MEETING SUMMARY
UTAH GEOTHERMAL WORKING GROUP
SALT LAKE CITY, UTAH
MARCH 14 AND 15, 2007

INTRODUCTION

The Utah Geothermal Working Group (UGWG) held its 7th meeting at the Utah State Library in Salt Lake City on March 14, 2007. The following day, the UGWG sponsored a field trip to the Raft River (Cassia County, Idaho) geothermal area where U.S. Geothermal Inc. is developing a 10 to 13 MW geothermal power project. A total of 69 people, including speakers, attended the two-day event. A list of attendees is attached.

The purpose of the meeting was to bring attendees up to date on recent federal and state actions that either already have affected or may affect the future development of geothermal energy, and to review regional geothermal power development projects. In contrast to the two-day meeting in March 2006 that focused on direct-use geothermal and ground source heat pumps, this meeting focused on power generation from high temperature geothermal sources and legislative efforts to further the use of geothermal power.

WEDNESDAY, MARCH 14, 2007

The following paragraphs summarize the presentations given by the thirteen speakers on March 14th.

Robert Blackett, Utah Geological Survey (UGS), summarized Utah geothermal development activity by reviewing the large, on-going, direct-use projects at Newcastle (Milgro Nurseries and Castle Valley Greenhouses) and Bluffdale (Utah Department of Corrections prison heating system and Bluffdale Flowers greenhouses), plus a potential project in northern Salt Lake City [Utah Transit Authority (UTA) - Warm Springs Service Center].

Expansion of geothermal space heating of greenhouses continues near Newcastle, in southern Iron County. Presently, geothermal is used to heat 1.1 million ft^2 at Milgro Nurseries and 50,000 ft^2 at Castle Valley greenhouses.

At Crystal Hot Springs geothermal area near Bluffdale in southern Salt Lake County, the Utah Department of Corrections and Johnson Controls, in 2005, completed phase II of a geothermal heating system to supply heat and hot water for 332,665 ft^2 of the Utah State Prison. Bluffdale Flowers anticipates expansion of their current greenhouse complex of 250,000 ft^2 by an additional 100,000 ft^2.

UTA acquired the 165,000 ft^2 Warm Springs Service Center (WSSC) north of downtown Salt Lake City, in 2003, for commuter train maintenance. In 2006, UGWG recommended to U.S. Department of Energy (DOE), a study to determine the feasibility of geothermal space heating at WSSC, which is near Wasatch Warm Springs. The OIT-Geo-Heat Center completed the study, analyzing two scenarios that yield payout periods from 10 to 12 years, and ROI from 6% to 11% on capital costs of $192K to $384K. UTA is assessing options with respect to available budget.

Robert Blackett, Post-Meeting Information

Passage of the Federal Energy Policy Act of 2005 (EPACT) resulted in new interest in geothermal development, a federal geothermal production tax credit, and new federal leasing and permitting rules. See the summary below of the presentation by Kermit Witherbee. EPACT also authorized the creation of the Intermountain West Geothermal Consortium (IWGC) to be managed by Boise State University with members University of Idaho, Idaho National Laboratory, University of Utah Energy & Geoscience Institute, Desert Research Institute, and Oregon Institute of Technology. IWGC's concept is to use emerging geoscience to study high-potential areas in the Intermountain region. The IWGC Utah Focus Area includes the "quadrangle" of Thermo Hot Springs (south), Meadow-Hatton (north), Roosevelt Hot Springs (west), and Cove Fort-Sulphurdale (east).

The 11-MW Blundell power-plant expansion at Roosevelt Hot Springs by PacifiCorp/Rocky Mountain Power is scheduled for completion in late 2007. Expansion consists of Ormat binary power units using spent geothermal fluid at approximately 350°F from the main power plant. See the summary of Rene Andrews' presentation below.

The previously announced power project by AMP Resources, LLC at the Cove Fort-Sulphurdale geothermal area (37 to 42 MW) in Beaver and Millard Counties was placed on hold in 2006. Enel North America, Inc. announced on March 20, 2007 (five days after this UGWG meeting) the acquisition of AMP Resources, LLC from AMP Capital Partners and a minority investor. Acquisition includes "one operating and four advance-stage geothermal projects expected to add 150 MW of capacity over the next four years to Enel's North American operations." These projects are located in Nevada, California, and Utah (source: GEA Update, March 19, 2007).

Idatherm LLC proposed geothermal power development at their Renaissance geothermal project near Honeyville in Box Elder County. Deep (11,000+ ft) exploratory drilling in 1974 by a consortium investigating the area's geothermal power potential discovered the resource. After testing, the project was abandoned. Idatherm, using unreleased data, developed a concept model, obtained leases, and proposed expanded exploratory drilling and development. See the summary below of the presentation by Dr. Carl Austin on the Renaissance project.

Philip Powlick, UGS State Energy Program, provided an update of the 2007 Utah State Legislature's new laws affecting renewable energy development in Utah. On February 27, 2007, the Utah Legislature unanimously passed a comprehensive tax bill (Senate Bill 223) that included the reauthorization and some expansions of the Utah Renewable Energy System Tax Credits that are administered by the State Energy Program (SEP).

Measures from the program that expired on December 31, 2006 and were reauthorized in SB 223 include (1) tax credits of 25% of costs for a renewable energy system in a residence or residential unit, with a maximum credit for residences of $2,000; (2) tax credits of 10% of costs for a renewable energy system in a commercial building or structure, with a maximum credit of $50,000; (3) expansion of the list of eligible technology types for residential systems - direct-use geothermal, ground source heat pumps and biomass; (4) expansion of the list of eligible technology types for commercial systems - geothermal electricity, direct-use geothermal, and ground source heat-pumps; (5) creation of a production tax credit for commercial wind, biomass, and geothermal systems that produce electricity and have production capacities of 660 kilowatts or greater - credit amount is 0.35 cents per kilowatt-hour of electricity produced during the first four years that a system is in operation; (6) new language providing that costs claimed must be reasonable and gives SEP the authority to define reasonable costs through rules; (7) conversion of the program from temporary to permanent status; under prior authorizing legislation the program expired after five years.

Under a hypothetical production-tax-credit benefit scenario for geothermal: assuming 25 MW and 90% capacity factor (8,760 hrs x .9 x 25,000 x $0.0035 = $689,850/yr), this equates to $2.76 million over four years.

Overview of other renewable energy tax credits: SEP/UGS to define reasonable cost; all credits permanently authorized (no five-year sunset); no cap on total amount or cost of credits awarded; SEP/UGS certifies credit eligibility.

Roger Hill, GeoPowering the West Coordinator, Sandia National Laboratory, provided an overview of the status of the U.S. Department of Energy's Geothermal Program. Currently, DOE has slated the geothermal program for closeout in FY-2007. There have been efforts to fund components of the DOE Geothermal Program through other avenues, but there are no solid indications as yet that those proposals will be successful. The Administration budget submitted to OMB apparently includes $5 million for program closeout in FY07 and zero funding in FY08.

Kermit Witherbee, U.S. Dept. of the Interior, National Geothermal Program Manager, presented the new federal rules for geothermal leasing and geothermal unit agreements.

Geothermal Leasing: (1) All competitive leasing for nominated lands, (2) lands nominated by public/industry limited to 5120 acres (8 mi^2) maximum, (3) each nomination to include filing fee of $100 + $0.10/acre, (4) parcels not receiving bids available for non-competitive leasing for 2 years to 1st applicant, and (5) maximum lease of 5120 ac, maximum state total acreage – 51,200 ac.

Direct-Use Leasing: (1) Interior Secretary may identify lands for direct use for non-competitive leasing; (2) lease size no more that reasonably necessary for proposed use; (3) U.S. Bureau of Land Management (BLM) publishes 90 day notice – if lands have competitive interest, then offered next lease sale; and (4) state, tribal, or local governments can use for public purpose, other than commercial electric generation, with nominal fee.

Other points of discussion included: lease duration/work commitment, unit and communitization agreements, termination for non-payment; annual rentals and royalty payments throughout the project, royalty rates (1.75% to 3.5% of value of electricity), lease conversion royalty rates, and production incentives for "new generation" – duration of four years (by 8/7/2011).

Roger Hill, Technical Director of Geopowering the West, Sandia National Laboratory, outlined the potential for geothermal penetration within utility portfolios based upon a 2005 study done for Sandia Labs by Shimon Awerbuch, J.C. Jansen, Luuk Beurskens, and Thomas Drennen titled "The Role of Geothermal in Enhancing Energy Diversity and Security in the Western U.S. – A Mean-Variance Portfolio Optimization of the Region's Generating Mix to 2013."

Load growth in the western U.S. is expected to continue. Several scenarios are analyzed to perform utility energy portfolio optimization to identify energy mixes with minimum cost and risk. Data from the DOE Energy Information Administration (EIA) is used to perform the optimization with shares of all forms of energy technology based on costs and associated risks in 2003 and projected to 2013.

The optimization showed that, several mixes, with up to nine times the amount of geothermal generation in the EIA 2013 mix, with respect to cost, were either comparable or less relative to the EIA 2013 mix. The analysis further showed that by factoring in increasing demand for fuel, decommissioning existing plants, and resource shortages, the move to larger gas/coal shares adds to the portfolio cost and risk. It also reduces energy diversity and energy security.

Carl Austin, Ph.D., Exploration Manager, Idatherm LLC, provided an overview of Idatherm's Renaissance geothermal project near Honeyville in Box Elder County, Utah.

Paper published in 2006 GRC Transactions v. 30, p. 853-857, "Renaissance – A Geothermal Resource in Northern Utah" by C.F. Austin, R.R. Austin, and M.C. Erskine.

Geothermal exploration in the 1960s delineated a possible resource in northern Utah near Brigham City. The area was reviewed by Ward Austin, exploration geologist for Geothermal Kinetics, using seismic, magnetotellurics, gravity, geochemistry, air photos, and other techniques to develop a model that predicted high-temperature fluids at 6000 ft depth at a drill location northwest of Brigham City. Utah Power and Light and Geothermal Kinetics, using oil-field technology, drilled the Davis #1 well in 1974. No resource was found at 6000 ft depth, so the target model was reinterpreted and drilling continued to 11,005 ft total depth. Published interpretations of the predicted resource were that a viable resource was not found and the project was abandoned.

Idatherm had access to previously unreleased data. During drilling, near 8200 ft depth, the well flowed spontaneously at 3500 gpm with a surface temperature of 286°F (expanded, cooled fluids). A fluid sample analyzed from the 8125-8300 ft interval yielded TDS of 54,305 ppm with a silica content of 305 ppm. Silica geothermometry suggested equilibrium temperatures in excess of 400°F.

A reinterpretation by Idatherm of the geology of the region involves the Wellsville Mountains having detached from the main Wasatch Mountains (Bear River Range and East Cache fault zone), rotating westward from a southern hinge point. Other evidence, including a large snowmelt anomaly, suggests a young, cooling intrusive body beneath the Wellsville Mountains. Production depth (8250 ft) appears controlled by a thrust fault, which repeats the Ordovician Swan Peak Formation.

Rene Andrews, Blundell Plant Supervisor, Rocky Mountain Power, provided an update on the Blundell Geothermal Plant expansion in Beaver County, Utah.

PacifiCorp has operated the 26-MW Blundell geothermal plant near Milford since 1984. Here, steam is separated from hot brine at ~ 500°F from four production wells, that range from 2000 to 6000 feet depth. Hot (350°F) brine is returned to the reservoir via three injection wells (up to ~ 7000 ft depth).

In April of 2006, PacifiCorp announced a planned 11 MW expansion of the Blundell geothermal plant using a "bottoming cycle." PacifiCorp contracted with Ormat Nevada, Inc. for an 11-MW Ormat energy converter (binary cycle unit) to extract heat from the hot (350°F) brine return fluid. Delivery of the Ormat unit is expected in the second quarter of 2007.

PacifiCorp contracted with Centry Constructors & Engineers (of Salt Lake City) to build the project. Project is scheduled for completion by December 1, 2007.

Halley Dickey, United Technologies Corp., described the concepts behind United Technology's application of essentially reversing the refrigeration cycle of Carrier chillers to generate small-scale power using a geothermal source at Chena Hot Springs, Alaska.

The concept has been known for a long time, but not been tried in geothermal applications until now. Carrier developed the concept with sister divisions United Technologies Research Center and United Technologies Power, resulting in release of the PureCycle™ 200. The PureCycle™ has used waste heat exhaust gases and air-cooled condenser equipment to generate power (200 kW)**.** The Chena Power plant takes the PureCycle™ concept one step further, generating power from a 164°F geothermal source and a 120°F temperature differential between the evaporator and condenser. Because this approaches the temperature differential of the air-conditioning unit the power plant was derived from, the same refrigerant typically used in Carrier Refrigeration systems could be used for the Chena power plant.

An advantage of using refrigeration technology for power generation is that the hardware used for these applications has a lower cost structure than that of traditional power generating equipment. By keeping the same components to the extent possible, the PureCycle™ 200, reportedly, can reduce construction costs by taking advantage of Carrier's mass production line.

Three principle changes are made to transform a Carrier chiller into a power plant. The turbine/generator assembly has a small percentage of parts uniquely manufactured for power production versus its corresponding chiller/compressor assembly. A pump has been added to circulate the liquid refrigerant and maintain operating pressure. Also, the heat exchangers,

while standard Carrier manufactured units, are specifically sized for power plant operation at design temperature.

The geothermal source at Chena is a 700-ft deep, 10-in diameter, production well located 0.75 mile from the power plant, connected via an insulated 8-in HDPE pipeline. The well produces 500+ gpm of 164°F water. Injection wells are located near the power plant. Cooling water (approximately 45±°F) is supplied by gravity feed (siphon) from a well located about 0.5 mile (33 ft uphill) from the power plant through a 16-in insulated steel pipe.

Kevin Kitz, V.P. Project Development, U.S. Geothermal Inc., presented an overview of generic geothermal power development, and a detailed project history of U.S. Geothermal Inc.'s (USG) geothermal project at Raft River in Cassia County, Idaho.

Geothermal power plant cost summary: Plant size can vary from approximately 10 MW to 70 MW, but 25 MW is typical. Cost factors include resource temperature, depth, and productivity; distance to electrical transmission lines; and type of power plant technology. The first 25 MW of capacity was estimated to cost $76.1 million. The second 25 MW would cost an additional $66.1 million. For a 25 MW plant, annual operating costs can vary from $3.3 million to $3.7 million.

The DOE operated the Raft River geothermal project from 1975 to 1983, spending $40 million to demonstrate use of binary-cycle power. The site was acquired by USG in June 2002 and consists of 660 acres of privately held land plus 4417 acres under lease. The site includes five production wells (4925 – 6542 ft deep), two moderate-depth (3800 – 3900 ft deep) injection wells, and several monitor wells. USG has secured 36 MW of transmission capacity from BPA/Idaho Power and will interconnect with the Raft River Co-operative.

Measured temperatures vary from 275° to 300°F at depths of 4500 to 6000 ft in a fractured/faulted reservoir of crystalline rock. On-going efforts include surface preparations for installation of the 13 MW binary unit by September 2007, additional production well drilling, and interference testing within existing wells.

THURSDAY, MARCH 15, 2007

Thirty three participants went on the field trip to the Raft River geothermal project site of U.S. Geothermal Inc., in Cassia County, Idaho. U. S. Geothermal reported the following activities:

- 10 to 13 MW on-line by September 2007
- Currently ready for delivery of the binary unit(s)
- Drilling an additional production well
- Interference testing of wells
- Development of a revised/expanded reservoir simulation model

UGWG MEETING ATTENDEES
March 14 and 15, 2007

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