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FURTHERING IMPLEMENTATION OF SUSTAINABLE RENEWABLE ENERGY: GEOTHERMAL ENERGY PROJECT VALUATION REVISITED BASED ON REAL OPTIONS ANALYSIS

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Overview

Project valuation of geothermal energy resources development for electricity generation is particularly amenable to apply real options analysis (ROA). The first reason is that getting a good knowledge and understanding of geothermal reservoirs is expensive and time consuming, not being able to see directly what's going on in the reservoir, and is therefore a source of uncertainty.

Every working geothermal field is the result of a number of geological and hydrological coincidences. Thus each geothermal field is only equal to itself. This calls for a stepwise development pattern as described below.

The second reason that ROA is particularly suited for geothermal project valuation is that stepwise development requires analyzing whether development should be deferred, expanded, contracted or abandoned, and gives rise to sequential compound real options.

Drilling exploratory wells is typically the first expensive project activity and must be sustained by an economic valuation exercise. Discounted Net Present Value (NPV) analysis falls short and may result in prematurely abandoning potentially profitable projects for two reasons: high uncertainty requires utilizing large discount rates, but most important NPV does not reflect the managerial flexibility embedded in geothermal projects.

This paper explores how real options analysis can be applied to value geothermal resource development for electricity generation. A model reflecting the stepwise development pattern is suggested: considering an initial investment in exploratory wells and basic generating capacity, opening the options to expand modularly or to install low pressure turbine generators or binary fluid plants. Since geothermal reservoir understanding is enriched by resource exploitation, better information leads to sounder valuation and to better decisions to be made in successive rounds.

Methods

ROA starts by identification of sources of uncertainty, and anticipating relevant future decisions by recognizing the flexibility embedded in a project. Next, a computational model must be developed aimed at estimating an "expanded" NPV that reflects the value of optimal decisions available to management to respond to uncertainty.

The main source of uncertainty in geothermal resource development is the sustainable reservoir potential, especially in the initial development stages.

Identifying flexibilities in geothermal projects is relatively straightforward because in a simplified way, the typical development pattern proceeds stepwise. Start conducting surface exploration to locate promising drilling sites, then drilling and testing exploratory wells, proceeding with development and production wells, adding surface installations to generate electricity, all the way monitoring the behavior of the field. Further, if things go well, with better information, drill new wells to expand exploitation of the field, expand generation capacity, continue testing, monitoring, modeling and understanding the resource to estimate its sustainable potential.

The computational model adopted uses site specific geothermal sustainable resource potential as the source of uncertainty. The initial estimated resource potential and its possible upward and downward range is chosen as the exogenous state variable used to develop a binomial lattice. The rationale is that in geothermal development projects, as exploitation proceeds, yields better information regarding it's potential, and those new estimates would be would be utilized in future revisions. Resource potential, in turn, determines binomial lattice node valuation depending on the investments to add generating capacity modularly, freezing further development while waiting for better information, capacity reduction to recover equipment salvage value or abandoning field development. Node valuation is then solved via backward chaining dynamic programming to the beginning node to estimate discounted cash flows at the initial decision node.

Current, reasonable figures for investment costs in wells and generating capacity, for drilling and plant construction times, for O&M costs, for quantity and quality of geothermal fluid production and for electricity rates lend support to the model.

Results

Results show the benefits of modular expansion, which lends support to the current development practice. They suggest that ROA provides a useful project valuation scheme for geothermal resource development decision making under risk because it allows a variety of embedded flexibilities to be reflected in an expanded NPV. One attractive feature is that the model parameters can be easily updated to reflect successively better potential resource estimates to review the model as development proceeds.

Conclusions

Expanded NPV geothermal project valuation resulting from ROA gives a better investment decision making indicator, identifying and involving risks and enriching valuation by exploiting the opportunities that arise from uncertainty. Although the suggested model is simplified for clarity's sake, more complex models can be developed, including resource characterization, direct heating utilization, but it's clear that ROA can contribute to justify enhanced implementation of renewable energy.

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