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A Review of Geothermal Power Generation Projects in the Basin and Range Province in 1994

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Introduction

This is the second annual update to be published in the GRC *BULLETIN* covering the Basin and Range Geothermal Province of the United States. The year shown in the title for each field is the year(s) the power plants came online. Without the assistance of many people, either directly or indirectly, this would be a much less complete review.

No new geothermal power generation projects were commenced or completed in the province during 1994. Consequently the statistics presented in last year's article (Benoit, 1994) remain generally correct with only some minor changes in the number of wells supplying some plants. Twenty-five power plants of varying size continue to operate (Figure 1).

It was a discouraging year for geothermal exploration and development in the Basin and Range Province in California, Nevada, Oregon and Utah. Only three significant exploratory wells were drilled. Infield drilling for additional production or injection capacity occurred only at Bradys and Coso. Also, all new power plants that were planned for construction or commencement of operations during 1994 were either delayed or cancelled.

Operating Projects

Beowawe, 1985—12.5 MW Dual-Flash

At Beowawe, the dual-flash power plant operated normally throughout the year. A scheduled biannual power plant maintenance outage was conducted during May, and one production well required a major workover after the casing spontaneously split sometime during the outage, which allowed cold water to flow down into the reservoir at a rate of 900 gallons per minute. This workover was complicated by a severe nighttime windstorm that blew 6,700 ft of drillpipe out of the derrick and damaged the rig, requiring a replacement to finish the workover.

The power plant capacity gradually increased to full output (16.7 MW) during the first three quarters of the year due to increased reservoir pressure, which resulted from modifying the injection strategy. All injectate is now directly returned to the reservoir via a well at the western edge of the silica terrace. A tracer test confirmed returns of injectate to all three production wells. The increase in reservoir pressure has, at least temporarily, compensated for the cooling of the production wells, which continued through the year.

Bradys, 1992—21 MW Pumped Dual-Flash

The Bradys project operated normally with no major outages. Plant availability was in excess of 99 percent for the year. Only one production well pump, out of a total of eight, required major repairs or rebuild work during the year, as compared to three in 1993. One new makeup production well was drilled and placed in service in May. One new injection well, which required three redrills to locate adequate permeability, was completed during mid-1994. Late in the year, planning commenced to convert one of the deep injection wells on the west side of the I-80 freeway to a production well in order to take advantage of the higher temperature fluid in the deeper wells.

Desert Peak, Nevada, 1985—9 MW Dual-Flash

The plant operated at an average net output of 8.3 MW in 1994. The only abnormal event during the year was a planned rotor change in the turbine to increase turbine efficiency. This plant has the only Delaval turbine in the United States' geothermal industry.

At the end of 1995, the power sales agreement with Sierra Pacific Power Co. will reach the end of its 10-year term. This is the first of the

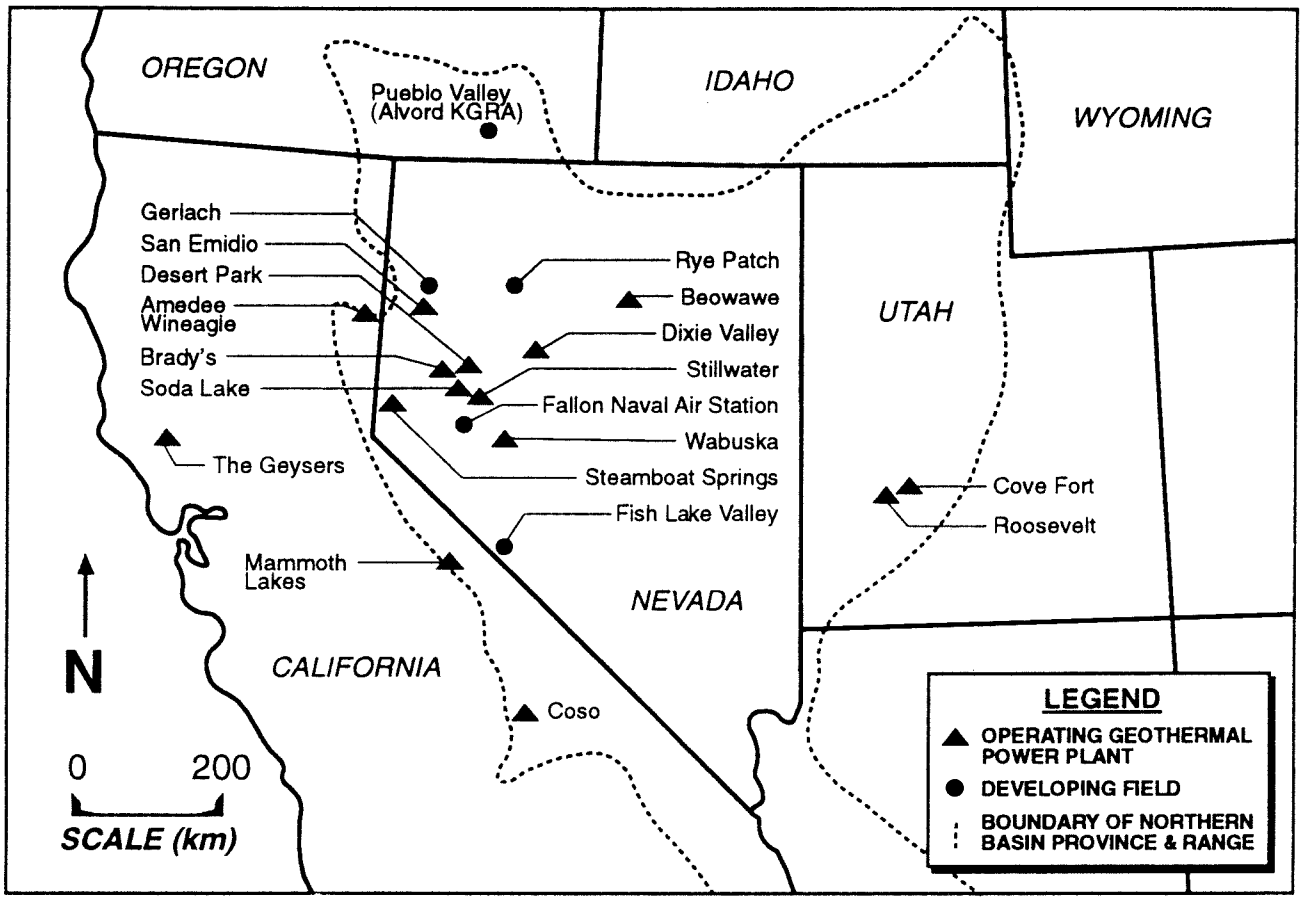

Figure 1. Location Map *(modified from Edmiston).*

three "demonstration" contracts Sierra signed with the geothermal industry in the mid-1980s. The other two were for the initial binary power plant at Steamboat Springs and at Darroughs Hot Springs in the Big Smoky Valley of central Nevada. The contract at Darroughs was never put into effect as limited exploratory drilling did not indicate adequate resource temperature.

Dixie Valley, 1988—56 MW Dual-Flash

At Dixie Valley, Nevada, the dual-flash power plant continued to operate at more or less contract capacity. Total output in 1994 was lower than in previous years. The first scheduled maintenance outage in 3 years was performed in the spring. During the outage, minor workovers of all production wells were performed, allowing replacement and maintenance of the carbonate scale inhibition systems, some of which had operated continuously for 3 years. Testing of a non-corrosive inhibition chemical continued intermittently during the year. In October, a helicopter flew into the transmission line, severely damaging nine wooden H-pole structures and sending about 9,000 feet of conductor to the ground. Miraculously, no one was injured and the helicopter suffered only minor damage. The transmission line repair required eight days of around-the-clock work.

Dixie Valley Power Partners, which is a partnership of Dixie Geothermal Corp., (an affiliate of Caithness Corp.) and ESI Energy Inc. (a subsidiary of FPL Group), drilled a deep exploratory well (36-14) a couple of miles southwest of the existing Oxbow power plant. No information has been publicly released from this well. This, along with the Navy SNORT 2 well at Indian Wells Valley, California, were the only major exploratory wells drilled in the Basin and Range Province during 1994. The well was drilled to supply a proposed 20 MW power plant and to fulfill, perhaps, the last Standard Offer 4 contract with Southern California Edison in the Basin and Range Province.

Ten 500-foot deep temperature gradient holes were jointly drilled by Dixie Valley Power Partners and Oxbow Geothermal Corp. during the summer.

Empire, Nevada, 1987—3 MW Binary

This plant continued to operate below rated capacity due to resource cooling that occurred early in the life of the project. Production temperatures did not change during 1994. Plans for resource enhancement were made during 1994 and, hopefully, will be implemented in 1995.

A short distance north of the power plant, the Integrated Ingredients Dehydration Facility came on line in February. This vegetable dehydration facility is owned by Burns Philp, an Australian food processing company, and is capable of processing 300,000 pounds of raw onions daily into 50,000 pounds of dry product. It processes both onions and garlic grown in Nevada and California. The raw product and geothermal fluid are both supplied by Empire Farms. An 1,800-foot deep replacement well was drilled in 1994 to replace a cooler, shallower production well drilled in 1993. The new well produces 308°F fluid and this fluid is injected back into the reservoir.

Soda Lake, Nevada, 1987 and 1991—12.5 MW Binary

The capacity of the plant was increased by putting the most recent well (drilled in 1993) into production. An additional production well is planned to bring the plant to full output but is on hold until there is a final decision on the long-term capacity rating for the sale of power from the project.

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

The 12.5 MW single-flash plant continued to operate normally throughout the year. Unfortunately, a planned binary plant expansion is now on hold, as the Nevada Public Service Commission disapproved, on the basis of price, a proposed contract with Sierra Pacific Power Co. during 1994. It is a sign of the times that the contract price was the same as the most recent contracts Sierra Pacific had signed. Caithness has appealed this decision to the courts.

The two large binary plants in the terrace area operated normally throughout the year with the exception of two major generator failures. These generators were placed in service less than 2 years ago. Also, the original binary plant, placed in service in 1986, continues to have routine generator problems.

Plans for a Kalina Cycle plant at Steamboat are on hold due to lack of a power sales agreement with Sierra Pacific Power Co. Sierra Pacific is in the process merging with Washington Water and Power, and headquarters staff will be moved to Spokane, Washington.

Stillwater, Nevada, 1989—12 MW Binary

The output of the plant was increased by installation of a higher capacity production pump in one well and the installation of a permanent standby pump in a spare production well. The temperature recovery program apparently peaked in mid-year, and flow rates and temperatures have remained essentially stable for the last half of the year. The plant now operates near its rated capacity, but there was some loss of output in 1994 with abnormally warm weather reducing the efficiency of the air coolers.

Wabuska, Nevada ,1984—1.2 MW Binary

The two units operated normally throughout the year with no major outages. The control cabinets were upgraded by replacing relays with computerized control systems. This has reduced downtime and improved reliability. No well work was performed during the year. During the 11 years this plant has been operating, the reservoir temperatures have declined at most only 1 or 2°F.

Amedee Geothermal Venture 1, California, 1989—1.6 MW Binary

There were no significant changes to this power plant in 1994. The fluid temperature is continuing to slowly decline and the plant output is now down to 0.85 MW.

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

During 1994, the total output of the power plants increased by about 6 MW due to an ongoing aggressive drilling program utilizing as many as four rigs.

The Calpine/Los Angeles Department of Water and Power project on the west side of the Coso field continued to languish in 1994 with no work being performed on site.

Mammoth Lakes, California, 1986 and 1991—40 MW Binary

The three binary plants operated throughout the year with an availability over 99 percent. There were no new wells drilled. Permitting for a fourth power plant continued during 1994. Mono County has made application to the California Energy Commission for $1 million for the next phase of drilling the LVF 51-20 "magma" well. DOE funding is also required but appears questionable at this time.

Wineagle, California, 1985—0.8 MW Binary

There were no changes to this project during 1994. The fluid temperature has declined to 217°F but now appears to have stabilized. During 1995, this project will reach the end of its 10th year under the Standard Offer 4 contract. It will be the first geothermal plant in the Basin and Range Province to do so.

Bonnett Geothermal Power Plant (Cove Fort), Utah, 1985 - 1990—10 MW Binary, Dry Steam, and Single-Flash

In 1994 the power plant name was changed from Cove Fort to Bonnett and the Utah Municipal Power Agency purchased all lease rights from Mother Earth Industries. In November, an injection well was successfully tested, opening the way for flow testing of a previously drilled hot-water well that could potentially increase plant production by 1.5 MW. After 2 years of being out of service, the Ormat binary units and the topping turbine are back on line. The steamfield pressure and temperature appear to have stabilized at 24 psig and 260°F.

Roosevelt, Utah, 1984—23 MW Single-Flash

The power plant and steam field operated normally throughout the year with an average output of 22.5 MW with no significant events.

Development Projects

Fallon Naval Air Station, Nevada

No additional exploratory drilling took place during 1994. The Navy obtained 72 line miles of seismic reflection data during 1994. The Navy continued preparations leading to a solicitation in early 1995 for proposals for development of geothermal resources on the air station. This is the Navy's third attempt at this project, dating to the early 1980s.

Fish Lake Valley, Nevada

Developmental drilling that was planned to begin in the spring of 1994 did not occur. The contract was transferred to a proposed Imperial Valley geothermal power plant by Magma. California Energy Company purchased Magma late in the year.

Gerlach, Nevada

ESI/San Emidio Resources Inc. drilled three temperature gradient holes to depths of 800 to 1,500 ft and one observation/production well to 3,000 ft a short distance north of the Great Boiling Spring. This was a continuation of exploration begun in 1993 with the intent of selling power to Sierra Pacific.

Pueblo Valley (Alvord KGRA), Oregon

No on-site work was performed during 1994. Anadarko anticipates proceeding with development when negotiations with Portland General Electric are completed.

Rye Patch, Nevada

Early in 1994, work terminated on the Rye Patch 12.5 MW binary plant with the plant 95 percent completed and with 6 MW of proven resource. Sierra Pacific also cancelled the power purchase agreement in 1994. No substantive work was done in 1994, and with the project in default, none is expected in 1995.

Indian Wells Valley, California

In October, the U.S. Navy completed the SNORT 2 well to a measured depth of 10,004 ft. This well was drilled just inside the border of the China Lake Naval Air Weapons Station on the western side of Indian Wells Valley. The well had a maximum temperature of 158°F and had artesian flow from below 6,700 ft in fractured, crystalline, basement rocks.

Conclusions

All in all, 1994 was a decent year for the operating geothermal power plants in the Basin and Range Province. They generally operated within the range of historic availability and capacity factors. The few showing output declines were balanced by others that registered improvements.

For projects in the development stage, 1994 was a very disappointing year given that, at the end of 1993, several new projects were envisaged to be either started or completed during 1994. For various reasons, four power plants that were in an advance stage of planning in 1993 were either cancelled or deferred in 1994. The Rye Patch project was terminated. Two other projects continue to be in the permitting stage.

Turmoil in the geothermal industry will continue during the upcoming year (1996) as some of the plants that began operating in 1985 either reach the end of their primary term or, in the case of the Standard Offer 4 contracts, go "over the cliff." In either case, substantially lower revenues are expected.

Acknowledgements

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Reference

Benoit, D., (1994). Review of geothermal power generation projects in the Basin and Range Province, 1993, *Geothermal Resources Council BULLETIN*, v. 23, no. 5, p. 173-178.