GEOTHERMAL RESERVOIR INSURANCE PROGRAM: EVALUATION OF ALTERNATIVES AND ASSESSMENT OF NEEDS

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A significant part of a recent workshop sponsored by the Electric Power Research Institute (EPRI 1978) was devoted to the question of the risks of geothermal development and the need for a geothermal reservoir insurance program. In this workshop, several viewpoints regarding the adequacy of the available measures for reducing financial risks to the developers and users of geothermal energy were discussed. The main point of agreement among the authors was the existence of risk in geothermal development, and that some method for reducing the financial risks to the developers and users of geothermal energy was necessary for accelerated development of this resource.

Several schemes were suggested to reduce the financial risks to the users of geothermal energy and the financial institutions responsible for extending loans for geothermal industrial projects.

The suggested schemes included the following (Aidlin 1978; Falick 1978):

- contractual arrangements between the resource company and the user that would place the risk of reservoir loss on the supplier, or apportions the risk between the supplier and user
- enactment of state legislation that would require regulatory agencies such as the Public Utilities Commission (PUC) to treat, for tariff base purposes, the first power plant as an R&D facility eligible for accelerated depreciation
- construction of "turn-key" power plants built by companies willing to assume financial risk in exchange for a guaranteed rate of return generated through the sale of electricity to utilities
- use of the existing Geothermal Loan Guarantee Program that allows a participating utility to repay the debt through government assistance
- encouragement of private industry to provide coverage for the risks of geothermal development.

Each of these suggested methods has its advantages and disadvantages and each covers risks to certain users with the possible exclusion of others, resulting in different groups having widely divergent views on the relative attractiveness and feasibility of one scheme versus another.

In addition, each scheme is accompanied by either direct or indirect costs to the potential end user whose views would be represented either by public interest groups or regulatory agencies mandated with protecting the public interest, and each is accompanied by a multitude of direct and indirect implications which are not totally known at this time.

In view of the inadequacies of the above schemes and uncertainties regarding their effectiveness in providing the necessary incentives for an accelerated pace of development, recent legislation (U.S. Congressional Record, 1979) directs the Department of Energy to consider initiating a government-sponsored insurance program that would supplement the policies that may be offered by the private insurance industry.

In this paper we present some thoughts on a study that would help in laying the groundwork for drafting regulations for the geothermal reservoir insurance program. The objectives of this study would be

1) to assess the likelihood and the financial consequences of premature depletion of reservoirs

2) to evaluate the advantages and shortcomings of alternative schemes for reducing the financial risks of geothermal development

3) to assess the need for government-sponsored reservoir insurance programs, and

4) to delineate the areas and conditions under which a reservoir insurance program would be most useful in promoting national goals.

In view of the importance of the government-funded reservoir insurance program and the complex nature of the problem, four issues must be considered in defining the scope and objectives of this study. First, the goals and expectations of the government must be specifically defined and a procedure be developed to allow for measuring the achievement of these goals. Second, the reservoir-related risk should be assessed and a framework should be developed for resolution of differences among the views expressed by segments of the industry on the likelihood of premature reservoir depletion and the financial consequences of such events. Third, given the diversity of opinion among interest groups, it is important that the viewpoints of various segments of industry and the public be sought and incorporated into the study. Fourth, the study should avoid recommending a policy that would be "optimal" from an overall point of view yet would involve so many compromises that no group would consider it beneficial. With these points in mind, we propose the following four steps.

DEFINING THE GOALS OF THE GEOTHERMAL DEVELOPMENT PROGRAM

An important first step is defining the specific short-term and long-term goals of the geothermal development program. A series of attributes (measures) should be defined to serve as proxies for those goals, and proper scales should be constructed to measure the level of achievement of the objectives of the program.

The development of objectives and the measure of their achievement can be accomplished by:

- establishing general objectives
- breaking the general objectives into subobjectives
- establishing measures to define the level of achievement of the subobjectives.

The most direct means for generating objectives are a careful study of policy documents and dialogues with decision makers who often act on their perceptions of society's needs and the affected parties.

Measures can often be structured in a meaningful way by use of a hierarchy. A hierarchy provides a means for subdividing a general objective into lower level measures of more detail. These lower level measures are in turn subdivided into more detailed measures until a level of detail is reached such that the lowest level of the hierarchy consists of specific, well-defined measures that can be reasonably quantified.

Use of a hierarchy ensures that the final set of measures will be comprehensive and complete. It also assists in quantifying the effects of uncertainty in lower-level measures on the overall program goals.

ASSESSING THE RISK OF PREMATURE RESERVOIR DEPLETION

The objectives of this step are (1) to assess the likelihood of premature depletion of several reservoirs for which adequate information is available (under different production scenarios), and (2) to estimate the financial consequences of such failures.

The characteristics of reservoirs and brine, and their spatial and temporal variations, have a significant effect on the reliability of the resource. Since a power plant or other facilities using geothermal energy may become inoperable if the pressure and temperature of the heat source and the flow rate drop below certain levels, the likelihood and magnitude of decline of these parameters over time and the variation of the physical parameters over space should be estimated.

Important physical parameters, including storability, transmissivity, and the location of the producing fracture, can be estimated by well logging and well tests.

In estimating the appropriate flow rate (when the fluid is reinjected), it is important to estimate the "breakthrough" time rather than the rate of decline of temperature after breakthrough when the user facility is a power plant.

To estimate variations of the fluid characteristics over time, one or more of the available dynamic reservoir models can be used to predict reservoir behavior as a function of its physical parameters and flow rate. Once the model(s) that best describes the reservoir has been selected, the probability distribution over breakthrough time can be estimated.

The probability distribution over the input parameters can be assessed (see Tversky and Kahneman, 1974, for a treatise on several probability assessment procedures), and for each production scenario, a combination of input parameters will give a point on the distribution of the output parameter.

Different failure times have different economic consequences which can be computed by standard cost accounting methods and can include penalties for loss of goodwill, etc. Combining the economic model with the failure probability model completes the risk analysis.

This analysis will serve three purposes: (1) it provides examples of the levels of risk involved in geothermal development; (2) it gives a procedure for reservoir risk assessment that can be used as a framework for risk assignment by the insurance industry and financial community; and (3) it can help resolve different viewpoints among segments of industry on issues related to reservoir risk, the relationship between reservoir failure and production policy.

EVALUATING ALTERNATIVE SCHEMES

This step involves a detailed analysis of various options available to developers and users of geothermal energy. The objective of this task is to evaluate not only existing options, but also the feasibility of alternative measures to reduce the risks of geothermal energy.

In addition to evaluating programs offered by the insurance industry, this step involves an analysis of the limitations, scope, and potential of the Geothermal Loan Guarantee Program. The analysis will incorporate the experience of the banking industry with that program. This step also includes an analysis of the differences between geothermal energy and other segments of the extraction industry from the viewpoint of the banking industry to account for the reluctance of bankers to extend loans to the developers of geothermal energy. One possible explanation for this reluctance is the uncertainty associated with estimations of proven reserves of geothermal reservoirs (Manderbach, 1978). However, it is important that this issue be systematically addressed.

It has been suggested that contracts between the developers and users of geothermal energy be designed in such a way that financial risks on the part of the users are reduced (Aidlin, 1978). Since this scheme still proposes that a portion of the risks be accepted by the utilities, the desirability of such a scheme from the viewpoint of the utility industry should be investigated. The confidence of the utility industry in the guarantees extended by smaller resource companies should be also evaluated.

A series of interviews with regulatory agencies can help ascertain the feasibility of suggested schemes such as allowing utility companies to recover plant costs through the rate structure by accelerated depreciation of power plants.

ACHIEVING CONSENSUS AND RECOMMENDING GUIDELINES

The objective of this step is to lay the groundwork for drafting regulations by determining the extent and mode of government involvement

that would best achieve national energy goals. The success of such a program would hinge on its ability to reflect not only national energy policy, but also the interests of the industries that would be directly affected by the reservoir insurance program. Moreover, associated issues such as the necessity of additional government personnel and the safeguards required for implementation of the program should be carefully assessed, and the advantages and disadvantages of the program regarding incentives for private industry should be evaluated.

A wide gap separates the viewpoints of interested parties at this time. An objective of this task is to facilitate the exchange of information among interested industries to achieve a common understanding regarding the extent of government involvement that would best achieve national goals without creating a huge bureaucracy or complex and unenforceable regulations. To achieve these objectives we suggest the following procedure:

1. Dissemination of a document summarizing the findings of the first three steps. Comments by recipients of the document be incorporated in a revised version, and the differences of viewpoint be outlined.

2. A smaller group, including experts in government, banking and insurance industries, public interest groups, and developers and users of geothermal energy, be selected for receipt of the revised document. The viewpoints and judgments of this group on the issues discussed in the document, as well as on the existing gap between the needed risk-reducing measures and the available programs be aggregated.

   The aggregation procedure can rely on one or several of the following techniques: (1) a dialectic forum for discussion of issues, (2) a procedure that would rely mainly on questionnaires such as the Delphi technique (3) the MAPS Design Technology (Multivariate Analysis, Participation, and Structure) that clusters ideas and issues in a form suitable for a strategic planning design, and (4) multiattribute decision analysis techniques (Keeney and Raiffa, 1976), by which the preferences and values of the differing groups will be assessed.

   The objective of this subtask is not to achieve a consensus, but to clarify issues and viewpoints and to bring the viewpoints of the different sectors closer to each other. An attempt should be made, however (through smaller groups if necessary), to achieve a consensus among the representatives of the same industry.

3. In this step, a smaller group would be invited to a panel discussion to resolve the differences in viewpoints, if any, and to arrive at a consensus on the gaps between the needed programs and existing alternatives, and the most fruitful means of government involvement for bridging this gap.

The end result of this task will be a series of recommendations to the DOE that would serve as the framework for the geothermal reservoir insurance program.

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