Geothermal Technologies Program 2011
SMU Geothermal Conference

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Presentation Outline

- Program’s past
- Present status of ARRA projects
- Program’s near future
The Geothermal Technologies Program annual budget peaked in the late 1970s, enabling advances in drilling, exploration, power plant systems, and reservoir modeling.

### Annual Budget for the Geothermal Technologies Program 1976 - 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual Budget (millions of $)</th>
<th>Adjusted to 2011 $</th>
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<td>925</td>
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<td>2012</td>
<td>1900</td>
<td>950</td>
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</table>

**Major Successes 1976-2006**

**Drilling**
- Developed polycrystalline diamond compact drill bits, which are used in 60% of oil and gas well footage and are estimated to reduce oil and gas offshore costs by $56/foot drilled

**Exploration**
- Operated the Industry Cooperative Exploration and Drilling program; of the 14 areas first studied in this program, 8 were developed by industry

**Power Plant**
- Improved binary conversion cycles; for mid-level temperatures (150-190°C) resulting in a 15% increase in productivity over flash

**Reservoir Technology**
- Developed geothermal reservoir models that are estimated to increase oil and gas well productivity by up to 20% and geothermal productivity by 10% (based on The Geysers)
- World’s first electric production from hot dry rock

**Sources:**
- Retrospective Benefit-Cost Evaluation of U.S. DOE Geothermal Technologies Program Investments, August 2010, RTI International
The Program currently supports a diverse portfolio that spans near- to long-term resources and low to high risk technology development. Almost $400 million in Recovery Act funding enabled this strategy.

**Current program pathways to increase geothermal power generation**

- **Enhanced Geothermal Systems**
  - Potential—USGS estimates 500 GWe in the Western US; NREL projects 16,000 GWe in the U.S.

- **Innovative Exploration Technologies**
  - Potential—USGS estimates 30 GWe of undiscovered hydrothermal

- **Low Temperature and Coproduced Resources**
  - Potential—USGS estimates up to 120 GW untapped low-temp resources
Low Temperature, Coproduced & Geopressed
The Recovery Act has provided a much needed boost to geothermal RD&D

Under Recovery, DOE has invested $368.2 million in geothermal projects in 39 states.

- Total Investment: $368.2
- Total Projects: 148
- States/Districts Represented (Prime Awardee) 39
FOA Objectives:

To demonstrate the technical and economic feasibility of geothermal energy from non-conventional geothermal resources, and to promote the development and commercial application of energy production from the following Subtopic Areas:

A. Low-Temperature Geothermal Fluids at temperatures between 150-300°F
B. Geothermal Fluids Coproduced from productive, unproductive, or marginal oil and/or gas wells (or other hydrocarbon production).
C. Geopressured Gas Resources that show potential for economic recovery of the heat, kinetic energy, and/or gas.

Funding: Up to $18.7M in Recovery Act funds to rapidly commercialize technologies and reduce upfront risk

FOA: DE-FOA-0000109, Close date: 7/22/2009
## ARRA Low Temperature Geothermal Demonstrations

<table>
<thead>
<tr>
<th>ARRA Topic</th>
<th>Grantee</th>
<th>Project Title</th>
<th>Objective</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal Demo</td>
<td>Beowawe Power, LLC</td>
<td>Beowawe Bottoming Binary Project</td>
<td>Installed a new low temperature binary unit that is attached to an existing plant providing 10% additional power.</td>
<td>Operational</td>
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<tr>
<td>Geothermal Demo</td>
<td>City of Klamath Falls</td>
<td>Klamath Falls Geothermal Low Temperature Power Plant</td>
<td>Construct a low temperature power plant combined with a district heating system to help power the city of Klamath Falls, OR.</td>
<td>In process of returning federal funds</td>
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<tr>
<td>Geothermal Demo</td>
<td>Johnson Controls, Inc.</td>
<td>Novel Energy Conversion Equipment for Low Temperature Geothermal Resources</td>
<td>Develop equipment that generates electricity from low temperature geothermal resources at a cost at least 20% below that of the currently available technology by improving on existing binary ORC systems through experimentation using alternative refrigerants.</td>
<td>Progressing</td>
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<tr>
<td>Geothermal Demo</td>
<td>New Mexico Institute of Mining and Technology</td>
<td>A Geothermal District Heating System and Alternative Energy Research Park on the NM Tech Campus</td>
<td>New Mexico Institute of Mining and Technology will construct a district heating system at the NM Tech Campus.</td>
<td>Withdrawn</td>
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<tr>
<td>Geothermal Demo</td>
<td>University of North Dakota</td>
<td>Electric Power Generation from Low-Temperature Geothermal Resources</td>
<td>Demonstrate the technologic and economic feasibility of generating electricity from low temperature (T&lt;~210 °F) geothermal water using binary, organic Rankine cycle (ORC) technology with air as the condensing medium.</td>
<td>Progressing</td>
</tr>
<tr>
<td>Geothermal Demo</td>
<td>Oasys Water</td>
<td>Osmotic Heat Engine for Energy Production from Low Temperature Geothermal Resources</td>
<td>Oasys Water plans to develop a new method for utilizing low temperature geothermal fluids to produce power.</td>
<td>Progressing</td>
</tr>
<tr>
<td>ARRA Topic</td>
<td>Grantee</td>
<td>Project Title</td>
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<td>Status</td>
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<tr>
<td>Geothermal Demo</td>
<td>Surprise Valley Electrification Corporation</td>
<td>Rural Cooperative Geothermal Development Electric and Agriculture</td>
<td>Low-temperature modular binary system will utilize a 239°F resource for power generation with co-use for aquaculture.</td>
<td>Drilling production well</td>
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<tr>
<td>Geothermal Demo</td>
<td>Terra-Gen Sierra Holdings, LLC</td>
<td>Dixie Valley Bottoming Binary Project</td>
<td>Funding for Terra-Gen Sierra Holdings will facilitate the installation of a low temperature binary unit that will add to power generation from the existing 60 MW Dixie Valley power plant.</td>
<td>Progressing</td>
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<tr>
<td>Geothermal Demo</td>
<td>Universal GeoPower LLC</td>
<td>Technical Demonstration and Economic Validation of Geothermally-Produced Electricity From Coproduced Water at Existing Oil/Gas Wells in Texas</td>
<td>Universal GeoPower LLC will utilize a modular low temperature binary unit to produce power from oil and gas wells in Liberty County, Texas.</td>
<td>Progressing</td>
</tr>
<tr>
<td>Geothermal Demo</td>
<td>University of North Dakota</td>
<td>Electric Power Generation from Coproduced Fluids from Oil and Gas Wells</td>
<td>1MW air-cooled modular binary plant that proposes to demo a 1MW binary organic Rankine cycle unit from co-produced oil and gas fluids with wellhead temps of 210 °F. Will use air as condensing medium.</td>
<td>Progressing</td>
</tr>
<tr>
<td>Geothermal Demo</td>
<td>Louisiana Tank, Inc.</td>
<td>Demonstrating the Commercial Feasibility of Geopressed – Geothermal Power Development at Sweet Lake Field Cameron Parish, Louisiana</td>
<td>Louisiana Tank, Inc. will demonstrate the feasibility of a geopressed power plant in Cameron Parish, Louisiana.</td>
<td>In process of returning federal funds</td>
</tr>
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</table>
MEMORANDUM OF UNDERSTANDING
BETWEEN
THE DEPARTMENT OF ENERGY’S GEOTHERMAL TECHNOLOGIES PROGRAM
AND OFFICE OF FOSSIL ENERGY’S ROCKY MOUNTAIN OILFIED TESTING CENTER (RMOTC)
REGARDING THE DEVELOPMENT OF GEOTHERMAL PROJECTS AT THE ROCKY MOUNTAIN OILFIELD
TESTING CENTER

Products and Deliverables:
RMOTC Site Visit: July 27-28, 2010
Draft MOU Agreement: August 6, 2010
Final MOU Agreement: August 31, 2010
Geothermal Blue Ribbon Panel Asked to Help Shape the Future

Fifteen geothermal experts identified the obstacles to geothermal energy growth, discussed the appropriate role of DOE, and recommended priority R&D areas for the Program.

**Recommendation**—Narrow the focus of the Program and invest in critical need areas, targeting high-quality near-term resources to help the industry grow and long-term resources to tap the huge geothermal potential.

**Accelerate Near-Term Market Growth**—*Hydrothermal*
- Develop an inventory of high-quality prospects using existing technology
- Advance exploration technologies to reduce the cost and risk of drilling
- Develop technologies that reduce O&M cost

**Secure the Future**—*Enhanced Geothermal Systems*
- Define the optimal conditions for EGS and identify the best prospects
- Model the feasibility of reservoir creation using existing technology
- Develop tools to optimize power production and reduce costs
- Demonstrate the ability to create and maintain a reservoir in multiple geologic conditions

Financing and permitting were identified as major challenges for the industry. Panel members noted that policy in the form of a cost-shared drilling program and streamlined permitting would help overcome those challenges.
Upcoming Program Activities

Data Collection and Model Validation
- To ensure Program cost analyses are representative and relevant
- To determine baseline cost and performance and track progress toward goals

Input to Strategic Planning and Roadmapping Efforts
- Blue Ribbon Panel Recommendations
- Exploration Roadmap
- EGS Roadmap
- Induced Seismicity Protocol
- Induced Seismicity Roadmap

Merit and Peer Reviews
- Proposal Evaluations
- Stage-Gate and Go/No-Go Reviews
- In-Progress Reviews
Upcoming Funding Opportunity Announcements (FOAs) will focus on exploration and EGS R&D and Systems Analysis.

**Geothermal R&D FOA**

- **Anticipated Release:** this week
- **Anticipated Total Funding:** $70 million over 3 years
- **Potential topics:**
  - Advanced Exploratory Drilling Technologies
  - Advanced Well Completion Technologies
  - Zonal Isolation
  - Observation Tools and Data Collection System for Reservoir Stimulation
  - Geophysical Exploration Technologies
  - Geochemistry/Rock-Fluid Interactions

  **For a link to the Notice of Intent go to:**
  geothermal.energy.gov

**Systems Analysis FOA**

- **Anticipated Release:** July 2011
- **Anticipated Total Funding:** $3M over 2 years
- **Potential topics:**
  - Techno-Economic Impact of Federally Funded Geothermal Technologies
  - Identification of Regional Geothermal Data Needs for Mapping New Geothermal Prospects
  - Establishing High Quality Geothermal Data Sets
  - Technology Assessment of Logging Techniques

**Innovative Heat Recovery FOA**

- Released in FY 2010, the objective of this FOA is to demonstrate innovative approaches to recovering heat from geothermal reservoirs.
- Selected projects will be announced in June 2011

You can sign up to receive notifications when FOAs are released:

www.geothermal.energy.gov
Geothermal Technology Advancement for Rapid Development of Resources in the U.S.

Funding Opportunity Announcement (FOA) Number: DE-FOA-0000522
Issue Date: June 8, 2011
Application Due Date: July 15, 2011

The complete Funding Opportunity Announcement can be viewed on FedConnect: www.fedconnect.net/FedConnect/PublicPages/PublicSearch/Public_Opportunities.aspx

DOE’s Geothermal Technologies Program works in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the domestic energy supply.

For more information on these awards, please visit: http://eere.energy.gov/financing/exchange.

Funding was made available in the following topic areas:

Topic 1: Advanced Exploratory Drilling Technologies
Topic 2: Advanced Well Completion Technologies
Topic 3: Zonal Isolation
Topic 4: Observation Tools and Data Collection System for Reservoir Stimulation
Topic 5: Geophysical Exploration Technologies
Topic 6: Geochemistry/Rock-Fluid Interactions
Thank you!

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U.S. Department of Energy
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