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1993 STATUS REPORT — THE BONNEVILLE POWER ADMINISTRATION'S GEOTHERMAL PROGRAM PART I: THE PILOT PROJECTS

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ABSTRACT

The goal of the Bonneville Power Administration's (BPA) Geothermal Program is to find cost-effective ways to develop the Pacific Northwest's geothermal resources. The program's main focus is three pilot generation projects. The history and current status of the projects are discussed. Power costs will be at or below BPA's 1990 alternative (avoided) costs, and are competitive with hydro projects recently acquired by BPA. After price, the main contract issue was risk allocation, particularly with respect to long-term reservoir performance. Activities supporting the projects are discussed in a separate paper.

BACKGROUND

The Pacific Northwest is thought to have abundant geothermal resources, but no high-temperature sites have achieved commercial power production. The electric power potential of Northwest geothermal systems with temperatures above 300°F is estimated to be at least several thousand megawatts (Brook and others, 1979; Bloomquist and others, 1985). Nevertheless, because of risks associated with finding and developing reservoirs, BPA planners have not considered geothermal to be reliably available. A power surplus in the Northwest through most of the 1980s hindered development, because there was no market for new generation. However, by 1989 the surplus was evaporating, and utilities were gearing up to acquire new resources.

BPA, a Federal power marketing agency within the U.S. Department of Energy (USDOE), sells wholesale power to utilities and other customers. About half of all the power used in the Northwest comes from BPA, and BPA provides about three-fourths of the region's transmission capacity. BPA's resources total about 23,500 megawatts (MW) of capacity (about 91 percent from hydro), and supply about 8700 average MW of firm energy (83-percent from hydro).

Hydro system output will be reduced by several hundred megawatts due to measures needed to restore endangered salmon runs in the Columbia and Snake Rivers. Another 200 MW, BPA's share of output from the Trojan Nuclear Plant, will be lost when the plant closes. We are actively acquiring new resources, and expect to buy between 1200 and 2100 average MW of new generation and conservation by 1998, and between 1900 and 3100 average MW by 2003. Region-wide, utilities are expected to need about 360 MW of new generation and conservation per year until the year 2000, assuming 1.7-percent per year load growth.

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act) created the Northwest Power Planning Council (Council), which includes two governor-appointed representatives from the states of Idaho, Montana, Oregon, and Washington. The Council periodically publishes a Power Plan, which is a regional planning document that guides BPA's resource planning. In March 1989, as part of preparing its 1991 Power Plan, the Council convened a Research, Development, and Demonstration (RD&D) Advisory Committee to develop strategies for resolving uncertainties affecting resource planning — particularly for promising renewable resources — and for improving their environmental acceptability and cost-effectiveness. Technical advisory panels, including one composed of geothermal specialists, recommended actions for the Committee to consider. These actions became the 1991 Power Plan's Geothermal Confirmation Agenda (Northwest Power Planning Council, 1991).

The Agenda included four activities:

1. Compile and circulate data on geothermal plant operating experience.
2. Document and circulate data on geothermal resource areas, particularly pre-development environmental characteristics.
3. Facilitate resolution of environmental and land use conflicts.
4. Initiate geothermal demonstration projects.

This report will focus on the geothermal demonstration projects, which were the cornerstone of the Agenda. The other three activities, as well as additional and future BPA initiatives, are described in a companion paper (Darr and Key, 1993).

GEOTHERMAL PILOT PROJECTS

The Council and BPA have long recognized geothermal's potential for providing cost-effective power to the region, but previous efforts to initiate demonstration projects were for various reasons (including an enduring power surplus) unsuccessful. BPA staff recognized that an RD&D plan supported by BPA's management and customers would have the best chance of being implemented. After months of consulting developers, state energy offices, Federal and state oversight agencies, technical experts, USDOE geothermal staff, and others, the outlines of a workable program began to emerge.

It became apparent that power contracts, with terms recognizing geothermal's unique characteristics, were the single most important ingredient needed to spark development in the Northwest. This may seem obvious to many, but several alternatives were proposed, particularly exploration drilling cost-shared by utilities. But since the ultimate goal of any exploration program is a power sale, confirming resources through drilling seemed to be only half the answer. For one thing, why would a developer risk millions of dollars to find reservoirs without a reasonable return (via a power sale) in sight? Secondly, it was plain that finding resources was only half the

problem. Given that geothermal is found in areas of recent volcanism, which tend to be areas with high recreational and scenic value like the High Cascades, our ability to site a project, get through an untried (in the Northwest) permitting process, and resolve land use conflicts appeared just as uncertain.

Developers said they would be willing to finance exploration themselves, and sell the power on an output basis — in other words, utilities would only have to pay for kilowatts delivered. A reasonable minimum plant size was initially thought to be 10 MW, as indicated by discussions with developers and by experience elsewhere. BPA wanted to do more than one project, preferably three, because one or more of them could fail due to the high risks involved. Since it could take four to six years to go from soliciting proposals to commercial operation, doing projects sequentially could result in failure to meet our objectives in a reasonable amount of time. We were encouraged by the success of Sierra Pacific's 1983 Request for Proposals in promoting geothermal development in Nevada, and by the positive impact of the standard offer contracts in California.

Every two years, BPA prepares a Resource Program, which describes the actions BPA will take to meet the power requirements of its customers. By early 1989, the confirmation program was sufficiently developed for BPA to announce, in its 1990 Resource Program, that it would be willing to purchase up to 10 MW of output from each of three geothermal pilot projects (Bonneville Power Administration, 1990). The goals of the projects would be to initiate development at three of the most promising reservoirs in or near BPA's service territory, and to make sure that technical and institutional obstacles to development could be overcome. Positive reaction to the Resource Program, coupled with the Council's recommendations in the 1991 Power Plan, led to issuance in July 1991 of a Request for Proposals (RFP).

Because BPA wanted others to share the cost of the program, the RFP required the projects be developed in joint ventures with regional utilities. Developers were allowed to submit proposals even if a utility partner had not yet been identified. Other conditions included:

- The resource had to be capable of supporting at least 100 MW of capacity. Since there was no way of knowing this prior to development, a resource assessment such as the U.S. Geological Survey's Circular 790 or other credible evidence could be used to meet this requirement.
- The proposed lease block had to be controlled by a single developer (unitized) or suitable for unitization. We wanted a single developer to manage utilization of the resource as a way of preventing overdevelopment and resource depletion.
- The project had to be subject to a Bureau of Land Management environmental process. This was partly to ensure that regulations pertaining to unit operations would apply, but was also a result of the small amount of staff BPA could devote to the projects. BPA wanted to be a cooperating agency in the environmental impact review, because we could not commit sufficient staff to being the lead agency.
- BPA would receive an option on an additional 100 MW, if available.

The RFP attracted seven proposals, and in December 1991 three projects were selected for contract negotiations. The three projects were from CE Exploration (a subsidiary of the California Energy Company) and the Eugene Water & Electric Board (EWEB) at Newberry Volcano, Oregon; Trans-Pacific Geothermal Corporation at Vale, Oregon; and Unocal at Glass Mountain (Medicine Lake), California. The Springfield Utility Board (SUB) has since become a partner in the Vale Project. Unocal sold its Medicine Lake leases to the California Energy Company in January, 1993. All three projects are approximately 30 MW in size and are expected to achieve commercial operation in 1996. The locations are shown in Figure 1.

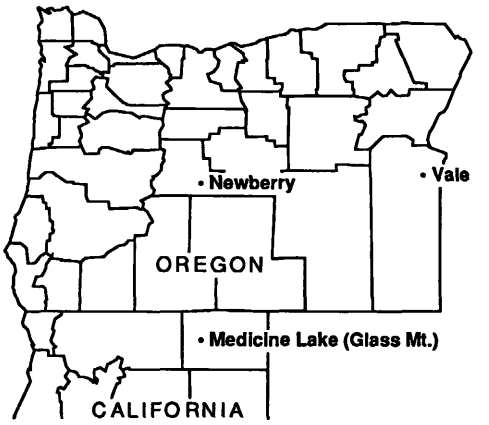

Figure 1. Pilot Project Locations

Contract negotiations began in early 1992, and a Memorandum of Understanding signifying agreement on contract principles was signed for Newberry in December 1992, and for Vale in January 1993. At the time of writing, agreement had not yet been reached on Medicine Lake. An environmental review process required by the National Environmental Policy Act of 1969 must be completed before BPA can make a decision whether or not to sign the power contracts. This process usually takes 18 to 24 months to complete. Since all three projects are on Federal land, this environmental review would have been required prior to building a power plant, whether BPA was involved or not.

COST COMPARISON

Terms and conditions of the power contracts will not be made public until the contracts are finalized. However, general comments and a generic analysis are permissible. EWEB and SUB, both BPA customers, will purchase 10 MW from Newberry and Vale, respectively, with BPA purchasing the remaining output. EWEB and SUB will receive a credit on their BPA power bill ("billing credit") for the difference between BPA's wholesale power rate and the cost of power from the project. Billing credits were created by the Northwest Power Act, and are intended to encourage Northwest utilities to develop their own resources by removing the disincentive of always being able to buy power more cheaply from BPA. EWEB and SUB will also receive an option on 33 MW of future capacity, if available. In return, the two Oregon utilities will play a lead role in the public involvement and permitting processes. EWEB has already initiated a well-received public involvement process in central Oregon.

These are very long-term contracts, 40 to 50 years, and the payment streams are front loaded, reflecting debt service. Like

hydro, wind, and solar, geothermal has high capital costs but low operating costs and no fuel cost. For evaluation purposes, BPA converts a project's cost stream (which typically varies from year to year) to a series of equal payments. This is a way to place projects with different contract terms and costs streams on an equal footing. The equal payment amount is called the levelized cost of power, which BPA expresses in constant ("real") dollars. A cost stream can be shaped in an infinite number of ways and still result in the same levelized cost. An example of two cost streams that equate to the same levelized cost is shown in Figure 2. The area graph is a front-loaded cost stream (as might be proposed by an independent power producer), and the line graph is a cost stream reflecting capital cost repayment spread over the entire contract life (like a utility-financed project).

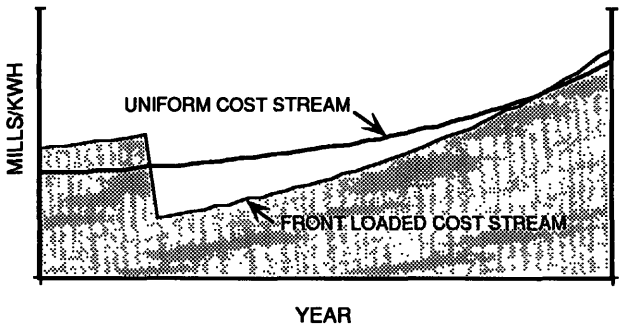

Figure 2. Example of two cost streams that result in the same levelized cost.

BPA periodically publishes its Alternative Costs (what the rest of the world calls avoided costs). They were first published in 1990, and revised in 1993. The 1990 schedule of benchmark alternative costs is shown in Table 1. The actual alternative cost for a project will reflect adjustments to the benchmark for location, seasonality of output, and other factors. The resulting levelized cost is termed the Adjusted Alternative Cost (AAC), and this was the price cap for the geothermal pilot projects. In other words, the cost of power from the Newberry and Vale projects must be at or below BPA's AAC, based on the 1990 benchmarks. Using a levelized cost target gives the developers some ability to shape the cost stream to adjust to financing terms, interest rates, and other factors that could change before contract signing. This contrasts with the way many utilities (including BPA) typically conduct competitive power acquisitions, where the developer must commit to a price before financing is obtained or other important project components are in place.

Resource Life	On-Line Year 1992	1993	1994	1995	1996
5.0	25.0	25.3	25.5	25.8	26.0
10.0	25.9	26.2	26.4	26.7	26.9
15.0	26.8	27.0	27.3	27.5	27.8
20.0	27.7	28.0	28.2	28.5	28.7
25.0	28.5	28.8	29.2	29.6	30.0
30.0	29.2	29.7	30.2	30.7	31.2
35.0	30.0	30.6	31.2	31.9	32.5
40.0	30.7	31.5	32.3	33.0	33.8
45.0	31.5	32.4	33.3	34.2	35.1
50.0	32.2	33.2	34.3	35.3	36.3

BPA'S 1990 BENCHMARK ALTERNATIVE COSTS
(Real levelized mills per kilowatt-hour in 1990 dollars)

Table 1

In Table 2, the levelized cost for the Newberry and Vale projects are compared to the levelized costs of four hydro projects BPA acquired (or is in the process of acquiring) through its 1990 Billing Credit Solicitation. Two of the hydro projects are more expensive — on a real, levelized cost basis — than either of the geothermal projects. First-year costs of GEO B are actually lower than three of the four hydro projects. It should be noted, however, that the results of this kind of comparison are sensitive to the discount rates and inflation assumptions used in the levelized cost computation. Standard BPA assumptions were used in this analysis.

Project	Contract Term (Years)	On-Line Year	Levelized Cost (1990 mills/kWh)
Hydro A	20	1993	41.7
Hydro B	44	1994	36.4
Hydro C	33	1996	38.5
Hydro D	45	1996	33.9
Geo A	50	1996	37.2
Geo B	45	1996	31.2

LEVELIZED COSTS FOR
SELECTED BPA ACQUISITIONS

Table 2

CONTRACT ISSUES

After price, the main contract issue related (predictably) to risk allocation. Since the price streams are front loaded, BPA wants to be sure the projects operate for the entire contract term. To achieve this, the developers are required to maintain operating security (plant and wellfield repair and replacement) accounts and to maintain minimum capacity factors. Unless due to an uncontrollable force, default subjects the developer to penalty payments ("termination charge") for early termination of the contract. These charges pay BPA the difference between the front loaded payments and a more uniform payment stream spread over the effective life of the contract. Termination charges can be extremely heavy if incurred during the middle years of the contract term. Under these circumstances, BPA may also have the right to take over operation of the project.

The developers, on the other hand, did not want to be penalized for reservoir nonperformance caused by factors beyond their control, and this is addressed in the contracts. They also wanted to avoid contract terms that would make it difficult for them to finance the project. BPA is willing to work with them to solve problems dreamed up by obdurate bankers.

BPA's feeling, and we'll see if future events bear us out, is that most of the reservoir risk occurs during the early years of the project, when the financier has the most to lose. Requirements imposed by the bank will tend to protect BPA as well. If reservoir capacity is sufficient to operate the project for the first ten to twenty years, we believe (not naively, we hope) that maintenance issues — rather than reservoir sustainability — will dominate the remainder of the contract term. This should be especially true for the first plant, to which the entire lease block will be devoted until BPA approves its partition into par-

ticipating areas.

SUPPORTING ACTIVITIES

To help ensure geothermal's successful introduction into the Northwest, BPA has undertaken or financed activities that support the pilot projects. These activities include establishing hydrologic baseline monitoring programs, performing economic and environmental impact studies, funding a report on environmental issues related to geothermal, and working with environmental groups. Future efforts will include exploration for resources in southeastern Oregon, a geothermal heat pump demonstration project in Montana, technical assistance to help make geothermal heat pumps competitive as a conservation resource in BPA resource acquisitions, and development of a geothermal curriculum for the Oregon schools for grades 4 through 8. These activities are described in (Darr and Key, 1993).

SUMMARY AND CONCLUSIONS

The Northwest Power Act established an order of preference for resources acquired by BPA, with renewables having second priority after conservation. The Act also authorized BPA to acquire "demonstration or pilot projects with a potential for providing cost-effective service to the region." We were not forced to do these projects, but instead aggressively sought ways to make them happen, once they could be justified by regional power need. BPA believes geothermal is an environmentally desirable power source with potential for supplying a significant portion of the Northwest's power needs. Low-temperature, direct-application geothermal resources and geothermal heat pumps can also help reduce the need for new power plants and make up for generation lost due to fishery issues and nuclear plant shutdowns.

Power contracts that account for factors unique to geothermal will do the most to further development of the Pacific Northwest's geothermal resources. These contracts can be structured in ways that are cost-effective and minimize risk to both utilities and developers, but utilities must be willing to look beyond the short term. Geothermal is already cost-competitive with new hydro projects, and the second project developed at pilot project sites should be cheaper. The BPA program has tried to profit from and improve upon past experience, and has resulted in constructive partnerships between utilities and developers.

ACKNOWLEDGEMENT

The pilot projects would never have gotten this far without the advice and support of developers, state energy offices, and Federal and state agencies in the Northwest. The author would also like to thank the California Energy Company for having the good sense to open a Portland office and staffing it with Dave McClain and Marci Proutt, and to Tsvi Meidav and Jack Pigott at Trans-Pacific for hanging in there.

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