ALTERNATE ENERGY INVESTMENT DECISION MODELLING: THE CASE OF GEOPRESSURED-GEOTHERMAL INVESTMENT DECISIONS

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ABSTRACT

This decision modelling project utilizes multiattribute utility theory to capture both the economic and non-economic criteria potential geopressured-geothermal resource developers utilize to reach a decision to participate, or not, in a venture such as geopressured-geothermal development. Knowledge from this work will be utilized in conjunction with a geopressured-geothermal economic model to determine effects of various incentive schemes proposed to expedite the development of the geopressured-geothermal resource along the Texas-Louisiana Gulf Coast. This study is a portion of an on-going DOE sponsored geopressured-geothermal research program at the Center for Energy Studies at the University of Texas at Austin.

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INTRODUCTION

The expedited development of the geopressured-geothermal resource along the Texas-Louisiana Gulf Coast is one of the goals of the Department of Energy's (DOE) policy of increased reliance on domestic energy resources. The government's role in encouraging this development as promulgated through legislation such as the geothermal loan guaranty program has thus far not been entirely successful. Recent work done by Frederick, et. al., [1], examined the inter-play between various types of government incentives to the geopressured-geothermal energy development, the pace of that development and types of parties which might become involved. This current work, based upon the findings of Frederick, et. al., delves into the decision-making processes a firm uses to capture both the economic and non-economic criteria utilized to reach a decision to participate in ventures such as geopressured-geothermal development.

This on-going program is divided into two general work areas. In one area researchers are building an economic model which will utilize distributions of information as inputs and will in turn generate distributions of outputs, which represent ranges within which companies are thought to make their venture decisions on an economic basis.

The second research area, called the decision modelling project, which is the specific concern of this paper, deals with the non-economic factors and criteria that company decision-makers utilize in conjunction with economic data in the decision-making process.

The decision modelling project was designed as part of this DOE sponsored research program to identify investment decision criteria which will then be utilized to determine the effects of various incentive schemes. Recognizing that economic factors are usually the only ones incorporated into decision models, this project focuses on including the qualitative factors which shape investment decision behavior. The decision analysis includes: 1) investigation of the decision-making process, i.e., describing the decision-making process in the organization for projects such as geopressured-geothermal, determining the stages and flows of this process, identifying the information which is considered; 2) identification of decision factors, their respective threshold levels, ranges and relative importance.

Since interest in geopressured-geothermal is not limited to one industry, the project was designed to be sensitive to the differences among industries. Toward that end three distinct groups were invited to participate in the study: public and privately owned electric utility companies, energy producers, and gas pipeline companies.

METHODOLOGY

The methodology is a blend of qualitative and quantitative techniques. Group discussions and interviews with representative decision-makers provide information relevant to (1) above. Techniques to identify and model the decision-making behavior (2) include the use of relevance trees and assessment of multi-attribute utility functions. Two relevance trees were developed to insure the flexibility needed to accomodate the differences among industry groups. The initial relevance tree factors were determined from information gained in earlier research. These factors were expanded and refined after conferring with industry experts from academia and the business sector. Figure 1 is the relevance tree for the utilities group; figure 2 is the

ELECTRIC UTILITIES

INVESTMENT DECISION-MAKING RELEVANCE TREE

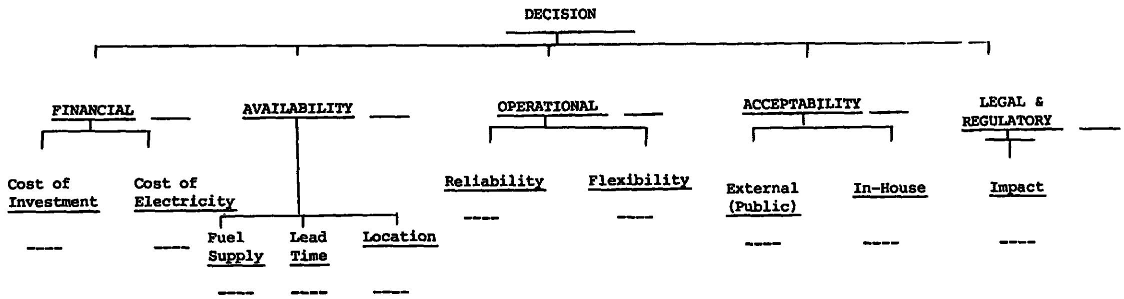

Figure 1

tree for the producers and pipeline groups. Although the same five main branches appear on each tree, they have different characteristics. Under the financial factor, Return On Investment (ROI) is a sufficient measure of the efficiency of investment capital for producers and pipeline companies. However, the utilities, due largely to regulatory considerations, are sensitive to two sub-components, cost of investment and cost of electricity. The availability factor is also operationalized differently, with utilities showing concern for fuel supply and lead time in addition to site location. A third example, of the different perspectives among industry groups is the operational factor. The utilities' mandate to provide uninterrupted continuous service requires a reliable and flexible source of energy. The other industries are not under that mandate and are more concerned with flow characteristics and technological reliability.

Attributes from the relevance trees are then used in the assessment of multiattribute utility functions. Efforts to quantify the preferences of investors were based on recent multiattribute utility theory [2, 3, 4].

The choice of the form of the multiattribute utility function requires testing for mutual preference independence and utility independence. After verifying mutual preference independence and establishing utility independence for the one necessary factor, lottery questions are used to determine whether the additive or multiplicative form of the multiattribute utility function is appropriate. For each industry representative conditional utility functions for individual factors are assessed with either the lottery or direct assessment methods. The results of a series of trade-off questions are then used to determine the scaling constants. With this

PRODUCERS AND PIPELINES

INVESTMENT DECISION-MAKING RELEVANCE TREE

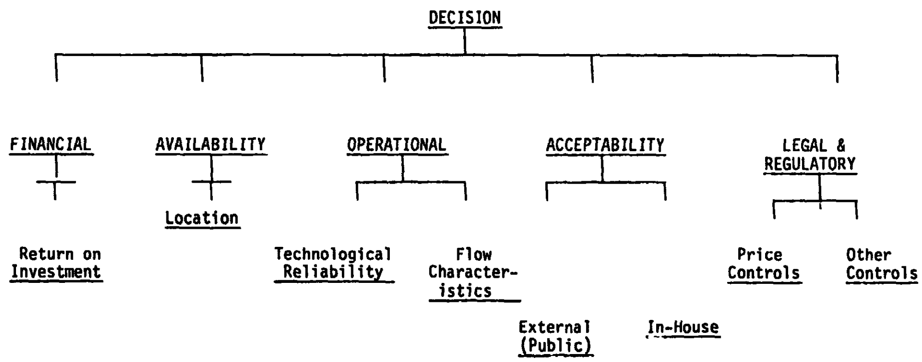

Figure 2

information a multiattribute utility function is developed in the form:

$$u(x_i) = \sum_{i=1}^{n} k_i\ u_i\ (x_i) \qquad (1)$$

or

$$1 + ku(x_i) = \pi\ (1 + kk_i u_i(x_i)) \qquad (2)$$

where u_i represents the conditional utility of an individual factor; k_i, the scaling constant of an individual factor; and k, another scaling constant found from the value of the k_i's.

PRELIMINARY RESULTS

At the first meeting five electric utility companies were represented by individuals who were all principally involved with traditional power systems planning. During this initial meeting a number of points concerning investments in integrated geopressured-geothermal energy sources became clear.

The utility representatives are purchasers of technology, not developers. They view geopressured-geothermal as currently being in the technological development stage. Hence, while they were aware of geopressured-geothermal, they had not formally considered it as an alternative. Statements were made by the representatives to the effect that they would consider geopressured-geothermal when it became "viable". They defined viable as some point where reservoir and technological questions are largely answered.

Representatives also noted that when an investment alternative is deemed viable, needed and attractive by a technical unit, it is advanced as a recommendation to a final decision stage with the company's directors.

During the course of the meeting the discussion was expanded to include the potential use of the geopressured-geothermal resource as a source of methane for current methane burning generating facilities. However, the opinion expressed was that the current environment is not conducive to developing the resource solely for methane extraction.

The development of the decision models for the individual utility representatives was initiated by soliciting agreement on the factors in the relevance tree (Figure 1) and each factor's range. After a period of discussion, the concensus of the representatives was that the factors adequately and completely represented the types of information considered in their investment decisions. Moreover, they also agreed that the pre-selected ranges were satisfactory. The tests of the independence conditions established that the additive form of the multiattribute utility function was appropriate.

The conditional utility curves assessed for each representative showed that on some factors the different electric utilities had widely differing risk preferences. This was most notable on the financial factors (cost of investment and cost of electricity).

The analysis to determine the most important factors and critical ranges of each factor for the electric utility representatives is underway. This work, plus that from the remaining two industry groups, will then be used to determine the effects of various incentive schemes.

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