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A DECADE OF GEOTHERMAL DEVELOPMENT IN NEVADA 1978 - 1988

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ABSTRACT

Development of Nevada's geothermal resources has accelerated in the last decade making it second only to California in geothermal utilization. Principal areas of development include both flash and binary geothermal power plants, industrial process heating, commercial and residential space heating, and aquaculture.

The main reasons for this rapid and far reaching development appear to include the availability of a widespread and compatible geothermal resource and data base, the successful implementation of temporary artificial financial incentives, active and relevant research programs, and a generous amount of entrepreneurship.

This paper presents an historical perspective of major geothermal project milestones as they were influenced by significant government sponsored research and development programs, the development of the current state regulatory framework, and various financial incentives. It is postulated that, in spite of the limited electrical market, lack of adequate power transmission lines, and reductions in the cost of fossil fuels, the combination of the factors described above prevailed and contributed to the growth of Nevada's Geothermal Industry.

GEOTHERMAL ELECTRIC POWER PLANTS

At the present time, there are eight geothermal electric power plants in the State of Nevada (Fig. 1).

Tad's Enterprises received the first electrical generator construction permit from the Nevada Public Service Commission (NPSC) in May 1984 (Fig. 2) and on September 30th, put the first commercially produced geothermal electricity on line at Wabuska Hot Springs, approximately 40 miles east of Carson City. Tad's is now operating two systems, generating electricity from an inlet temperature of 220° F, producing a total of 1.2 MWe for Sierra Pacific.

In December, 1985, three more power plants came on line. One of these, located at Desert Peak, 65 miles northeast of Reno, was authorized in 1981 by a contract between Sierra Pacific and Phillips Petroleum Co. (later bought out by Chevron Resources Co.) as a pilot plant. The

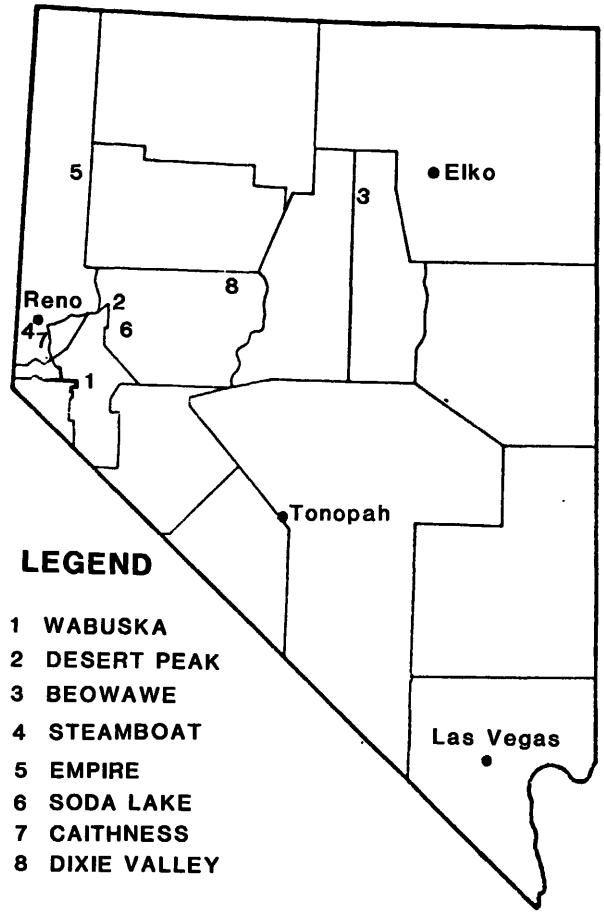

Figure 1. Location of Geothermal Electric Power Plants in Nevada

reservoir temperature at Desert Peak is about 400°F and the power system uses a single flash system that produces 10 MWe.

Another plant to come on-line that same month is located at Beowawe Hot Springs, 55 miles west of Elko. Beowawe, owned and operated by Chevron Geothermal Co. operates from geothermal fluid at 420° F, using a double flash system, producing approximately 16 MWe of power. The electrical output is sold to Southern California Edison and Sierra Pacific. Ormat Systems, Inc. and

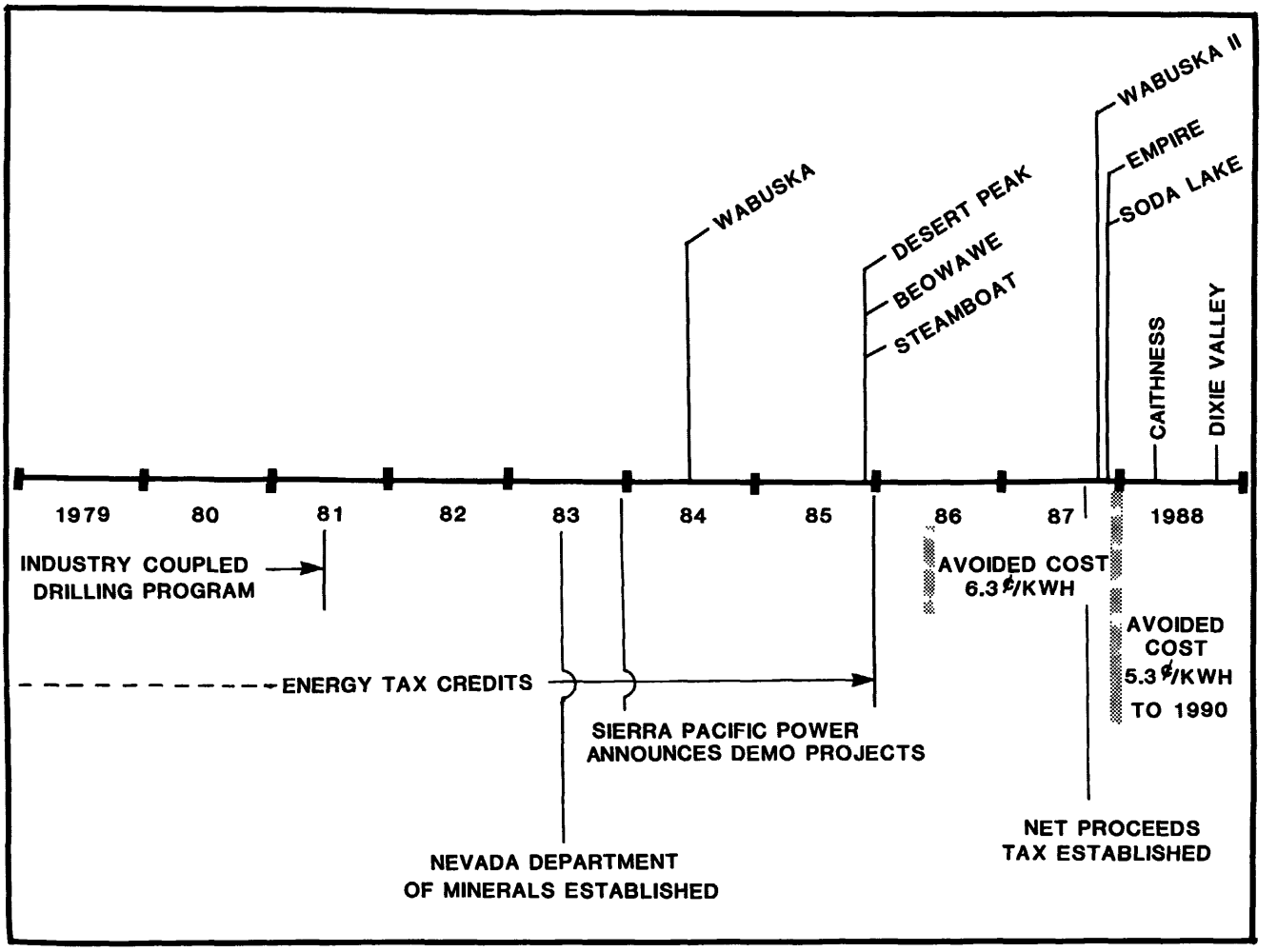

Figure 2. Development Time Line of Geothermal Power Plants in Nevada

Geothermal Development Associates also announced completion of the GDA-ORMAT Steamboat Springs Geothermal Plant in December, 1985. This plant, like Desert Peak, was also a Pilot Plant. The energy is purchased by Sierra Pacific under a 10-year contract. The plant consists of seven binary power modules, using geothermal fluids at a temperature of 325° F, producing a total gross generating capacity of 7.4 MWe.

In December, 1987, Ormat placed two binary geothermal power plants into service. The Empire geothermal project is located 10 miles south of Gerlach Nevada and operates four binary modules at a gross capacity of 4.8 MWe. The other plant is located in the Soda Lake area, five miles northwest of Fallon. Three binary modules use a geothermal resource that was developed by Chevron Resources. Soda Lake has a gross capacity of 3.6 MWe. Both plants sell power to Sierra Pacific.

The Yankee/Caithness joint venture put a power plant on line at Steamboat Hot Springs, 10 miles south of Reno, on January 19, 1988. This plant has a single flash system and uses a Geothermal Energy Corporation turbine, which was originally constructed in the 1940's and intended for use on U.S. Navy Destroyers. The plant has a gross capacity of 13.5 MWe and also sells power to Sierra Pacific.

DIRECT USE PROJECTS

The distribution of the principal direct use projects in Nevada is shown on Figure 3. Space and water heating are among the most important and natural uses of geothermal energy. Historically, direct use of geothermal energy dates back to prehistoric times when members of the indigenous Native American populations used hots spring for a variety of applications. Figure 4 shows the development of the principal direct use projects in Nevada for the last ten years. Geothermal water can be pumped directly into radiators if the chemical composition permits. However, if the chemical quality of the water causes scaling or corrosion, heat exchangers must be used.

Many homes, churches, and commercial buildings in southwest Reno are able to use geothermal wells for space heating. The Warren Estates subdivision has two wells that supply

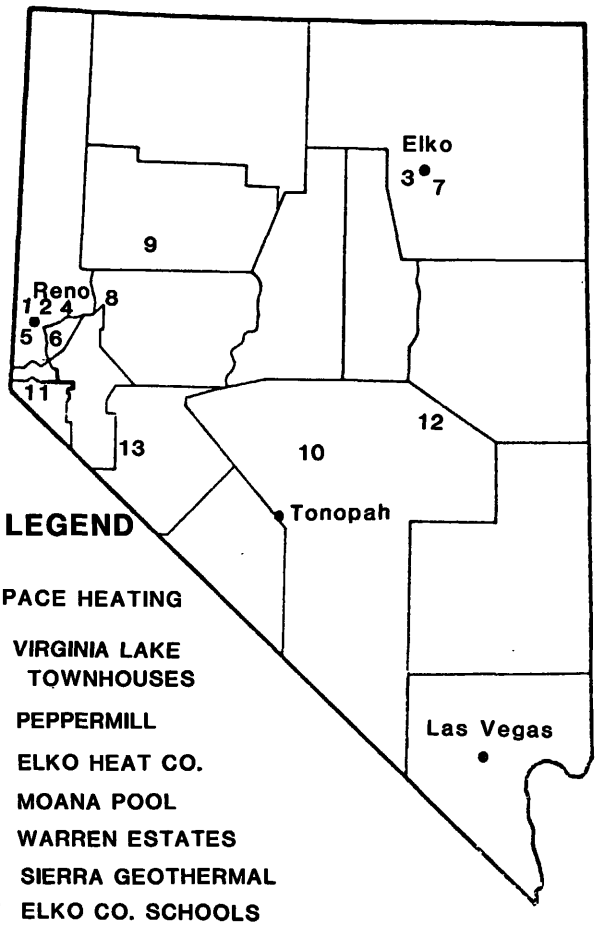

Figure 3. Location of Direct Use Projects in Nevada

geothermal water to 60 lots in order to heat homes, domestic water, swimming pools, and spas. Sierra Geothermal is another privately owned and financed geothermal district heating system.

The Peppermill Hotel and Casino is saving 33 percent in monthly utility costs by pumping geothermal water to heat a 15 story tower. Nearby Virginia Lake Townhouses provides hot water to 40 homes and plans to expand the operation to heat another 40 condominiums.

Elko is also utilizing its geothermal resources. The Elko Heat Company uses one well to heat a casino, two banks, and a laundry. The Elko County School District uses another well to heat the Junior and Senior High Schools, the Hospital, Convention Center, municipal swimming pool, and several other administration buildings.

A vegetable dehydration plant at Brady's Hot Springs, the first in the United States, pumps geothermal waters at a temperature of 270° F to a battery of dryers, producing about one million pounds of dehydrated onions per month. The plant operates from May through October and saves about $250,000 per year by using geothermal energy instead of natural gas.

One of the most recent and innovative applications of geothermal energy is presently under development at two gold mines in northern Nevada. Geothermal heat energy is being used to enhance cyanide heap leaching operations, and to extend the leaching season through the cold winter months.

The Round Mountain Gold Corporation completed construction of a geothermally heated leach pad in December, 1987. Geothermal fluids at a temperature of 180° F are pumped to a large flat-plate heat exchanger at a rate of 600 GPM. Leaching solutions that contain cyanide are circulated through the heat exchanger at 2000 GPM, increasing reaction rates and reducing the formation of ice on the leach pads. The Round Mountain Gold Corp. produced 193,000 ounces of gold in 1987 and is expected to produce 200,000 ounces in 1988.

Pegasus Gold Corp., located in Pershing County, uses geothermal fluids at an initial temperature of 230° F to provide heat to one of the largest single leach pads in the world. Water in the cyanide circuit is supplied to the heap at a rate of 1200 GPM. Geothermal fluids are supplied to the heap on an as needed basis.

Nevada's geothermal waters have also been found ideal for raising several species of fish. Warm springs in western and southern Nevada have sufficiently high flow rates and sufficiently low total dissolved solids to support catfish, freshwater prawns, and both live bearing and egg laying tropical fish.

One of the first commercial operations in Nevada began at the Shoshone Indian Reservation at Duckwater in Nye County. Water from Big Spring, 95° F, is diverted to a series of concrete raceways, each supporting approximately 2000 fish. The catfish grow quickly in the water, which ranges in temperature from 85 to 90° F, and reach a size of 1.25 pounds in just six months. Fish raised in concrete raceways are said to have a better flavor because they do not live in muddy channels or ponds. These fish are sold to markets throughout the west.

Commercial production of giant freshwater prawns has been demonstrated at Hobo Hot Springs. In 1983, Gourmet Prawnz and the Washoe Tribe began a joint venture to cultivate prawns for consumption. By 1985, prawns and other live bearing tropical fish were being raised strictly for the pet market. Birk (1987) presented initial results on the propagation and grow-out of selected species. Present activities at this

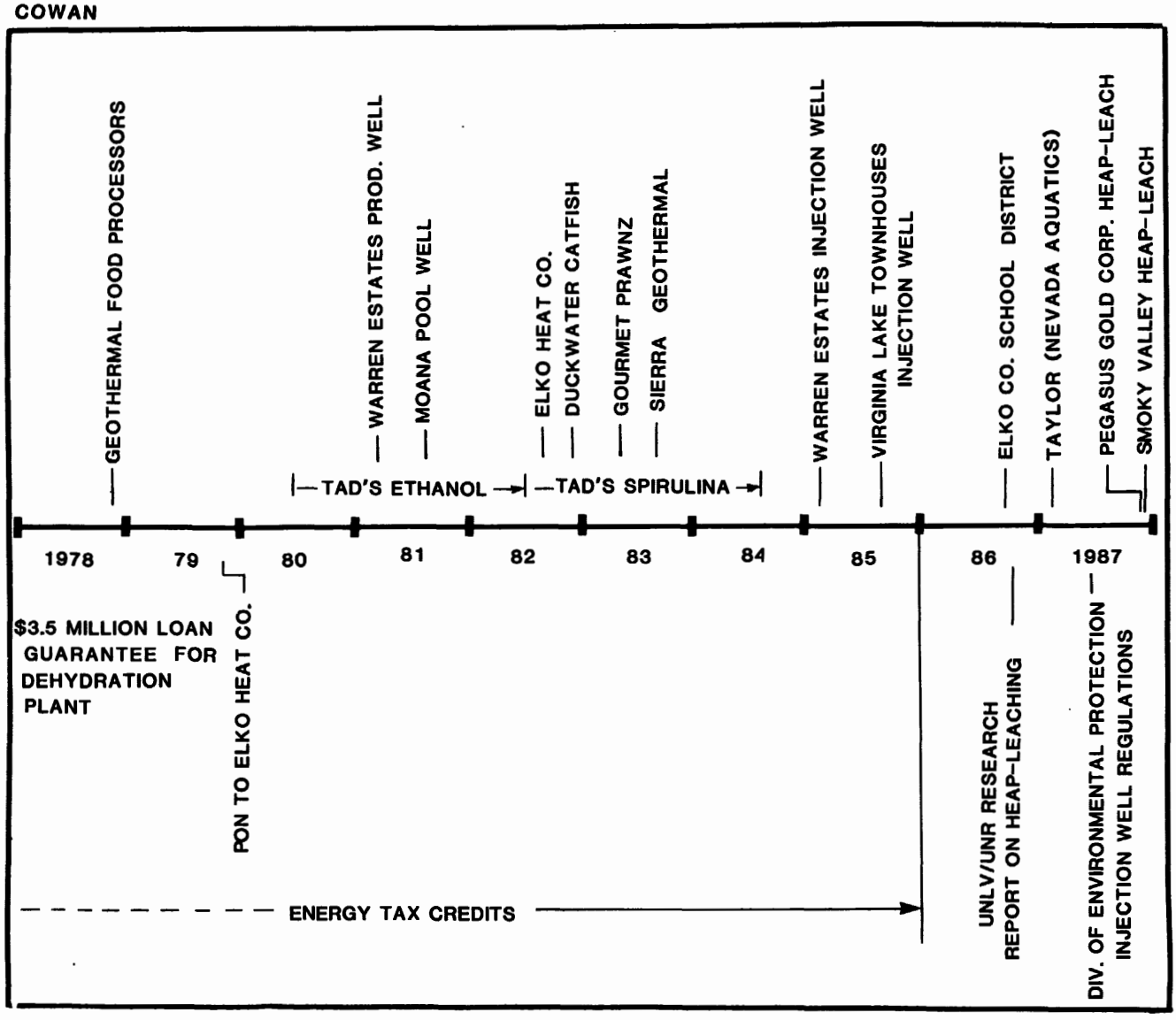

Figure 4. Development Time Line of Geothermal Direct Use Projects in Nevada

facility, which combines research and commerce, includes intensive cultivation of egg-laying tropical fish (Angel Fish), studies of threatened and endangered species from the Amazon River Basin, identification of tropical species for food fish, and use of spent geothermal fluids in a vertically integrated agricultural application. These fish are marketed to wholesalers and pet stores in California and Nevada.

Tropical fish propagation is also underway at Hind's Hot Springs, in Lander County. Dr. Robert Taylor started a company known as Nevada Aquatics in January, 1987. Water from the hot springs, which range in temperature from 135 to 150° F is diverted to a series of 20 ponds. The operation produces both live-bearing and egg-laying tropical fish, as well as several varieties of a species of fresh water sharks. These fish are also marketed in Nevada and California.

FINANCIAL INCENTIVES

Nevada's geothermal resources were developed over a period of ten years with the assistance of both natural and artificial financial incentives. In addition, an ongoing program of relevant research and development, as well as the evolution of a directed regulatory framework, helped foster the growth of the geothermal industry.

One of the first was the U.S. Department of Energy-sponsored Industry Coupled Drilling Program, which lasted from 1978 to 1981, and provided large scale financial incentives to geothermal exploration and development companies (Fig. 2). Fiore (1980) described the program's elements and reviewed its status for Utah and Nevada. The program provided funds to purchase proprietary geothermal data and matching funds for major drilling operations, thus significantly

reducing financial risk for development companies. Twelve geographic areas throughout Nevada were investigated and, as a measure of success, five now support power plants.

In December, 1983, Sierra Pacific Power Company announced plans to participate in three geothermal demonstration programs. Two projects were eventually developed: the Phillips Petroleum project at Desert Peak, and the Geothermal Development Associates project at Steamboat Hot Springs. The third contract never materialized and was cancelled. The demonstration programs provided a financial incentive of approximately $0.065/KWh for geothermally produced electricity.

Energy Tax Credits, which had been available since 1976, were set to expire on December 31, 1985. With the prospect of loosing valuable tax and other investment credits, three geothermal power plants pushed to complete construction and demonstrate their capacity to produce power before the cutoff date. Both the Desert Peak and Beowawe Plants initiated and operations prior to December 31. The Steamboat Binary plant completed a certification test of 100 hours of operation, but did not commence full-time production until several months later.

In June, 1986, after months of debate, the Nevada Public Service Commission (NPSC) set long term avoided cost rates for electricity generated from Qualifying Facilities (QF's) at 6.3 cents/kWh (NPSC Docket nos. 85-1004, 85-1005). The NPSC set a limit of 35 MWe and required QF's to be on-line, or certified, by December 31, 1987. Wabuska II, Empire, and Soda Lake plants, which are all Ormat binary units, satisfied these requirements. The Caithness Corp. flash plant at Steamboat did not go on-line until January, 1988. The plant is presently producing approximately 12.5 MWe for sale to Sierra Pacific at a rate of about 5 cents/kWh. This contract is still under negotiation.

A subsequent ruling by the NPSC (Docket no. 86-126) reduced the long term avoided cost rates to 5.3 cents/kWh for a total of 50 additional megawatts for QF's that go online by 1990.

The Oxbow power plant in Dixie Valley was unaffected by the rate change since its power is sold to Southern California Edison under a Standard Offer 4. A key factor in this situation was Oxbow's independent construction of a 225 mile long power line from Dixie Valley to Bishop. California.

Direct use project development has also been influenced by financial and other incentives. In late 1978, a $3.5 million dollar loan was guaranteed by the U.S. Department of Energy, enabling construction of the first vegetable dehydration plant at Brady's Hot Springs (Fig. 4).

Another DOE financial incentive was the Program Opportunity Notice (PON), which was a cost-share program with private industry designed to demonstrate the technical and economic feasibility of direct use geothermal heat (Childs, 1980). The Elko Heat Company successfully participated in the PON, which cost- shared much of the $1.5 million in project expenses. A flurry of activity, especially the construction of residential geothermal wells in the Moana area of southwest Reno, occurred prior to the December 31, 1985 cutoff date for federal energy tax credits. Projects that benefited included the Warren Estates and Sierra Geothermal district heating systems, the Duckwater Catfish farms, Gourmet Prawnz, and the Virginia Lake Townhouses.

The Wabuska geothermal resource has a history of development that dates back to the turn of the century. The most recent projects include the geothermal ethanol plant, which produced an alcohol that could be blended with gasoline and sold as gasohol. That project was terminated in 1982 when gasoline prices began to fall. Spirolina, a high-protein algae, was also grown at the Wabuska site for a while, but was discontinued when the power plant went on-line.

The development of the Elko County School District geothermal project was assisted by the DOE School and Hospital Grant Program. Elko County also contributed to the project.

In 1986, research scientists from the University of Nevada, Las Vegas and the University of Nevada, Reno completed and published the results of a bench-scale experiment that demonstrated the use of geothermal heat energy in gold mining cyanide heap leaching operations (Flynn and others, 1986). By late 1987, two gold mines, Pegasus Gold Corp. and Smoky Valley Gold Corp. were using geothermal energy to increase the temperature in the cyanide leaching circuit and to maintain operations during the cold winter months.

INSTITUTIONAL DEVELOPMENTS

Two significant institutional developments occurred during the last ten years that influenced the geothermal industry. The most significant was the classification of geothermal energy as a mineral, as opposed to a water, resource, and the subsequent establishment of the Nevada Department of Minerals (DOM) in 1983. DOM is the principal regulatory agency for geothermal resources and supervises and approves all drilling and development in Nevada.

In 1987, the Nevada Administrative Code (NAC) was amended to include a method for determining the gross value of geothermal resources. The Department of Taxation and the geothermal industry worked together to develop a formula to assess and tax the net proceeds of operations that extract geothermal resources for a profit (NAC 362.015). This formula is the basis for the state tax on geothermal power plants.

SUMMARY AND CONCLUSIONS

Nevada has made great progress in using its widespread geothermal resources throughout the state in the last decade. Much of this progress has been influenced by artificial financial incentives, including DOE sponsored demonstration and research programs, federal tax incentives, utility demonstration programs and state-mandated long-term avoided cost rates for electricity. In fact, project development is shown to accelerate

during windows of financial opportunity which are stimulated by artificial means.

Less obvious is the profit motive for project development. Many of the privately financed direct use projects were initiated to capitalize on a variety of market opportunities including district space heating, tropical fish, and catfish. The track record for most of these projects is still being established and will be fully addressed in a subsequent report. The profit motive is also the principal reason for the construction of a 225 mile long power line from Dixie Valley to the lucrative electrical markets in southern California.

Geothermal progress in Nevada has given rise to additional state regulations that provide for financial incentives for development, environmental protection, and taxation. This progress is consistent with a national policy for energy conservation and a state policy of economic diversification.

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