**2011 Geothermal Technologies Peer Review**

**Caldwell Ranch Exploration and Confirmation Project**

**Summary**

1. **Caldwell Ranch Exploration and Confirmation Project, The Geysers, Sonoma County, CA**

Company: Geysers Power Company, LLC (“Calpine”)

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Project Team: Calpine Resource Technology staff at The Geysers

Subcontractors: Numerous drilling services companies meeting ARRA Davis-Bacon requirements

1. **Purpose and Project Objectives**

The purpose of the Caldwell Ranch Exploration and Confirmation Project is to drill, test, and confirm the present economic viability of the undeveloped geothermal reservoir in the 870 acre Caldwell Ranch area of the Northwest Geysers. The project area is the site of the demolished CCPA No.1 power plant and steam field which were abandoned primarily for economic reasons. The subject wells were permanently shut-in after the CCPA steamfield was closed in May 1996 and then plugged and abandoned in 1999 and 2000.

The objectives of the project were to:

1. Re-open and re-complete three abandoned wells: Prati 5 (P-5), Prati 14 (P-14) and Prati 38 (P-38).
2. Characterize ­current reservoir production flow rates, temperature, pressure, thickness, permeability, and fluid chemistry and compare these current data with data collected before 1996. The determination of the vertical depth distribution of NCG concentrations using a high-temperature (~350 oC) downhole geochemical sampler and high-temperature logging tools is a significant part of this objective.
3. Update the preliminary LBNL geologic reservoir model for the adjacent Northwest Geysers EGS Demonstration Project with the data from the P-5, P-14, and P-38 wells.

Calpine’s goal is to determine the feasibility of developing a new sustainable steam supply to existing power plants, or the proposed Wild Horse Power Plant. Re-development of the Caldwell Ranch Project area will depend heavily on current noncondensible gas (NCG) concentrations, and Calpine’s ability to mitigate NCG concentration levels.

The project’s purpose is to bring additional megawatts of geothermal power on-line. Previous studies by others indicate the Caldwell Ranch area may be capable of generating 22 to 45 megawatts (MW) of electrical power.

1. **Technical Challenges and Targets**

Drilling challenges included the removal of cement plugs and retainers, repairing of damaged casing, fishing for coiled tubing dropped during production, clean-out of bridges in open wellbore, and the sidetracking of the wellbores through unstable formation with lost circulation zones. The subject wells were deepened into rocks with temperatures near 350 oC.

A primary performance metric for re-opening and re-completing the subject wells is the number of days spent drilling. The subject wells were programmed for re-opening, deepening and re-completion in 30 to 60 drilling days at nominal costs of $2 to $5 million, respectively. In comparison, new “grass roots” well to a nominal depth of 10,000’ at The Geysers costs requires about 90 days to drill and costs approximately $6.5 million.

1. **Technical Approach**

Our approach to solving foreseen drilling problems was to use aerated drilling fluids and foam cement to drill through unstable formation and lost circulation zones.

Temperatures approaching 400 0C are known in the NW Geysers Demonstration Project which is adjacent to the Caldwell Ranch Project area. The high temperatures encountered in the wellbores required specialized downhole geochemical sampling equipment and pressure-temperature (PT) and pressure-temperature-spinner (PTS) tools.

An innovative combination of isotopic analyses of the rocks, fluids, and noble gasses collected from the wells in addition to the static and flowing log interpretation was designed to provide inputs to understanding the hydrothermal reservoir volume and thermal structure. The collection of cores was particularly because the physical properties of the rock in the high temperature reservoir (HTR) have not previously been measured.

1. **Technical Accomplishments**

* Three abandoned wells were re-opened and recompleted to nominal depths of 10,000 feet. Two of the wells required sidetracking.
* Two flow tests plus an estimate indicate Prati 5 Sidetrack 1 (P-5 St1), Prati 14 (P-14) and Prati 38 Sidetrack 2 (P-38 St2) are capable of initially capable of producing an equivalent of 12 megawatts (MW) of steam using a conversion rate of 19,000 pounds of steam/hour (KPH) per megawatt/hour.
* Both downhole and surface geochemical samples were collected and analyzed. The preliminary analyses show that the current conditions in the reservoir are notably different than the pre-1996 geothermal reservoir. The noncondensible gas concentrations from P-5 St1 and P-38 St2 are significantly lower than when the original wells which were produced prior to May 1996.
* A core was retrieved from P-5 St1 from a depth of 9940 feet with measured rock temperatures exceeding 650 oF (>345 oC).

1. **Challenges to Date**

* All of the drilling, logging, and sampling challenges due to the high temperature conditions were met.
* The problems in obtaining a high-temperature core while circulating with air were met by using a relatively high-rate of water “mist” injection while coring in a reduced-diameter well bore so that the core drilling assemble would fit snuggly and not wobble.

1. **Conclusion and Plans for the future**

The project consisted of three phases: (1) Identification of existing wells to characterize the geothermal reservoir in Caldwell Ranch Project Area; (2) Re-opening and recompleting three previously abandoned wells; and (3) Well testing and laboratory analyses. Phase 1 and Phase 2 are complete. Well testing and core analysis will be complete by the end of FY 2011. The goal is to connect the Caldwell Ranch Project wells to an existing power, or if economically feasible as determined by reservoir modeling and flow predictions, construct the Wild Horse Power Plant. Whether or not the Wild Horse Power Plant is constructed, or the steam is piped to an existing power plant, it is Calpine’s goal to add sustainable net production from the Caldwell Ranch Project area to The Geysers output without increasing the decline of adjacent, existing steam fields.

1. **Publications and Presentations**

None to date.