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A Review of Geothermal Power Generation in the Basin and Range Province in 1995

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Introduction

This is the third annual update to be published in the GRC *BULLETIN* covering the geothermal projects in the Basin and Range Province of the United States. Information presented here has been graciously supplied by various individuals and/or companies or obtained from the public record. Thanks to the assistance of many sources, this article provides a detailed review of projects in that region.

The portion of the Basin and Range Province of most interest to geothermists is contained within the states of California (2039 MW of geothermal power), Nevada (170 MW), Oregon (0 MW), Idaho (0 MW) and Utah (33 MW) (Figure 1). The total installed geothermal capacity within the Basin and Range Province is about 510 MW. For comparison purposes, in August 1995 The Geysers was generating 1,285 MW with an installed capacity of 1,834 MW (down from a high of 2,098 installed MW). The Imperial Valley, including Cerro Prieto, has an installed capacity of 1,112 MW.

No new geothermal power generation projects were commenced or completed in the province during 1995, consequently, the statistics presented two years ago (Benoit, 1994) remain generally unchanged with only some minor modifications in the number of wells supplying some plants. Only one new project, at Mammoth Lakes, now appears possible in the next few years, and the Wabuska project has been temporarily shut down. Twenty-four power plants with individual turbines ranging in capacity from less than 1 MW to 56 MW (net) continue to operate. Operators have begun favoring power plant efficiency improvements over additional drilling as the most economical method for maintaining or increasing electrical output.

During 1995, no significant geothermal exploration took place in the Basin and Range Province. No exploratory wells were drilled. Infield drilling of new production wells occurred only at Coso, California, and Dixie Valley, Nevada, with only four new wells completed. This reduction in drilling activity is also reflected in some federal leasing numbers. For instance, by the end of 1993, there were 224 leases in Nevada, covering 365,000 acres. By the end of 1995 this number had decreased to 173 leases, covering 245,700 acres.

Operating Projects

Beowawe, Nevada 1985— 12.5 MW Dual-Flash

The Beowawe project had a difficult year with the plant out of service for two months in the late fall for major repairs of the turbine casing and fourth and fifth stage rotor blades. Aside from this, the field and plant continued to operate within a megawatt of nominal capacity throughout the year. The three injection pumps were each destaged from 12 to nine stages to match the lower pressures required to inject back into the reservoir. This resulted in a net increase of 0.3 MW. There were no well workovers or modifications. The upcoming year will be a challenge for this project. In August the plant will go beyond year 10 of its Standard Offer No. 4 contract and the sale price of electricity will decrease from 10 cents to 11 cents per kilowatt hour.

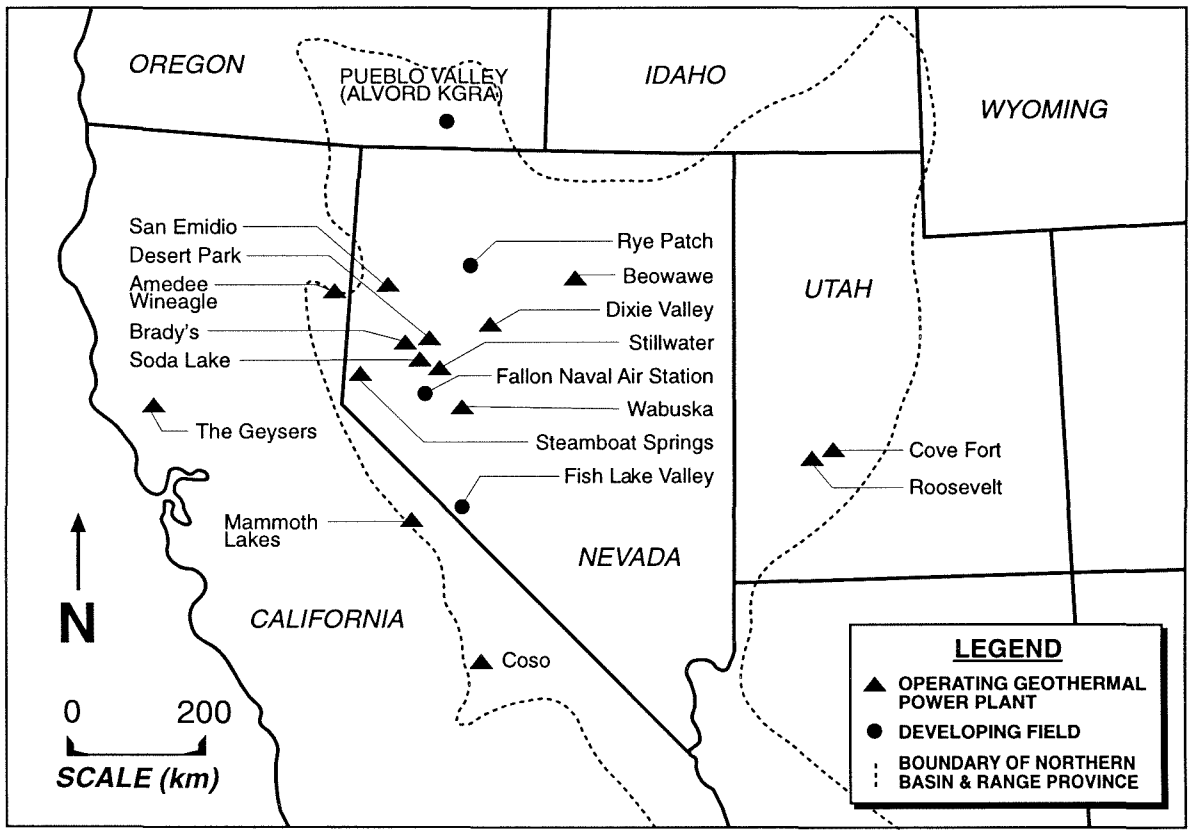

Figure 1. Power generation in the Basin and Range Province in 1995.
(Location Map—Modified from Edmiston).

Bradys, Nevada 1992—21 MW Pumped Dual-Flash

During 1995, the Bradys project operated normally with no major outages. The most significant event of the year was the conversion of a relatively deep injection well (82A-11) into the deepest production well in the field. When pumped, this well quickly heated up to a temperature of 372°F and is now the hottest well in the field. The Bradys project intends to capitalize on this success by drilling additional relatively deep production wells in the vicinity of 82A-11. This will allow shallower and cooler wells to be shutin and the total volume of production and injection will be reduced.

Desert Peak, Nevada 1985—9 MW Dual-Flash

On 31 December 1995 the 10-year "demonstration" contract for power sales to Sierra Pacific Power Co. was fulfilled. This contract priced the electricity at 6.7 cents/kWh. This has been replaced with a short-term "avoided cost" contract with Sierra Pacific at 2.53 cents/kilowatt hour. The staffing at the power plant has been reduced to four operators, reflecting the difficult decisions required to continue operating even dependable and proven, low-cost geothermal power plants at the low electricity prices currently dominating the market.

During the year the plant produced an average 8.7 MW (net). There were workovers on production well 86-21, which was slightly deepened, and the lone injection well for a near-surface casing repair. These represent the first significant workovers on the three Desert Peak wells in 10 years of service.

Dixie Valley, Nevada 1988—56 MW Dual-Flash

Total output in 1995 rebounded from 1994 when there was a maintainence outage and the transmission line was damaged by a military helicopter. Late in 1995, a replacement production well (73B-7) was drilled and placed in service. During the drilling of this well, two hydrofrac tests and a borehole televiewer log of most of the well were obtained in a joint project with the U.S.

Geological Survey and Stanford University as part of a study to determine the stress/strain orientation and magnitude along the Stillwater fault. This marks the first time this type of information has been collected in Dixie Valley and, possibly, in any Basin and Range geothermal field. An unsuccessful oil/gas well was drilled a few miles northeast of the geothermal field by Ouida, a small independent.

Mechanical integrity tests to verify that the injection wells were returning all injectate to the reservoir were performed on four of the eight injectors, utilizing temperature/pressure/spinner logs. These tests of the casings should be conducted every five years in Nevada under Division of Environmental Protection regulations. This marks the first time that testing was conducted by this method.

Oxbow was selected by the Deptartment of Energy to construct a bottoming cycle power plant utilizing heat from the 230° injectate, and a feasibility study of this project began. This plant would be a third-stage flash, operating under vacuum conditions.

Dixie Valley Power Partners, a partnership of Dixie Geothermal Corp. (an affiliate of Caithness Power Inc.) and ESI Energy (a subsidiary of Florida Power and Light) reached an agreement with Southern California Edison to sell back its Standard Offer No. 4 contract. The California Public Service Commission has yet to approve this agreement.

Empire, Nevada 1987— Binary

The plant continued to operate at its historical output throughout the year.

Soda Lake, Nevada 1987 and 1991—14.3 MW Binary

This plant operated normally throughout the year and managed to set a new megawatt output high, about 5 percent above its previous record. At the end of the year, the Soda Lake Federal Unit was reduced to the participating area in size.

Steamboat Springs, Nevada 1987, 1988 and 1992— 42.5 MW Single-Flash and Binary

During 1995, the 12.5 MW single-flash Caithness Power Inc. geothermal project was on-line 98.9 percent of the year. No well work or new construction was conducted. In the last quarter of 1995, ESI Energy joined the project as a senior lender. New capital is funding the project, allowing significant plant and gathering system improvements to be made in 1996. The need for improvement is evident from the steam plume from the Steamboat No. 1 well, which is visible most days from Reno. There was no public progress on the Caithness appeal of the 1994 Public Utility Commission decision that effectively halted the planned plant expansion.

This year the four air-cooled binary plants operated by SBGeo produced at record levels, averaging 47.2 MW. This high output resulted from many plant enhancements. Testing and installation of more efficient air condenser fan blades, redesigned generators, and the development of a new computer indication and control system had the greatest positive impact. The foremost improvement was from the original 1987 and 1988 SBI and 1A plants.

In December SBGeo and REDA Pump began testing a submersible pump in a production well. The pump, driven by two 135 HP motors, was installed in the HA-4 well at a depth of 500 feet. Approximately 800 gpm of 316°F water was piped to the SB1 plant. The original test period of 90 days may be extended to 120 days if positive results are observed.

Stillwater, Nevada 1989—12 MW Binary

This plant operated normally throughout the year with no significant events.

Wabuska, Nevada 1984—1.2 MW Binary

The power plant operated routinely until the early fall of 1995, when it was shut down so that the working fluid could be changed from freon to either isobutane or isopentane. This relatively old Ormat unit was the first to produce geothermal electricity in Nevada.

Amedee Geothermal Venture 1, California 1989— 1.6 MW Binary

The plant continues to operate consistently with high availability but a low capacity factor, caused by earlier cooling of the production fluid. The current Standard Offer No. 4 firm capacity rating is .736 MW. Upgrades were made to major plant valves and certain controls to replace Victaulic valves that had very short in-service lives. Recent studies have confirmed that the subsidence observed at the site in the early years of operation is diminishing.

Coso, California 1987-1990—260 MW Dual-Flash and Single-Flash

During the year, three plants (nine turbines) produced an average of 264.7 mw (net), resulting in a combined capacity factor of 110.3 percent. This is the greatest annual generation supplied from the field. A system to allow transfer of steam between the three plants was completed. Three production wells and one temperature-gradient hole were completed in 1995. This is a reduction from the five production wells drilled in 1994. More than 120 wells have now been drilled at Coso.

Calpine and the Los Angeles Department of Water and Power (LADWP) continued negotiations regarding production from the LADWP lease on the west margin of the Coso field.

Mammoth Lakes, California 1986 and 1991—40 MW Binary

The three existing plants operated normally throughout the year with no changes in the plants or wellfield. The Idaho National Engineering Laboratory did some testing and experimentation with Pacific Energy to document plant operations at some conditions that are off design.

The most encouraging news in the Basin and Range Province regarding new project development is at Mammoth, where the application to Mono County, California, was accepted for a fourth plant with a 12 MW net output. In 1989 this application was denied until the first three plants would operate as planned. This 12 MW plant would deliver power under terms of a Standard Offer No. 4 contract. This appears to be the last Standard Offer No. 4 contract to be utilized in the U. S. geothermal industry. The new plant location has not yet been selected and will depend upon the results of future exploration. It is anticipated that the plant construction will be completed in about three years.

Wineagle, California 1985—0.8 MW Binary

No physical changes to this project occurred during 1995. The Wineagle resource temperature remained stable at 217°F during the year, and the plant has been operating at high availability. In the middle of the year, Wineagle went over the Standard Offer No. 4 "cliff," the first geothermal plant in the Basin and Range Province to do so. Current plans are to keep the plant on-line for an indefinite period.

Cove Fort, Utah 1985, 1988 and 1990—10 MW Single-Flash and Binary

Early in the year, the Bonnett geothermal power plant output was at 4 MW, using the five existing dry steam wells and with all four Ormat units, the topping turbine and the steam turbine operating. The wellhead pressures in these wells have remained at 24 psig. In October, a pump was set in hot water well P 91-4, which was drilled in 1991 but not previously tested. The well produced 310°F water with good productivity and little drawdown, even at 2,000 gpm.

When this well is in service, the operating strategy will be to send high-pressure separated steam, and steam from the dry steam wells, to the steam turbine. Low-pressure steam will go to the Ormat units, and the topping turbine will be mothballed. It is anticipated that this will produce an additional 2.5 MW for a 6 MW net total output.

The hot water reservoir is characterized by a relatively deep 1,100 foot water level, but offsetting this is the size of the liquid reservoir at Cove Fort, which may be the largest in the United States.

Roosevelt, Utah 1984—23 MW Single-Flash

The most significant event of the year was damage to the turbine rotor, discovered during a planned power plant outage extending the outage to 3-1/2 months. This turbine also suffered extensive damage in 1993. Injection well 14-2 was worked over to repair the wellhead and replace some damaged near-surface casing.

Extensive discussions took place with the Bureau of Land Management (BLM) regarding the federal unit reducing to the participating area. This event will impact nearly all of the existing federal geothermal units in the coming year or two. Roosevelt was the first federal unit to be involved in the process due to its early onset of production.

Development Projects

Fallon Naval Air Station, Nevada

No onsite work took place at this project during 1995, but Oxbow Power Corp. and the Dept. of Energy entered into an agreement that could result in a 6,000-foot slim test well in the first half of 1996. In December permits were obtained to drill intermediate depth holes to assist in siting the deep slim test.

Fish Lake Valley, Nevada

No work was conducted on this project in 1995.

Pueblo Valley (Alvord KGRA), Oregon

Anadarko completed the scoping report for the Draft Environmental Impact Statement for this project. All work was then suspended due to a decision by Portland General Electric to halt operations under the terms of the Memorandum of Understanding (MOU) in place with Anadarko. In early 1996, Anadarko began the process of trying to sell the leases.

Rye Patch, Nevada

No onsite work was performed on this project. The nearly completed power plant remains mothballed and for sale.

Conclusions

During 1995, no geothermal exploratory drilling took place in the Basin and Range Province for the first time since the early 1970s. There were no KGRA sales. Two of the earliest power plants on-line reached the end of their initial contract periods, and actions taken to keep these plants operating show a challenging period coming up for several other plants. Overall, the operating plants had a mixed year with some plants or fields setting output records while others were out of service for periods of a few months.

The upcoming few years will provide a challenge for operators in the Basin and Range Province to continue operating the plants at the current competative power sales prices.

Acknowledgements

Tom Flynn and Trudy Zitter critically read and improved this manuscript.

Reference

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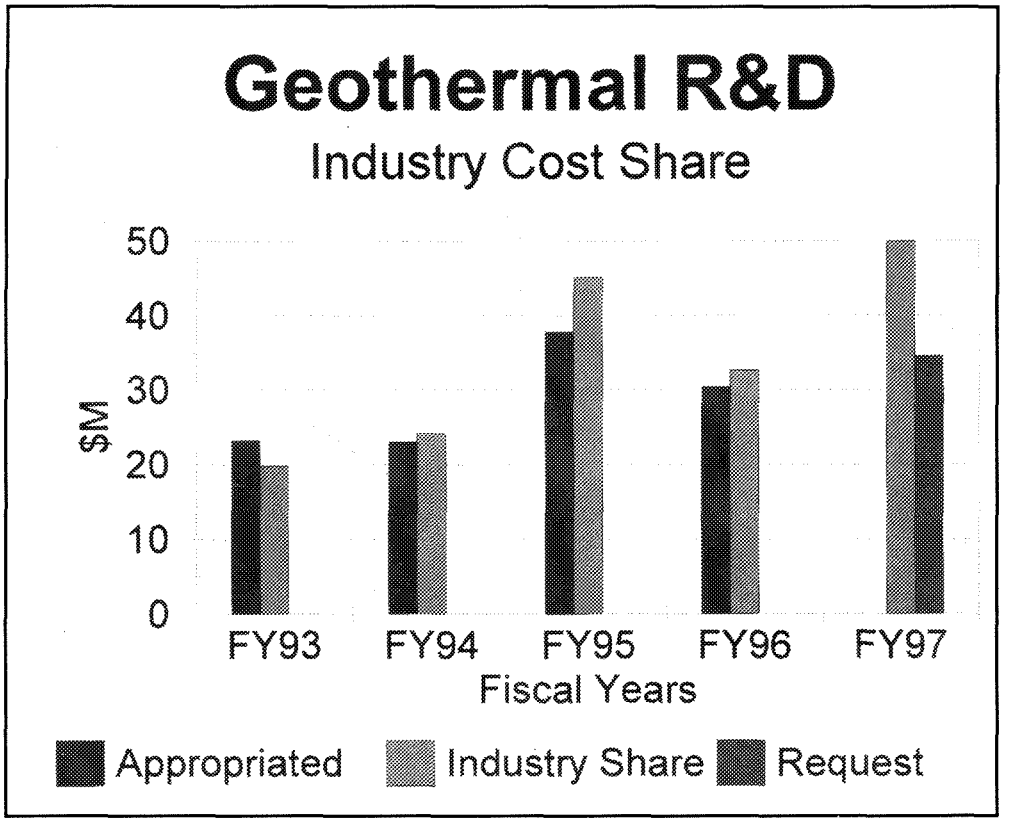

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