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Geothermal Energy in Oregon

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ABSTRACT

Almost 30 years ago a geothermal power plant commenced operations near Lakeview Oregon. While it only operated for 12 months, it represented a milestone that only now may be exceeded. This paper documents recent geothermal power exploration and development efforts in Oregon.

Geothermal explorationists are actively working on six prospects around the state. They are located at Newberry volcano, Crump Geyser, Neal Hot Springs, Klamath Falls (2), and Paisley. These sites may have as much potential as 200 MW. By the time of presentation in April 2010 at least one of these projects may be operating.

1. LOCATION

Oregon is located along the Pacific Ocean north of California where tectonic plates collide. Abundant centers of volcanism younger than 100,000 years old form the backbone of the state, the Cascade Mountain Range (fig. 2). Volcanoes have been erupting in the Cascade Range for over 500,000 years. During the past 4,000 years eruptions have occurred at an average rate of about 2 per century USGES, 2009). Mt. St. Helens eruptions in 1980 provide evidence of recent magmatic eruptions in the Cascades .Heat-flow coming from magma at depth (>10km / 6 mi.) is concentrated along the Cascade Range (Blackwell, et all 1990.) Few deep wells have been drilled to confirm the elevated heat and potential geothermal resources. However, wells drilled at Newberry Volcano in Oregon and in the Cascades of British Columbia have found temperatures in excess of 200°C (500°F).

Oregon contains nine physiographic provinces according to the U.S. Geological Survey. Geothermal resource areas can be found in the Cascades (both western and high), the high desert (Basin & Range Province) and transition zones between them. Perhaps the best example of transition area of interest is Newberry Volcano, located in central Oregon. It is a Quaternary dormant volcano that last erupted 1350 years ago. Essentially the eastern two thirds of the state contain some level of geothermal energy (fig. 3). In Oregon today the Geo-Heat Center at Oregon Institute of Technology identifies 2195 individual resources (GHC, 2007).

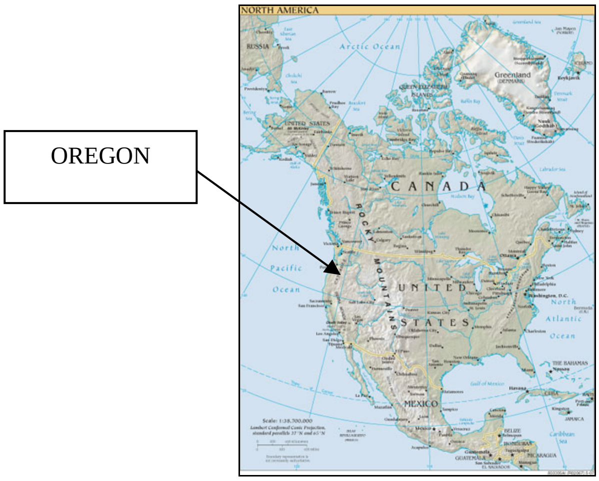
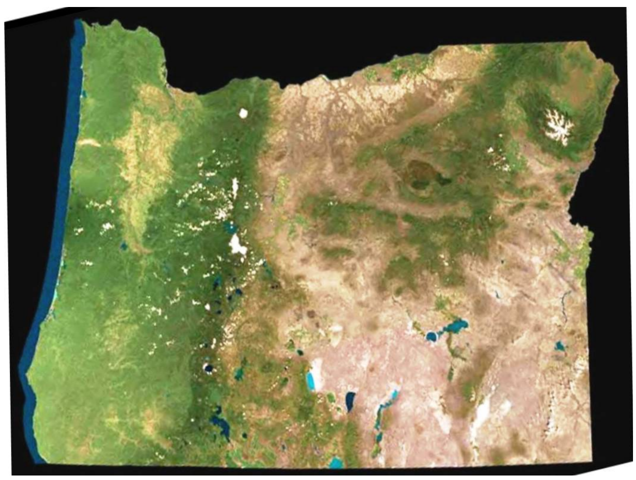


Figure 1: Oregon Location

Washington▲ (North)



California▼

Figure 2: Oregon Satellite Image

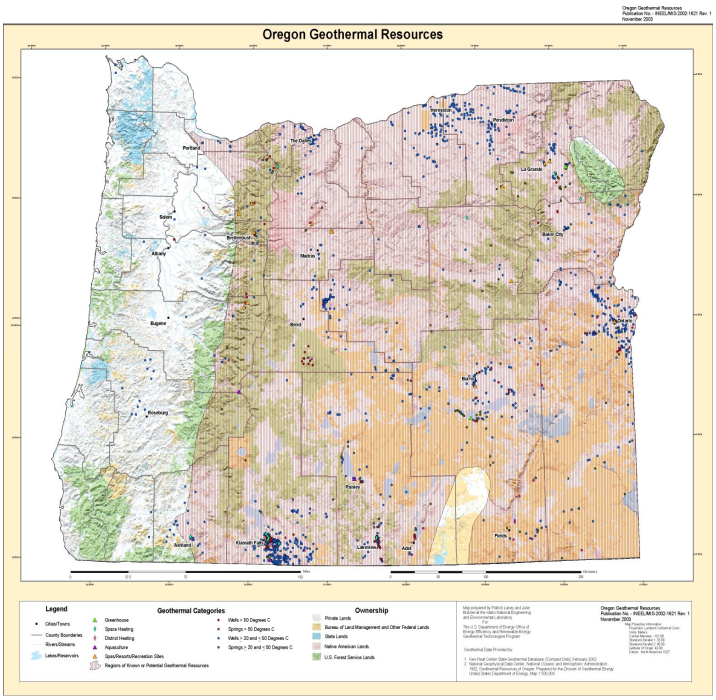


Figure 3: Oregon Geothermal Resources

2. DIRECT USE DEVELOPMENT

Native Americans used hot springs in numerous Oregon locations. OIT estimates there are 630 applications in Oregon that provide 626,703 gigjoules (594 x 10^9 Btu) of energy per year for space heating, greenhouses, aquaculture, pools and resorts of uses (fig. 4). Many cities and towns in the eastern two thirds of the state use geothermal energy.

Klamath Falls boasts that you can go from birth through death all in geothermally heated facilities. These buildings include the local hospital, elementary schools through college, brewpub, homes, businesses, assisted living facilities and a funeral parlor.

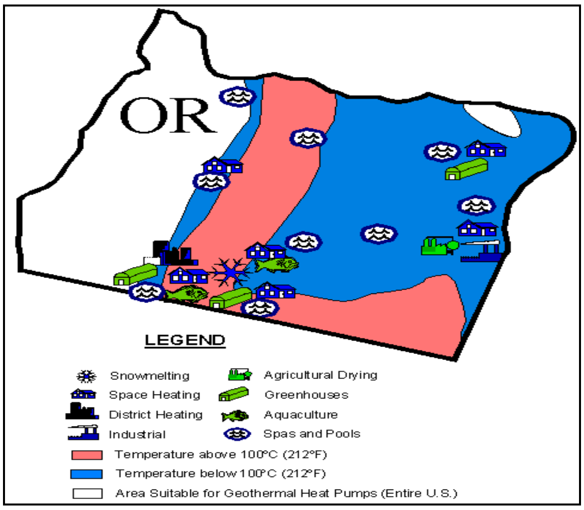


Figure 4: Geo-Heat Center Map of Oregon Applications

The City of Klamath Falls Geothermal Utility provides cost effective heating services utilizing a renewable, non-polluting "green" resource. The City of Klamath Falls is located in a Known Geothermal Resource Area (KGRA). Utilizing geothermal water supplied from wells producing 94-105°C (200-220°F) water, the City operates a geothermal utility system which provides heating services to commercial and government buildings throughout the downtown core area as well as geothermal sidewalk and bridge snow melt systems. The sidewalk and bridge snow melt systems provide safety and convenience throughout the winter months that would not be obtainable without low cost geothermal energy.

The benefit of geothermal heating is lower energy costs compared to competing heating sources. As oil, natural gas and electricity sources continue to increase, the cost of providing geothermal heat remains low along with providing a much higher heating efficiency than other heat sources.

Figure 5: Klamath Falls geothermal sidewalk (courtesy City of Klamath Falls Public Works)

Lakeview, Oregon has long experience using local geothermal resources. The Town of Lakeview has wells and a system designed for increased commercial users. Geothermal wells in the area have temperatures up to 96°C (205°F). The range of geothermal applications includes a commercial greenhouse operation and space heating at a hotel, homes and the Oregon Department of Corrections

Warner Creek Facility. Additional geothermal resources exist in the north and south areas of Lakeview's Urban Growth Boundary and the Town of Lakeview is currently working on developing these resources for power generation and district heating.

Vale hot springs, near the Idaho border was a stop for early settlers on the Oregon Trail. Until recently a mushroom plant used those same 97°C (207°F) waters in its operation. It closed for reasons unknown. Seasonal agricultural processing and modest space heating applications exist. La Grande has warm water within City limits. Hot Lakes Resort, just south of La Grande, is undergoing restoration with soaking tubs under construction in May 2009 (Hot Lake Springs, 2009). Burns and other areas have useful geothermal resources for space heating, greenhouses and pools.

Isolated hot springs and resorts are found in the Blue Mountains, Columbia Plateau and along the western Cascades. Some are undeveloped pools and others like Belknap Hot Springs are large resorts. The rest of Oregon has groundwater suitable for ground source heat pump use as shown in Figure 3. In sum, Oregon has a long proud growing tradition of direct use geothermal energy.

3. POWER GENERATION DEVELOPMENT

Past Activities

Wildcat exploration for high-temperature resources occurred first in 1959 with the arrival of Magma Power. Magma affiliate Nevada Thermal drilled a 513 m (1684 ft) well in the Warner Valley near Adel. The well reportedly flowed 121°°C (250°F) water. The well began geysering and has since been known as Crump Geyser. In 1960 Magma drilled a 155m (510 ft) well just north of Lakeview that flowed 103°C (217°F). That well was subsequently put to use heating a greenhouse. (Brown, et al, 1983)

Wildcat generation occurred in March 1982 when a 40kW Solar Power Systems binary plant operated briefly at the Rockford Ranch well in Lakeview Oregon. Pacific Power & Light contracted in May of that year to buy the output of that 40 kW plant for six months to demonstrate plant technical feasibility using 80°C (176°F) water. Results were largely negative. Later in 1982 three 400 kW Solar Power System binary generators were installed in the Hammersly Canyon area north of Lakeview. The operation used 100°C (212°F) and in April 1983 three 300 kW Ormat binary generators were added. In March 1984, PP&L again contracted for one year to purchase the plant output of the now 2.1 MW project. Utility research goals were similar to the prior demonstration. No significant operation at the larger plant ever took place. It produced power for one year after which difficulties caused the operation to cease. These included landing a long term power sales agreement, cooling operation, and interference with nearby wells (Sifford, 1990).

Developments described above occurred on private land. Firms looking at larger prospects on federal lands followed leasing guidelines created by the passage of the Geothermal Steam Act of 1970. Federal lands – USDI Bureau of Land Management (BLM) and USDA Forest Service (USFS) – amount to over one half of Oregon land ownership. Those same federal lands are mostly in the Cascade Range, central Oregon and eastern Oregon, all areas of high geothermal potential.

Both competitive and noncompetitive leasing has occurred in Oregon for over 30 years, beginning in earnest in 1976. The first geothermal lease applications in Oregon began at Newberry volcano, recorded in February of 1974, one month after geothermal lease procedures for federal lands had been formalized. In 1976 the Newberry Known Geothermal Resource Area (KGRA) was created, covering mainly the caldera portion of the volcano. The Caldera was closed to further exploration by formation of the Newberry National Monument in 1990. Lands outside the caldera are generally open for further development.

After a long hiatus, the most recent competitive federal lease auction was held in December 2008 for parcels at Glass Butte in Central Oregon. Two companies, Ormat Nevada and Magma Energy (US) bid on 11 parcels totaling over 41,000 acres. It was appealed by the Oregon Natural Desert Association. On April 28, 2009, the IBLA denied ONDA's petition stay. (Kaufman, 2009).

Pueblo Valley. As early as 1978 the U.S. Geological Survey cited the Alvord Valley geothermal resource potential as among the highest in Oregon. Competitive leasing applications led to the creation of the Alvord KGRA. Exploration for geothermal resources took place there and the adjacent Pueblo Valley. Then, as now, environmental concerns, litigation, and administrative requirements impeded development. In the Pueblo Valley, Anadarko Petroleum drilled and tested a 450m (1480 ft.) small diameter well. It flowed 1200 l/m (320 gpm) at 137°C (305°F). In 1995, Anadarko submitted plans to supply, build, and operate a 23 MW (net) air-cooled binary power plant in Pueblo Valley. The project received intense opposition in the scoping phase of the environmental review (McClenahan, 2005). Anadarko negotiated at length with Portland General Electric and other private utilities but was unable to secure a power sales agreement. Between the opposition and lack of market Anadarko abandoned the project shortly thereafter.

Newberry. CalEnergy Co. took lease positions at several Oregon locations in the late 1980s. From that start the subsidiary CE Exploration proposed to build and operate a 33-MW geothermal power plant and supporting facilities on the west flank of Newberry Volcano. These facilities were to be located on Deschutes National Forest lands outside the Newberry National Volcanic Monument. The project was undertaken as part of BPA's Geothermal Pilot Program started in 1991. The goal of this program was to initiate development of the Pacific Northwest's large, but essentially untapped, geothermal resources, to confirm availability to meet regional energy needs. Net power sales were to be sold to BPA and Eugene Water & Electric Board. It included a well conceived and executed public involvement effort. Federal agencies approved the project in 1994. CE Exploration and others drilled seven gradient wells that established the heat flow and CE Exploration conducted magnetotelluric surveys prior to the exploration test drilling. CE Exploration tested the ring fracture system on the west side of the caldera. CE's wells encountered a fresh granodiorite rock at bottom hole but limited porosity and sub-commercial production rates (McClain, 2009). CE Exploration drilled four deeper test holes on the upper northwest flank of the volcano. Two of those holes were drilled as production test wells; hole 86-21 drilled to 2800 meters (9200 ft) and hole 23-22 drilled to 2926 m (9602 ft). Well 23-22 is reported to have had a bottom-hole temperature of 290°C (550°F). Well 86-21 is reported to have had a bottom-hole temperature of 315°C (600°F) (Waibel, 2009). Drilling results apparently convinced CE

Exploration management and BPA moved the project to Glass Mountain in 1996 (Pease, 2005).

Vale. One other BPA Geothermal Pilot Program project took place in the early 1990s at Vale, Oregon. It was to be 30 MW with BPA and partner Springfield Utility Board purchasing the power. TransPacific Geothermal drilled 17 shallow and two deep exploration wells before relinquishing federal leases due to their inability to confirm an economically viable resource. Parties to that agreement moved the project to Glass Mountain in 1994 (Pease, 2005).

Current Development

Wildcat efforts aside, the discussion above illustrates three prudent, deliberate efforts to generate geothermal power at Pueblo Valley, Newberry Volcano and Vale, Oregon. For the last 12 years Oregon experienced a period of geothermal exploration dormancy. One positive development is renewable (power) portfolio standards that came into effect in Oregon based on 2007 legislation. It requires large private utilities to meet a portion of their loads with renewable energy sources, typically a ladder of percentages over time. For the state's largest private utilities, it starts at 5% in 2011 and ends with 25% by 2025 (ODOE, 2007). In addition, renewable projects in Oregon under 10 MW in size have a standard contract available. Current prices are $71 per MWh on-peak and 56 /MWh off-peak, (PP&L, 2009). Projects larger than 10 MW require negotiations with utilities. Two of the projects, at Newberry and Neal, base their development on similar contracts with California and Idaho utilities, respectively.

Exploration for geothermal resources capable of generating power is taking place today at Newberry volcano, Neal Hot Springs, Crump Geyser, Klamath Falls (2), and Paisley. These sites may have as much potential as 200 MW. Project concepts range from 280 kW at Oregon Institute of Technology to as much as 40 MW at Crump Geyser. Perhaps by the time of presentation in April 2010 one of these prospects may be entering an early construction phase.

Newberry: Davenport Power is Project Operator for Northwest Geothermal Co. at Newberry volcano. Northwest Geothermal entered into a 20-year power sales agreement with Pacific Gas & Electric Co. in 2006 for up to 120 MW of power. At that time drilling preparation and environmental work began. Drilling of two deep wells began in 2007 and continued in 2008. Data from the two wells drilled so far are being analyzed at Southern Methodist University in Dallas, Texas. While Newberry has encountered both heat and fluid, they have not hit what Davenport Newberry Geothermal President Perry characterized as a "gusher." The company is evaluating data it has accumulated so far and permitting additional wells. Each well is estimated to cost around $5-$7 million each. (SeattlePI.com, 2008)

Neal Hot Springs is located 23 km (14 mi.) northwest of Vale. U.S. Geothermal Inc.. is exploring the Neal Hot Springs, Oregon prospect. Gravity and magnetic surveys were completed in 2007 and geophysical work in 2008. In July 2008 the firm completed a flow test of production well (NHS-1) at the Neal Hot Springs Project. The results indicate temperatures of 141ºC (287ºF) at a peak rate of 2,055 gpm (7800 l/m) (http://www.usgeothermal.com/NewsReleases/Jul-10-2008.pdf). Additional wells and reservoir testing is needed before the size and power generation potential of the Neal Hot Springs geothermal reservoir can be determined.

U.S. Geothermal announced in February 2009 that an interconnection agreement for the Neal Hot Springs project has been signed with the Idaho Power Company. The agreement encompasses the design and construction of a key transmission line and substation from the Neal Hot Springs project site to Idaho Power's nearby transmission grid. The new 16 km (10 mi) line is being designed for 36 megawatts of transmission capacity and is estimated to cost $3.2 million. On May 27, 2009 the firm announced that it was selected by the U.S. Department of Energy (USDOE) to enter into due diligence review on an $85 million project loan for its Neal Hot Springs project in eastern Oregon. The USDOE loan is expected to provide 80% of the $106 million estimated total capital cost. The Neal Hot Springs project is currently expected to deliver electrical power beginning in late 2011 (Kitz, 2009).

Crump "Geyser" is in the Warner Valley of south central Oregon, about 50km (30mi) east of Lakeview. GeothermEx estimated in 2006 that Crump may have a potential to produce as much as 40 – 60 MW. Nevada Geothermal Power holds leases on private land in the valley and has completed passive exploration including geophysical studies. Next steps are exploration drilling, testing and reservoir confirmation in addition to project feasibility studies.

In Klamath Falls the Oregon Institute of Technology drilled a deep test well in early 2009. Its goal is to generate power to meet campus needs. South of the Klamath Falls Raser Technologies is proposing a 10 MW project.

Elsewhere in Lake County, private parties and the Surprise Valley Electric Cooperative are examining potential generation using hot wells in Paisley. This project is in the early development stage. Other sites include long-time federal lease applications in the Cascades that the BLM just finished addressing in a programmatic EIS (BLM, 2008). The author does not ascribe much potential to those sites.

Table 1. Oregon Geothermal Power Prospects 2009

Site	Potential/Contract
Newberry	120
Crump	40
Neal	26
Klamath Falls	10
Paisley	?
Mt Hood NF leases	?
Willamette NF leases	?
Total	196

CONCLUSION

A geothermal exploration renaissance of sorts is underway in Oregon. Klamath Falls continues its steady growth, both in direct use and now possibly power. Exploration is returning to sites drilled 50 year ago at Warner Valley and 30 years ago ay Neal hot springs. Much of what is proposed is relatively small and on private land, two key factors. Those along with genuine interest from power companies both in and out of Oregon are motivating development. Even recent federal lease sales have been held, at Glass Buttes, another site examined closely for development over 30 years ago. The author is optimistic that a couple of the high-temperature prospects will materialize into modest power plants. If so, it would prove geothermal power viability in an environmentally sensitive land with less expensive alternatives.

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