI.
 - A. Develop more efficient energy conversion equipment such as turbine generators and heat exchangers.
 - B. Develop high pressure gas separation equipment.
 - C. Develop efficient methods (including equipment) for reinjection of the geopressured fluids into either shallow or deep formations.

Oil and Gas Industry:

1. Establish a depletion allowance and intangible drilling expense write off system.
2. Deregulate the price of gas produced from geopressured resources.
3. DOE sponsorships of a test drilling program to determine resource information such as probable size of geopressured reservoirs.
4. Special tax credits based upon production of gas from geopressured resources.
5. Accelerated depreciation of gas processing plant and equipment.

Joint Ventures:

1. Geopressured Demonstration Plant sponsored jointly by DOE/Gulf Coast Utilities/Oil & Gas Industry/EPRI/GRI.
2. Special investment tax credits for developers of geopressured equipment and for purchasers of this equipment.

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APPENDIX D

SUMMARY DOCUMENT

SUMMARY OF COMMENTS AND OPINIONS ON
INCENTIVES TO THE DEVELOPMENT AND USE OF
GEOPRESSURE/GEOTHERMAL RESOURCES IN
THE STATE OF TEXAS

As part of the planning study for the development of geopressure/geothermal resources in Texas, a list of possible incentives to development and use were prepared (see attachment). These were sent mainly to members of the GP/GT advisory board for comment. Following this, representatives of the various organizations were visited and interviewed. After providing an overview and update on the project, these general questions were asked:

- a) Which incentive listed is most important to your organization?
- b) Which incentive(s) would you add to the list?
- c) At what point would your organization become active in the development and/or use of GP/GT?

The organizations visited were the electric utilities mainly along the Gulf coast, oil/gas producers, and pipe line companies.

The following represents a compilation and summary of the interviews as interpreted by the project team members. As such it does reflect their observations and opinions as to the position on this matter on the part of the organizations interviewed.

Utilities

An overall assessment of the attitude of the electric utilities is one of mild to extreme conservatism. They all said they would be willing to operate in any of three positions: a) drill the wells, produce the energy and generate electricity, b) buy the resources from a

producer (fuel supplier) and produce electricity, c) let others produce the resources, generate the electricity and they would just buy the power to put in their system. Initially, the last position was some what of the preferred one although they all had fuel producing subsidiaries.

One consideration in a utility being producer of GP/GT energy and generator of electricity is that the second part of this operation is under the jurisdiction of the State Public Utility Commission.. There is some concern as to what can be put into the rate base and at what cost the "fuel" part of the utility charges the "electric" part of the utility.

One utility expressed a willingness to try to produce electricity from even a single well (2 to 5MW) as a demonstration under the right conditions. The "bottom line" in all of our discussions was ECONOMICS. This attitude on the part of the utilities is understandable when one considers that they are a regulated monopoly. This puts them in a slightly schizophrenic position. The public is asking for reduced costs and expecting innovative approaches on the part of the utilities, yet by charter they are restricted to operate in a "safe, conservative" manner. They are not in the "risk venture" business as, for example, are the oil companies.

With regard to the incentives there was not clear consensus as to the most important. They felt the incentives would be good but they were not sure the use of GP/GT energy would be economically feasible.

The idea of joint ventures with the U.S. Government was not attractive unless the mix of funding was such that most of it was put up by the government. (A 50-50 partnership was viewed as one having all

the hassle of government rules and regulations, and interference, and costing twice what it would if the utilities did it alone).

The incentives of tax credits would mainly be attractive if they were tax rebates, i.e., a direct reduction of taxes. This was one of the unexpected factors brought out, which in retrospect, should have been expected. Many utilities have major building programs underway. As such, they are accumulating large investment tax credits. Therefore, reductions of taxable income are not of immediate benefit.

The incentive of having access to the dissolved methane as a boiler fuel was interesting, but not considered a major factor. Since the Texas Railroad Commission has issued Docket 600 directing the phasing out of natural gas as a boiler fuel, most of the utilities have established a multi-year plan to comply and these have now been underway for several years. Therefore, many existing plants are being converted or retired. It would allow for a stretching out of those plants which cannot be converted. However, this was viewed as an uncertain variable: will there be enough dissolved gas? how long will it last? will they be allowed to use it? would it be more valuable sold for another use? Some of the utilities still have favorable gas contracts so that the dissolved gas would not be economical at the present estimated costs to produce it.

The major "missing" incentive was: LESS RULES AND REGULATIONS. (Enough said).

The utilities and the producers all expressed a concern about the size of the reservoirs. Since this is a low quality energy source, there must be a sufficiently large reservoir per well (drainage area) to guarantee an economic life for the electrical generating plant.

(This could be as short as 15 years, to as much as 30 years. An estimate of the drainage value is between 0.2 and 1.0 cubic miles).

Some of the possible GP/GT formations may have many layers of producing zones. This may be a way to achieve an effective total volume, but would require multiple completions from a single well. In general, for oil and gas wells, the rules of the Texas Railroad Commission do not allow for multiple completions. This factor has been discussed with the Texas Railroad Commission, and they have agreed to study the matter in regard to geopressured/geothermal reservoirs.

Another potential obstacle to the utilities, producers, and transmission companies is the question of how to obtain the "right-of-way" for the GP/GT pipelines from the wells to the generating facilities. Would the present condemnation procedures apply? Other legal problems concern who owns the resource, the land estate or the mineral estate? Would existing oil and gas leases automatically include GP/GT? Since large drainage areas are required, will there be special unitization rules established? These questions are also in the domain of the Railroad Commission.

Another concern of the utilities is the size of the electrical generating plants. Our preliminary analysis suggests that a typical installation would have three to six wells tied together to produce 25 to 50 MW. Because of well spacing, this is about the limit of transport without excessive heat and pressure loss. The well spacing in turn, is dictated by the required drainage area. Also, there is a requirement that the wells flow continuously, making the electric generating plant essentially a base load plant. Normally only large size plants, 350 MW

and larger are used as base load, because of the economics of scale. The use of plants one-tenth this size may result in a cost penalty.

Also, the size of the utilities with regard to generating capacity and service area will influence the interest in GP/GT. A large load, compact metropolitan area is less likely to use this resource than smaller, large rural area utilities. In the latter case, with a large transmitting network, there may be side advantages in having small "lumps" of capacity through the service area. This would reduce line losses and provide more system stability.

In summary, the general position of the utilities with regard to GP/GT can best be classified as "guarded." They do not anticipate any active involvement until more information on formation properties is obtained. Current economic analysis is such that the uncertainties make them feel that this energy source is too risky.

Oil and Gas Industry

The exploration and production components of the oil and gas industry have extensive experience in "risk venture" business. The general response of this segment of the industry was that while incentives such as deregulated gas prices, allowance of intangible drilling costs as expense items for federal income tax purposes, and production tax credits were interesting, these items could not be considered sufficient to stimulate active development of the geopressed resource. The primary reasons given for this are the uncertainty that exists as to the size of a geopressed zone that can be produced from a single well bore, and the gas content of the geopressed fluids. The effect of salinity on the gas content of these fluids appears to be an item of considerable concern.

The current DOE test well program and laboratory research on the effect of salinity on dissolved gas content should provide useful insights into these two factors. When more information of this type is available, then the economic incentive would become more important in terms of making geopressed development projects competitive with other projects that are available for investment by the oil and gas industry.

The oil/gas producers also feel they have more than enough other prospects for their investment dollars. To them GP/GT is a low quality energy fuel and the effort to extract it may not be worth the cost.

Market sources also may present problems to the development of the resource. GP/GT cannot be stored once extracted (except for the dissolved gas). Its use to generate electricity was also questioned. As one person stated, "Don't the utilities now dump hot water at 350°F from current steam turbines?"

There was a consensus that the proper government role was to drill the first few exploratory wells, determine reservoir size and properties and in general reduce the zone of uncertainty about this resource.

Transmission Pipe Line Companies

The gas transmission phase of the business is related to the electric utility industry in that it is a regulated industry. One of the production incentives on the list, deregulation of the well head price of gas produced from geopressed aquifers, could have an effect on the desirability of acquiring this gas by a gas transmission company. This could occur if regulatory agencies require that incremental rather than average pricing rules be applied to gas that is sold by the transmission company. Another factor of significant interest to the gas transmission industry is what portion of their involvement in the development of

geopressured gas supplies will be allowed to be included in their rate base. Past experience with rulings of regulatory agencies has left them somewhat uncertain and concerned as to the effect of their involvement in projects that are not strictly within their normal operations routine.

Texas Railroad Commission

As mentioned previously, several issues were raised that are under the jurisdiction of the Texas Railroad Commission. These were discussed with the chairman of the commission and he requested that we formally ask the commission in writing to take these issues under consideration. This has been done. These issues are: use of GP/GT gas as a boiler fuel and multiple completion from a single well.

State of Louisiana Study

At the completion of this round of interviews and discussions, we met with our counterparts in Louisiana to exchange information on what we had found. The Louisiana group will try to interview some of their contacts in the petro-chemical industry to see what their interest is. Also, they are developing an economic evaluation model incorporating risk. We plan to extend our planning models to include more details and perform sensitivity analysis. The Louisiana group plans to hold a meeting in early October to consider the legal aspects of the GP/GT resources. We plan to hold an early November meeting of all interested parties.

An interesting idea was brought up in our discussions. There may be some benefit in developing a simple sequential decision making model (stochastic decision tree) to determine the probable consequences of proceeding (and to what step) or stopping the effort, based on each successive result obtained.

In summary, a wide range of interest in the geopressed energy resource was exhibited by all participants. However, to some degree, all participants expressed that a lack of knowledge about key physical parameters of the resource, i.e., reservoir volume, recoverability, gas content, were primary factors that were inhibiting their direct participation in the development of these resources.