Building Geothermal Bridges between Old Technologies and Existing Wells

by Maria Richards, Gillian McWhirt, and Jill Gregory
SMU Geothermal Lab, Dallas, Texas

To further understand technologies allowing the geothermal community to expand production into oil- and gas-field settings, on June 12 and 13, 2007, the **Southern Methodist University (SMU) Geothermal Lab** hosted its second conference on ***Geothermal Energy Utilization Associated with Oil and Gas Development***. Nearly 200 people from North America, Europe, Australia, and Asia attended, many new to geothermal. **David Blackwell** opened the conference, describing activities over the past year. He was followed by **Berni Karl** of **Chena Hot Springs**, Alaska, who described his 400 kWe geothermal system and set the mood for the conference by saying, "Don't ever take 'no' for an answer. 'No' means 'maybe' and 'maybe' means 'yes!'"

Jeff Tester of the **Massachusetts Institute of Technology** summarized the recent *Future of Geothermal Energy* report, emphasizing that an investment of $300-$400 million over 15 years, along with a comparable amount for research and development, would demonstrate commercial enhanced geothermal systems (EGS) technology at several sites across the US and enable the development of 100,000 MWe by 2050.

Patrick Ledru, Research Coordinator for the **French Bureau de Recherches Géologiques et Minières** described the goal of the European Commission (EC) for 2010: to double the 2001 contribution of renewable energy from 6 to 12% of the total energy consumption with a corresponding 20% decrease in greenhouse gas emissions. The geothermal electric production goal is increased from 500 to 1000 MWe, which is already exceeded with 1179 MWe. The EC also actively promotes geothermal heat pumps and direct use. Output is currently at 13,626 MWt with a goal of 25,000 MWt by 2010. To facilitate this, an innovative networking project called ENGINE transfers information among communities at scientific, company, and country levels.

At the SMU conference, five companies described technologies used for current or future geothermal electrical production. Referring to the 40-year track record of **ORMAT Technologies**, **Paul Thomsen** of ORMAT emphasized the importance of matching geothermal equipment with the resource and showed how his company's 800MWe of geothermal power, produced worldwide, is from equipment custom-made for each environment. **Halley Dickey**, of **UTC-Power**, highlighted the Chena Hot Springs equipment success, the "plug-n-play" technology, and the UTC 225 kWe PureCycle® power plant with its low-temperature capability and off-the-shelf availability. Technologies new to geothermal were discussed by **Brian Hageman** of **Deluge Inc.** and **Robert Hunt** of **Linear Power Ltd**. **Robert Hunt** said natural-gas wells have a large kinetic energy potential and Linear Power Ltd. is developing equipment that attaches to the wellhead and can harness this kinetic resource. **Brian Hageman** invented The Natural Energy Engine^{TM} Technology that uses the thermal expansion of a gas to convert heat to mechanical power. Hageman's thermal hydraulic engine is able to pump 7-to-8 barrels of oil a day using no electricity. The oldest power conversion technology is an ammonia absorption power cycle, which **Don Erikson** from **Energy Concepts** designs. In fact, he designed a system for Chena Hot Springs that keeps

their ice hotel frozen during the 24-hour long, summer days. Because of glide matching, absorption power cycles may be more efficient than the Rankine cycle. Absorption power cycles can condense at 95°F and convert heat to power from sources between 150 to 300°F.

Often oil and gas wells used for geothermal projects will need to be refractured to produce enough water to generate geothermal power. Fracturing is a subject critical for EGS systems and **Doone Wyborn**, representing **Geodynamics Ltd.** of Australia, spoke of his company's EGS project underway in Australia. Massive fracturing has occurred in the Cooper Basin, with 40,000m^3 of fresh water injected in the Habanero 1 reservoir over a period of two years, expanding the connected zone to 4 km^2. In the next 20 years, Geodynamics expects to have drilled 19 injection wells and 24 production wells. A 40 MWe power plant is the goal by 2010 and ultimately a 500 km transmission line will be built to connect the geothermal area to the Australian grid.

Because of the low flow rates and dispersed locations of wells in most oil and gas fields, co-production of oil, natural gas, and geothermal waters is not a universal solution. The best production rate for one of these resources may not be best for the others. One scenario is to buy oil and gas wells before they are plugged and abandoned and convert them to geothermal production. **Prentice Creel**, from **Halliburton**, discussed evaluating well integrity for conversion to geothermal energy applications. The well completion history and production data are important and two items easily obtained for review. He gave an excellent how-to presentation that will be widely used.

Once you've "kicked the casing," putting the wells into a production configuration was the focus of **Martin Vorum's** presentation on the **National Renewable Energy Lab's** (NREL) new modeling program. The model looks at cost competitiveness using temperature, well field configuration, generator unit capacities, and flow rates. His example uses a range of 190 to 250°F fluids produced at rates of 10- to 70-gallons per minute per production well for a 5-spot well layout pattern. The levelized cost of energy generated by the model was estimated as ranging from 20¢/kWh to 2¢/kWh, respectively. The model is available for use by interested parties.

Geothermal energy development by oil and gas companies was common in the 1970s and 1980s when oil companies diversified into the geothermal industry. The decrease in energy prices in the 1980s and the difficulty of geothermal exploration are reasons many oil companies exited the field at that time. Currently, Europe and Australia are ahead of the US in developing EGS systems in oilfield settings, as pointed out by **Patrick Ledru**, and **Doone Wyborn**. The most expensive aspect of geothermal energy development is often reservoir uncertainty; thus, the known parameters of a produced oil and gas reservoir offer an important benefit. However, a drawback to using existing oil and gas wells is that their smaller well casing diameters limit fluid flow. **Susan Petty** of **Black Mountain Technologies**, gave the example, it would take ~ 117 wells with 5" casing, drilled 12,000 ft. deep, with temperatures at 300°F, to generate enough fluid for a 50 MWe power plant. **Susan Petty's** comparisons shed light on the barriers that must be overcome to develop a large-scale, commercial project.

Available project locations were on the minds of many attendees. **Ray Kaczorowski** of **International Paper** showed the locations of the company's US mineral estates: 33 are identified as geothermal areas of interest. Of these, 18 areas totaling 55,000 acres are

considered geothermal prospects located in the Texas Gulf Coast-Arkansas-Louisiana geopressured area and in the Pacific Northwest. One of the areas includes the Pleasant Bayou well that **Subir Sanyal** from **GeothermEx, Inc.**, reassessed to have 3890 kWe of power: 37% from geothermal energy, 49% from methane, and 14% from hydraulic energy. **Sabodh Garg**, with **Science Applications International Corporation**, reviewed the geopressured settings in the Gulf Coast area, summarizing numerous reports from the 1970s and 1980s available online at the www.osti.gov website.

Peter Boone oversees the **Texas General Land Office** (GLO) geothermal leases. He outlined procedures for leasing state-owned, mineral estate wells. Texas has a specific geothermal lease contract and many wells on Texas state land are available for energy development. For example, **ORMAT Technologies** leased Texas GLO land along the Gulf Coast in January 2007. **Paul Thomsen** gave an update on that leasing activity and answered questions about the company's plans. **ORMAT Technologies** is a partner in the **Rocky Mountain Oilfield Testing Center** project that **Lyle Johnson** oversees. This Wyoming project will use 170°F water to generate 180 kWe of power and is expected to be on line in January 2008.

Discussing geothermal project costs proved an important aspect of the conference. **Marlan Downey**, an American Association of Petroleum Geologists "Living Legend in the Oil and Gas Business" stated, "The way to catch oil and gas companies' attention is to 'show them the money'". Oil and gas companies are very interested in new projects; they just need to be shown how they will profit from them. Addressing this point, **Robert Banack** of **Dundee Securities** used an example of a 20 MWe project, presenting a geothermal capital cost and timeline for each stage, including a list of costs, percentage of capital needed, and possible finance sources. **Tim Smith**, of **Elements Market LLC**, simplified the details of the Renewable Energy Credits, Carbon Markets, Renewable Portfolio Standards, and the Production Tax Credit ($10/MHh) currently valid for new geothermal facilities through the end of 2008 for the first 10 years of operation. Since it is not always about money, rather sometimes energy needs, **Roger Hill**, representing the **GeoPowering the West Program** of the **US Department of Energy**, said domestic electricity, which relies on natural gas, will become increasingly sensitive to interruption and susceptible to spikes in price. He believes small-scale geothermal power plants will be ideal for filling in the gaps.

SMU Energy Director **Michael Paul** announced that if someone can produce it, SMU will buy it, and many other companies out there will do the same thing. Finding ways to sell new power was discussed in an open forum led by **Michael Cozzi** of **Cirro Energy Service, Inc.**, and **Susanne Vaughan** of **Austin Energy**. A key outcome of the discussion was that pricing for short-term leases is based on competition with natural-gas prices, and to be effective, geothermal electricity has to beat the price of natural gas. It also became clear that the geothermal industry still needs to educate utilities on its baseload advantages over wind and solar.

As the wrap-up presenter, **Richard Erdlac**, from **Energy America Geothermal**, encouraged attendees to "embrace a new energy future" and stressed that a good way for geothermal power to develop is through the oil- and gas-infrastructure. By the end of the conference, innovative ideas on how to make geothermal energy a major energy source for the US seemed to pulsate through the group. Reaching out to the oil- and gas-industries will be an

important aspect in expanding the ideas and finding solutions in a focused shift toward low-temperature, small-unit geothermal development.