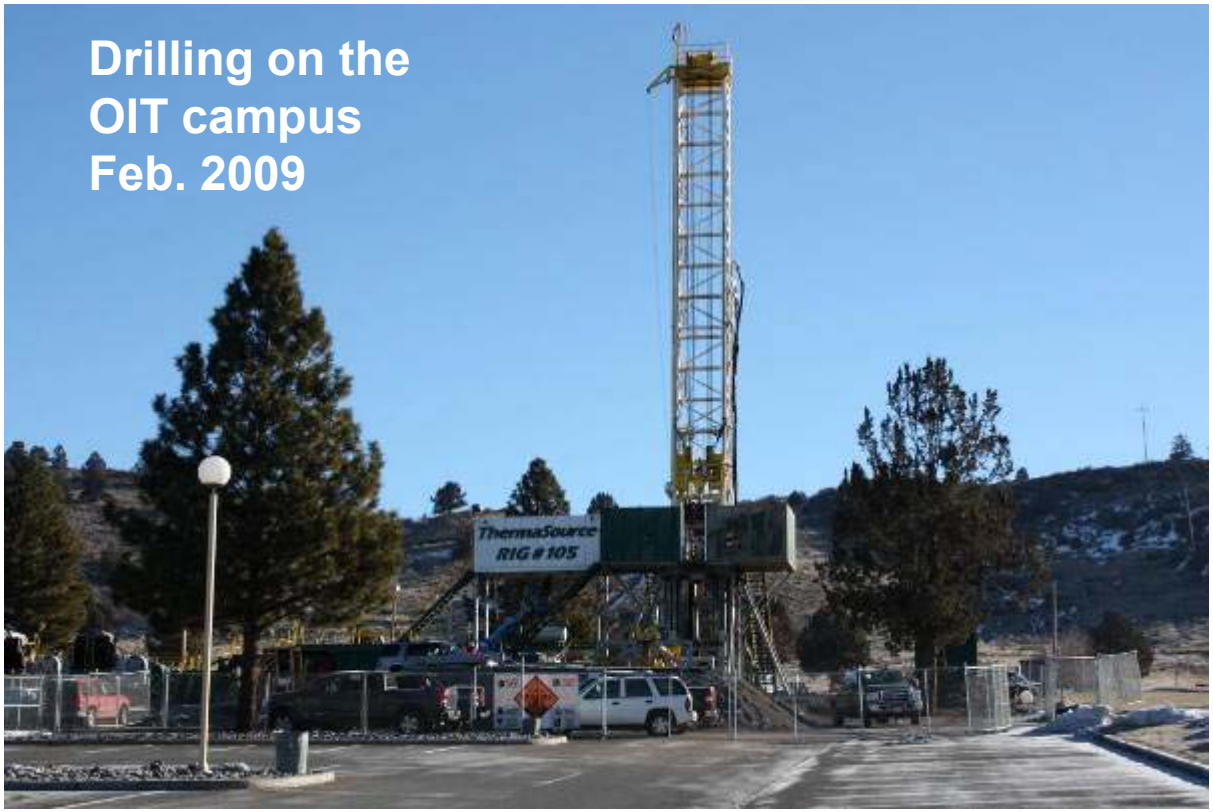


GEOTHERMAL POWER GENERATION PLANT

May 18, 2010

Principal Investigator
John W. Lund
Geo-Heat Center
Oregon Institute of Technology

Track Name: Analysis, Data System and Education

Overview

- **Timeline: July 1, 2008 to September 30, 2010**
- **Budget: DOE: $984,000 FY08**
  $1,522,400 FY09
  $1,000,000 FY10 (approved)
  OUS: $984,000 FY08
  $1,000,000 FY09
  $2,100,000 FY10 (approved)
- **Barriers**

  Water rights; existing injection wells capacity; temperature; costs; legal reviews by Oregon DoJ.
- **Partners: Johnson Controls??**

Geothermal Power Generation Plant

•Drilling a deep geothermal well on the Oregon Institute of Technology campus, Klamath Falls, OR

- Depth: 5,300 feet (1,600 m)
- Deviated to intersect the high angle normal fault on the east edge of campus
- Producing up to 2,500 gpm (158 L/s) of 196°F (91°F) fluid

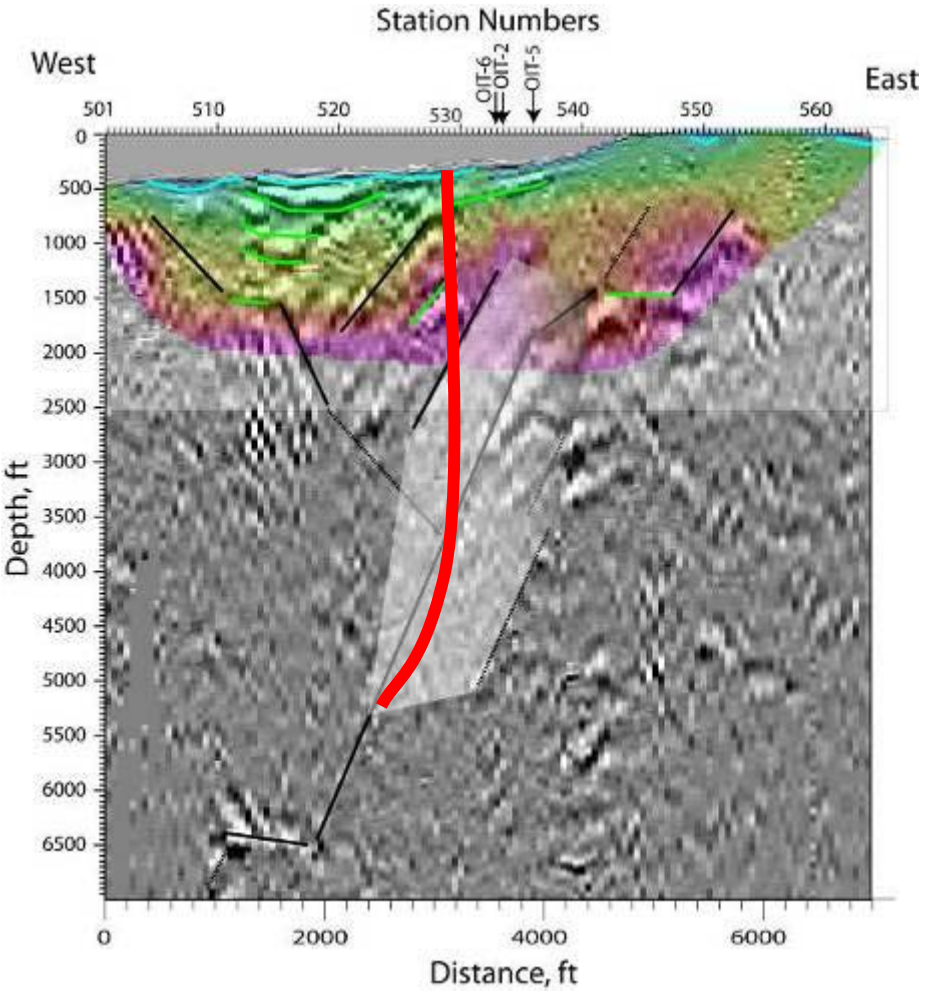
•Constructing a geothermal power plant on the Oregon Institute of Technology campus

- The plant will be a binary (ORC) type – air cooled
- 1.0 to 1.2 MWe gross – 0.8 to 1.0 MWe net

•Additional work required

- Construction a pipeline from the well to the power plant location
- Test pumping the well and installing a pump and VFD
- Construction a pipeline around campus and drilling a new injection well

The Deep Well on Campus



Objective of the Geothermal Power Generation Plant project

- Drill a deep geothermal well up to 6,000 feet (1,820 m)
- Obtain a predicted approximately 300°F (150°C) geothermal fluid
- Design, build and operate an approximately 1.5 MWe (gross) geothermal binary power plant
- Provide a training site for students in our Renewable Energy Engineering program (BS REE).
- Provide a "show-me" site for interested developers of geothermal power generating projects
- Provide the electrical energy needs for the Oregon Institute of Technology campus
- Provide funding for the Geo-Heat Center – supervision/reporting

Scientific/Technical Approach

- **Feasibility Study** prepared by EGS, Inc., Columbia Geoscience and ThermaSource Inc. – August 2006
- **Active source seismic investigation** of the high angle normal fault by Optim, Inc. – June 2008
- **Environmental Assessment** by MHA Environmental Consulting – Final: September 2008 - FONSI
- **Request for Proposals** for Geothermal Hot Water Well by OIT – October 2008
- **Drilling contract** awarded to ThermaSource, Inc. December, 2008
- **Drilling** of the deep well by ThermaSource – February-March, 2009 – to 5,300 feet in 39 days

Scientific/Technical Approach

- **Preliminary pumping test** of deep well – step tested to 1,500 gpm (95 L/s) of 196°F (91°C) – April 2009
- **Grant** from the Energy Trust of Oregon to retain Stephen Anderson (EE) to provide electrical connection study
- **Contract** let for construction of pipeline from well head to heat exchange building – site of proposed power plant
- **Application** to Oregon Department of Water Resources for our water rights permit of 2,500 gpm (158 L/s)
- **Negotiating** with Johnson Controls, Inc. for a possible demonstration power plant – funded by ARRA grant.
- **Contract** let with local consulting firm for performing a pump test in secure our water rights of 2,500 gpm.

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Important technical accomplishments FY09/10

- **Drilling** of the deep well to 5,300 feet (1,600 m) – 3/09
- **Obtaining** 1,500 gpm (95 L/s) of 196°F (91°C) fluid – 4/09
- **Obtaining** water rights permit for 2,500 gpm (159 L/s) of 200°F (93°F) geothermal fluid – 6/10

In order to:

- **Designing**, building and operating a 1.0 to 1.2 MWe (gross) geothermal binary power plant on campus – 6/12
- **Providing** funds for the Geo-Heat Center - supervision
- **Providing** training/research for students and a visitor site for potential developers.

The Technical Team

- **Oregon Institute of Technology**
  - John W. Lund, PE, Director Geo-Heat Center
  - Tonya “Toni” Boyd, Assistant Director, Geo-Heat Center
  - Dave Ebsen, Director, Facilities Services
- **Outside Consultants**
  - Stephen Anderson, PE (EE) Evergreen Consulting, Portland, OR
  - Brian Brown, PE (ME) Ft. Klamath, OR
  - Doug Adkins, PE (Water Rights Examiner) Klamath Falls, OR
  - Tim Thompson, PE (CE), Klamath Falls, OR
  - Paul Brophy, Geologist, Santa Rosa, CA
  - Al Waibel, Geologist, Portland, OR
  - Louis Capuano, Drilling Engineer, Santa Rosa, CA
  - Richard Campbell, ChE (power plant designer), Denver, CO
  - Hagen Hole, Drilling Engineer, New Zealand

Project Management/Coordination

- **Schedule:**
  - Project has taken about one year longer than anticipated – EA, drilling RFP/contract, well testing – all contracts must be reviewed by Oregon Department of Justice office
- **Funding (present):**
  - USDOE grants: $2,506,400
  - OUS grants/loans: $2,000,000
    - Providing up to $200,000/yr for the Geo-Heat Center – supervision, coordination, reporting

Project Management/Coordination

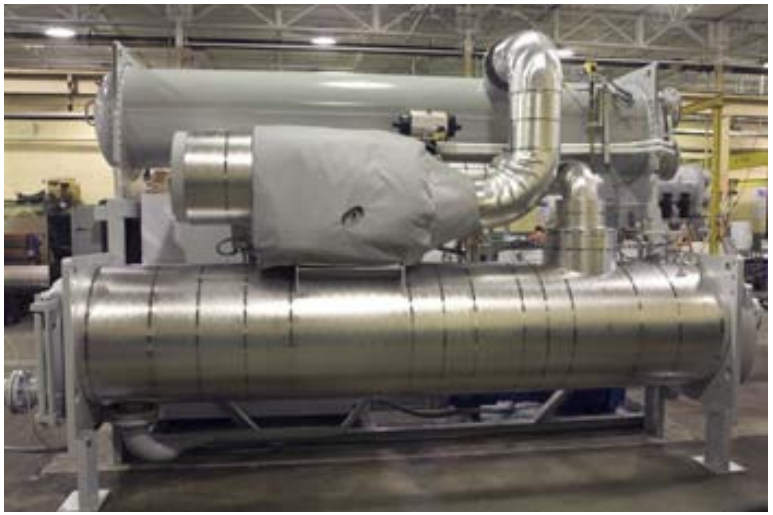
- **Funding (future):**
  - USDOE grant: $1,000,000 (FY10) (approved)
  - USDOE grant: $1,100,000 (FY11) (pending)
  - OUS grants/loans: $1,400,000 (pending)
  - Bus. Engr. Tax Credit: $700,000 (pending)
  - Johnson Controls: $2,000,000 (in negotiations)
- **Integrated with other projects:**
  - Small geothermal power plant (280 kW) on campus
- **Coordination with industry/stakeholders:**
  - Johnson Controls with a ARRA award
  - Pacific Power (PPA contract)
  - Supplying excess geothermal water to adjacent businesses/institutions – additional income/utilization

Important planned accomplishments

- **Constructing** the pipeline form the well to the plant site 6/10
- **Pump testing** the well to obtain our water rights 6/10
- **Purchasing** a pump and VFC unit – 7/10
- **Constructing** a pipeline around campus 9/10
- **Drilling** an additional injection well 9/10
- **Designing**, installing, testing and operating a 1.0 to 1.2 MWe geothermal power plant in campus by 6/12.
- **Obtaining** a PPA from Pacific Power 6/12

Mandatory Summary Slide

- **Major accomplishments to date:**
  - Seismic investigation of fault structure on campus
  - EA performed with “Finding of No Significant Impact” (FONSI)
  - Drilling a well to 5,300 ft. (1,600 m)
  - Test pumping the well at 1,500 gpm (95 L/s) producing 196°F (91°C) geothermal fluid
  - Constructing a pipeline from the well to power plant site
- **Future technical targets:**
  - Test pumping the well to establish our water rights – 2,500 gpm (158 L/s) at approx. 200°F (93°C) – installing a pump and VFD
  - Construction a pipeline around campus
  - Drilling an injection well
  - Designing, construction of a 1.0 to 1.2 MWe binary power plant
  - Provide a training/”show-me” site for students and visitors




well

Publications:

***Geothermal Uses and Projects on the Oregon Institute of Technology Campus,* by John Lund and Toni Boyd**

Presented at:

- Stanford Reservoir Engineering Workshop 2009
- World Geothermal Congress 2010, Bali, Indonesia
- California Geothermal Energy Commission Workshop, Davis, CA 2010

***Renewable to the Core: OIT Taps Campus Geothermal Resources* – District Energy 2010 – Toni Boyd**

Presentations:

- Numerous presentations to local community leaders and professional groups/service organizations/schools