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The Evolution of Geothermal Power: Fuel Supply, Operation & Maintenance's New Role

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ABSTRACT

Fuel supply adequacy for geothermal power plants is increasingly emphasized. Likewise, operation and maintenance (O&M) of geothermal and other small power plants came into the spotlight in 1988. Such trends reflect maturing of the independent geothermal power industry. Since PURPA was passed in 1978, the independent power industry evolved from the youth stage into early maturity. Plant fuel supply and O&M trends reflect geothermal industry evolution. Fuel supply assurances and O&M schemes for both geothermal and other new plants are presented. This paper analyzes means of assuring project backers that geothermal plant fuel and O&M will be adequate.

Introduction

This work is an extension of previous geothermal energy reports prepared by the authors for Bonneville Power Administration (BPA). The original work evaluated all geologic, environmental, legal & institutional information in existing records to rank geothermal sites in the region, (Bloomquist et. al., 1985). Subsequent research examined the most current plant construction, engineering, and technology. Independent power market effects on new geothermal projects are presented in the 1987 GRC Transactions, (Bloomquist, Geyer & Sifford, 1987).

Prior research indicates a trend of growing financial community influence over power plant development. Following this line of investigation, several bankers were interviewed for insight on geothermal power project financing. Below are areas by which the investment community evaluates geothermal power projects. Topics other than fuel supplies, operation and maintenance have been previously presented (Sifford, Bloomquist, & Geyer, 1987). This paper analyzes means of assuring project backers that plant fuel and O&M will be adequate. Examples from all independent power sources are used for comparison.

Constructors
Developers
Engineers
Equipment
Financing
Fuel Supplies
Operation & Maintenance
Power Sales
Regulation

Fuel Supplies

Adequate fuel supplies for geothermal and other small power plants are in the news. Why? Plant fuel supply trends reflect the maturity of independent power. It is known that non-utility power plants can be built and operated in the short term. Long term fuel supply is only now being confirmed. Financial backing of geothermal projects is another force behind this trend. Fuels drive revenues, without which, projects do not happen. A track record of long term fuel supply helps attract capital necessary to finance the next plant.

Other fuel supply examples in the power industry are instructive. Biomass fuel (wood) risks are typically reduced by having a lumber mill (or mills) contract with the plant. Better yet is to have the lumber mill be a participant in the power project. The Oregon Department of Energy Small Scale Energy Loan program has financed a number of biomass power plants. These plants are all subsidiary operations of lumber mills. Due diligence work on the loan requires several scenarios of mill residue supplies to determine whether the project can be financed. The first is based on historically good production years. Other scenarios are based on percentages of operation, ie., 75, 50, 25 and no mill output. In the latter case, other nearby mills and the forest would supply the plant. All this is simply part of the due diligence work banks and financiers perform.

Hydroelectric power plants have somewhat unique fuels: river or stream flow. While the cost of such fuel is arguably free, the amount of fuel available to use is critical. For all hydro projects, river flow must be known to size the plant. Long term hydrologic records for rivers are usually available. These records help indicate "critical water years", ie., droughts. The frequency and amplitude of critical water years indicates worst case flows, and resulting energy generation. Long term records yield the most reliable data. Conversely, if no records are available, then stream flow measurements must be made and records kept for a period of time; the longer the better.

Municipal solid waste (MSW) or garbage supplies are a unique fuel source. This fuel can be directed to an energy recovery facility through local government action. Such was the case with the 11 MW Marion County (Oregon) waste-to-energy plant. Most project investors in these plants will require two supply actions: first, local government ordinances or laws requiring a jurisdiction's MSW flows to be controlled by one authority; and two, a comprehensive waste management program to be put in place. The second action results in conservative "fuel"supplies, net of recycling and other waste reducing impacts. Plants therefore avoid being caught short of fuel if waste reduction programs are put in place after the plant is built.

Until recently, natural gas availability depended entirely on utility supplies. Project developers could only go to their local natural gas utilities for supplies. Gas-fired cogeneration fuel risks are now being reduced by securing natural gas fields in Canada and Texas, (Weber, 1988). Access must accompany gas field purchases; the two are inseparable to be of real value. Lack of gas pipeline capacity constrained the development of power plants with winning bids at one northeast utility (Kellerman, 1989). But securing gas fields and pipeline space are both new fuel supply techniques.

Geothermal resources cannot be purchased on the open market, legislated into existence, nor bought from the local utility. Geothermal fuel risks are reduced by satisfying banks' consulting engineers, in house engineers, or both, as to reservoir deliverability. Deliverability may be defined as not what is in the reservoir, but rather, what can be delivered to the surface and power plant. Deliverability over the financial life of the plant is critical. From experience at geothermal fields worldwide, a decline in reservoir production is usually only a question of cost - not how or when, (Budd, 1973). Several examples of recent geothermal project financings indicate the fuel supply assurances backers seek.

Swiss Bank financed the buyout of leases supplying steam to the Northern California Power Agency (NCPA) plant at The Geysers. In this case, steam reserves were proven. Deliverability is known at the largest developed geothermal field in the world. Negotiations centered around the value of the proven steam, and costs of future replacement wells, (Barrick & Riopelle, 1988).

Bankers Trust financed the ORMESA I project in the Imperial Valley. Fuel supply assurances were satisfied by a USDOE loan guaranty held by the original developer, (Carse & Jay, 1988). Federal government backing is enough to reduce most fuel risks. In fact, given just a little operating experience, such loan guarantees can be dropped. The ORMESA I project was refinanced without benefit of the federal loan guaranty shortly after the project started operation, (Liebman, 1989).

Another way to assure bankers as to adequate geothermal resources is to show up with a proven reservoir. This was the case of Oxbow Geothermal when it sought project financing for its Dixie Valley plant. Sufficient supply wells had been drilled prior to approaching the bankers, such that reservoir size was known. All that remained for the bankers to confirm was reservoir deliverability. For this task, Citibank used its staff of reservoir engineers. These engineers, located in Denver, Colorado are experienced oil and gas reservoir analysts. Applying their expertise to geothermal reservoirs was backed up by consulting engineers reports, (Kyle, 1989).

Finally, in all the above examples, consulting reservoir engineers are used extensively by the financial community. These individuals and firms provide objective evaluation of all data confirming geothermal reservoirs. Geological, geophysical and geochemical data, flow and storage capabilities, reservoir boundaries, deliverability and recharge are all analyzed. Only then can a fuel suply conclusion be reached.

Operation & Maintenance

Operation and maintenance (O&M) of geothermal and other small power plants came into focus in 1988. Many reasons explain the new emphasis, but again, power industry evolution underlies most of them. Since PURPA was passed in 1978, the independent power industry evolved through the youth stage into early maturity. Plant O&M trends reflect all aspects of industry evolution. Included in this evolution is the increasing degree of financial sophistication in projects. Financial backing of geothermal projects is increasingly the driving force behind such trends. This evolution affects developer perspective, power prices, project participation, and finally, future oppportunities to build plants.

The goal in the first part of the decade was developing a project. Getting a plant financed and built was the focus. Now that projects are built, focusing on operating the plant is only natural. Creating a good "track record" is the goal of geothermal and other independent power firms.

Some developers will admit that operating the project may not be their strong point. One company, Environmental Power Corp. states it succinctly: "We're developers, not operators", (Stoiaken, 1988). Recognizing that difference in abilities, it is in the developer's best interest to put qualified operators in it's plants.

As new independent power plants entered the market, electricity prices dropped, (Agello & Fellman, 1986). The margins for profit are slimmer with lower prices, making O&M costs all the more critical. Some early plants very likely had higher than expected O&M costs. Little room for error in O&M cost estimates now exists.

Developers now join with partners and financiers in projects. Plant operating costs therefore get closer review by more parties. Lenders and financiers are typically more conservative than developers. These backers like an experienced, big name company to operate power plants. This can translate into slightly lower financing costs. So, many developers accept third party O&M contracts for strictly financial reasons, instead of doing it themselves.

The increase in partnerships developing projects also points to another O&M trend: affiliates of partners performing plant O&M. Having a vested interest in plant performance motivates operators. Such motivation, in turn, provides security to financiers. Partners in recent plants include resource developers, utility subsidiaries and construction firms. Examples of those entities providing O&M services are shown in Table 1 below.

Good O&M goes beyond maximizing current profits. Smart developers know that a good performance record will be critical to obtaining financing and winning bids for future plants. One lender, Baybank Boston, noted assurance is needed "as our customers go on and develop new projects, that the importance of proper O&M on existing sites isn't overlooked", (Stoiaken, 1988). As electricity markets move towards bidding schemes, sophisticated financing is needed to keep costs to a minimum and meet bid specifications. Only those developers with good track records will obtain the financing so critical to win bids.

The O&M industry itself is mature. As a result, there is variety in O&M contract options. Plant designers and constructors are good candidates for O&M contracts, based on their ability to build the project and motivation to make sure it operates well. The previously cited example of project partners performing plant O&M is based on that same motivation.

Other incentives to peak performance exist. One good example is a bonus/penalty provision. Meeting performance standards may be time sensitive, hence, based on revenues instead of operation. For example, if seasonal rates are paid for the output, then it is imperative that the plant operates well during the peak time of year. A bonus for good operation, tied with a penalty for not meeting expectations helps insure optimum performance.

Table 1
Geothermal Power Plant Participant Operators

Plant	Operator
Beowawe	Chevron Resources
Heber flash	Dravo Plant Operating Group
Mammoth	Ben Holt Co.
Steamboat	ORMAT
Wineagle 1	Barber-Nichols Engineering

O&M contract term periods are usually less than the financing period. For example, Bankers Trust reports only one life of the financing O&M contract. It was for a gas-fired project, a relatively easy technology. The standard O&M contract period is closer to 5 years, (Stoiaken, 1988). Another term consideration is time to first major maintenance, perhaps 4 to 7 years, depending on technology. New geothermal plants typically schedule an inspection outage yearly, (Kleinhans & Prideaux, 1985). Three years might be an appropriate major maintenance period.

Payment terms to O&M contractors vary widely. Fixed fee, cost plus fixed fee, cost plus a percentage of fees, and firm price with escalation are all examples cited by Combustion Services Inc., a subsidiary of Combustion Engineering, (Stoiaken, 1988). Such information is typically proprietary. It is therefore difficult to estimate terms common to the geothermal industry.

The actual cost of operating and maintaining a geothermal plant is similar to that for any power plant. A "bathtub curve" is cited by Combustion Services Inc. as descriptive of this cost. The rate starts out high during the shakedown period, tapers down to a minimum as the plant begins to operate smoothly, and then goes up as parts start to wear out. Early experience with newly constructed geothermal plants indicates that their curve may not start out so high if operation is done correctly, (Kleinhans & Prideaux, 1985).

Conclusion

As independent geothermal developers build new plants, historical performance of existing plants becomes critical. Independent geothermal developers are now beyond the infancy stage of industry evolution. Plants were successfully built on time and under budget. Now such plants operate on time and within budget.

The ability to supply adequate fuel (steam or hot water) and to operate smoothly over the long term recieves great scrutiny by the financial community. To date, fuel supply assurances have been provided through several means, with consulting engineers used to confirm results. Similarly, providing quality plant operation and maintenance is demonstrated by motivated subsidiaries of project builders and partners, for example.

The results of meeting fuel supply and O&M expectations are twofold. First is the meeting of financial goals and profits. Second is the ability to obtain future financing and hence, compete in, future power supply solicitations. New geothermal power plant fuel supply and O&M performance therefore help assure a place in future supply options for this valuable resource.

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