**Geothermal Technology Program Mission**
*A major contributor to the nation’s baseload energy supply*

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**Accelerate Near Term Hydrothermal Growth**
- Lower hydrothermal exploration risks and costs
- Lower hydrothermal cost of electricity to 6 cents/kWh by 2020
- Accelerate the development of 30 GWe of undiscovered hydrothermal resources

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**Secure the Future with Enhanced Geothermal Systems (EGS)**
- Demonstrate that Enhanced Geothermal Systems are technically feasible by 2020
- Lower EGS cost of electricity 6 cents/kWh by 2030
- Accelerate the development of 100 GWe by 2050 (MIT) and ultimately demonstrate the full scale of geothermal resource potential

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**Identification**
- Lower exploration cost and risk to accelerate development

**Enhanced Geothermal**
- In and on the margins of hydrothermal fields
- “Green Field” development
- EGS test sites

**Blind Systems**
- Develop an inventory of new prospects. Reduce subsurface uncertainty.
### 2011-2013 Budget Comparison

**Increase in FY13 Request**

#### Funding Profile by Subprogram

<table>
<thead>
<tr>
<th>Subprogram</th>
<th>FY 2011 Appropriation (thousands of dollars)</th>
<th>FY 2012 Appropriation (thousands of dollars)</th>
<th>FY 2013 Request (thousands of dollars)</th>
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<tbody>
<tr>
<td>Enhanced Geothermal Systems</td>
<td>15,513</td>
<td>15,528</td>
<td>43,627</td>
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<tr>
<td>Hydrothermal &amp; Resource Confirmation</td>
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<tr>
<td>Innovative Exploration Technologies</td>
<td>12,602</td>
<td>12,483</td>
<td>13,512</td>
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<td>Low Temperature &amp; Coproduced Resources</td>
<td>3,877</td>
<td>4,852</td>
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<td>Systems Analysis</td>
<td>5,000</td>
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<tr>
<td>SBIR/STTR</td>
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<td>999</td>
<td>1,861</td>
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<td>Total for Geothermal Technologies</td>
<td>38,003</td>
<td>37,862</td>
<td>65,000</td>
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</table>
GTP Budget History

FY13 increase in EGS

FY 2012 and FY 2013

Funding in millions

Low Temp $5 $2
IET $12 $14
EGS $16
Systems Analysis $4 $4

FY 2007 Approp. $5.0
FY 2008 Approp. $19.3
ARRA $364
FY 2009 Approp. $43.3
FY 2010 Approp. $43.1
FY 2011 Approp. $38.0
FY 2012 Approp. $37.8
FY 2013 Request $65.0

- EGS
- Low Temp and Coproduced
- Innovative Exploration Technologies
- Hydrothermal and Resource Confirmation
- Ground Source Heat Pumps
- Systems Analysis
EERE Request by Program
Total: $2.3 billion

FY 2013 Request

- Renewable Energy
- Energy Efficiency
- Other Activities

Millions of $
American Recovery and Reinvestment Act
46% Spent

Payment Year

<table>
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<tr>
<th>Payment Year</th>
<th>Committed Funds</th>
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<tr>
<td>ARRA</td>
<td>$364</td>
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<tr>
<td>2010(Actuals)</td>
<td>$50</td>
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<tr>
<td>2011(Actuals)</td>
<td>$91</td>
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<td>2012(Combination)</td>
<td>$90</td>
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<tr>
<td>2013(Predicted)</td>
<td>$90</td>
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<tr>
<td>2014-Beyond</td>
<td>$43</td>
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</table>

* Currently reviewing projects that extend beyond 2013 to identify ways to accelerate costing to meet the new OMB Guidance on ARRA spending.
Realizing the Full Potential of Geothermal

Adapted from Chad Augustine, NREL
All numbers quoted come from the USGS 2008 Resource Assessment
Geothermal Program Priorities
FY12 and FY13

• **EGS test sites concept**
  • Most significant new initiative in the program
  • Fast-track planning and scoping in FY12

• **Resource and opportunity identification**
  • Leverage NGDS, IET investments

• **Regulatory Roadmaps**
  • Key opportunity for all stakeholders to streamline and optimize
  • Target 1st 8 states complete by 9/30/12

• **Funding leverage and interagency co-operation**
  • Strength of multiple funding sources and partners

• **O&G strategic engagement**
  • Deployment of binary turbines to best sites

• **Programmatic EA**
  • Commenced discussions on scope and utility
Enhanced Geothermal Systems

<table>
<thead>
<tr>
<th>Performer</th>
<th>Project Sites</th>
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<tbody>
<tr>
<td>Ormat Technologies, Inc.</td>
<td>Desert Peak, Nevada</td>
</tr>
<tr>
<td>Geysers Power Company, LLC</td>
<td>The Geysers, California</td>
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<tr>
<td>University of Utah</td>
<td>Raft River, Idaho</td>
</tr>
<tr>
<td>Ormat Technologies, Inc</td>
<td>Bradys Hot Springs, Nevada</td>
</tr>
<tr>
<td>AltaRock Energy Inc.</td>
<td>Newberry Volcano, Oregon</td>
</tr>
<tr>
<td>TGP Development Co.</td>
<td>New York Canyon, Nevada</td>
</tr>
<tr>
<td>NakNek Electric</td>
<td>NakNek, Alaska</td>
</tr>
</tbody>
</table>

**Current Portfolio**

- Seven EGS demonstrations to validate reservoir creation in different geologic conditions
- R&D funded by ARRA and in FY11.
  - Key areas: zonal isolation, observation and monitoring tools, well completions, subsurface modeling, induced seismicity, etc.
- Technical roadmapping

**Technical Targets**: Demonstrate technical feasibility of EGS at commercial scale by 2020 and lower LCOE to 6 cents/kWh by 2030

**FY13**

**EGS field test sites effort initiated**

- Multi-user pre-competitive R&D environment for EGS testing and validation
- Up to 3 geologically unique sites
- Government managed
- **Establish the technical and operational settings and parameters where EGS can be commercially successful**

**R&D**

- Focus on reservoir creation and monitoring
- Continue funding FY11 R&D awards as they progress to phase II
EGS Test Site Concept
Framework for Candidates

• **Project Goal:**
  – Testing a distinct and diverse set of sites, demonstrate the techniques and technologies required to make EGS as a commercial, renewable energy source

• **Scope:**
  – Define technical objectives, operating and project plan, schedule and governance plan

• **Priorities:**
  – Technical results and achievement
  – Timeline adherence

• **Key Risks:**
  – Insufficient multi-year funding
  – Improper planning and upfront analysis

• **Governance and Operating Plan:**
  – Open to a variety of approaches and models

• **Government Role:**
  – Ability to advance technologies and assume risk that’s not possible in the private sector.
EGS Test Site Concept
What We’re Doing Now

• **EGS project plan**
  - Charter Development – 03/30/12
  - Requirements gathering

• **Site selection criteria**
  - List site selection criteria – 03/31/12
  - Prioritize the list
  - Develop scheme for weighting criteria
  - Develop decision tree for EGS field test site

• **Technology baseline and path forward**
  - Identify critical technologies – 09/30/12
  - Develop necessary performance criteria
  - Define success parameters

• **Programmatic environmental assessment**
  - Initiate preliminary analysis – 04/30/12
  - What is proposed action(s) – 06/30/12
  - Analyze impact of the proposed action
  - Develop mitigation plan
2030 EGS Cost Reduction Goals

- **2011 COE (¢/kWh) @ 30-7% Discount Rate**
  - Characterize Resources & Access Reservoirs: 2.4¢/kWh
  - Power Plant Cost & Performance: 5.3¢/kWh
  - Operation & Maintenance (O&M) Costs: 4.3¢/kWh
  - Deployment Barriers & Costs: 2.4¢/kWh
  - System Validation: 6.0¢/kWh

- **2030 COE (¢/kWh) @ 7% Discount Rate**
  - Characterize Resources & Access Reservoirs: 2.2¢/kWh
  - Create Reservoirs & Develop Well-Fields: 5.8¢/kWh
  - Power Plant Cost and Performance: 2.7¢/kWh
  - Operation & Maintenance (O&M) Costs: 2.8¢/kWh
  - Technology demonstration: 2.4¢/kWh

Improvements in reservoir creation, lower drilling costs
- Improvements in plant efficiency (per unit cost)
- Reduced plant & field O&M costs
- Improved access to data & data quality
- Technology demonstration
- Larger power plants & reduced contingency
Hydrothermal and Resource Characterization

Innovative Exploration Technologies – Request $13.5M

Current Portfolio

- ARRA projects to confirm 400 MW of new hydrothermal resources by 2014
- R&D projects focused on increasing exploration success through advanced geophysical, geochemical and drilling methods
- Technology roadmapping
- Exploration data gap analysis
- USGS resource assessment efforts

FY13

R&D to lower exploration risk

- Continue funding FY11 R&D awards as they progress to phase II

Regional Data Gathering

- Using results from data gap analysis

Exploration best practices: Webinar on results of analysis as well as the OpenEI interface developed on April 11th.

Look for announcement and registration on the GTP website next week.

Technical Target: Lower LCOE to 6 cents/kWh by 2020
Geothermal Resource Opportunities
Critical Tool for Industry Growth

Dwindling number of identified new prospects

USGS estimates 30 GW hydrothermal and 500+ GW EGS undiscovered

Aggressively confirm and establish new resource opportunities

Accelerated development of geothermal potential

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<table>
<thead>
<tr>
<th>2012</th>
<th>2013 Competition</th>
<th>2014</th>
</tr>
</thead>
</table>

Data Gap Analysis

Leverage:
- Ongoing resource assessment
- National Geothermal Data System (NGDS)
- Existing remote sensing databases to identify data gaps

Data Gathering

- Select innovative tools and methods for regional data gathering
- Leverage exploration R&D to gather new data

Compilation

- Integrate new and existing data sources
- Screen and prioritize sites based on results

Deliverable: Selected areas for regional data gathering

Deliverable: New data compiled into NGDS

Deliverable: New geothermal opportunities identified

---

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2012 2013 Competition 2014

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- Screen and prioritize sites based on results

Deliverable: Selected areas for regional data gathering

Deliverable: New data compiled into NGDS

Deliverable: New geothermal opportunities identified
Current Portfolio

- 17 demonstration projects in progress including low temperature and co-produced resources
- Testing sites at Rocky Mountain Oilfield Testing Center (RMOTC)
- ARRA R&D projects focused on working fluids and efficient cooling
- Collaboration with oil and gas field operators to demonstrate power production in a commercial field

FY13

- Demonstration
  - Continue funding phase II of successful demonstration projects selected in FY10
- Technical headroom for innovation

Surprise Valley Electrification Corporation:
Increasing electricity costs from the Bonneville Power Administration have incentivized rural coops like Surprise Valley to look for other sources of power.

Technical Targets: Lower LCOE to 6 cents/kWh by 2020
Systems Analysis assesses geothermal resources, cost drivers, the impact of policy, and progress toward goals.

Current Portfolio

- National Geothermal Data System design, testing and population
- Regulatory Roadmap
- National Geothermal Academy
- Levelized cost of electricity (LCOE) analysis
- Lifecycle analysis
- Field test site planning, analysis and initial scoping
- Induced Seismicity Protocol

FY13

- Techno-economic and financial analysis
- Environmental impact analysis
- Continued work on regulatory roadmap
- Geothermal data provision
- Intergovernmental and international coordination
- Workforce development
- Induced Seismicity Best Practices

To provide distributed and open source access to geothermal data in order to reduce the risk and cost of geothermal development in the US.
Through SBIR/STTR, the Program supports small businesses to advance geothermal technologies.

**Small Business Innovation Research (SBIR) Program and the Small Business Technology Transfer (STTR)**

- In FY 2012, the Geothermal Technologies Program contributed $778,000 to the SBIR program and $105,000 to the STTR program for geothermal projects
- In FY13 $1.86M is estimated for SBIR/STTR

<table>
<thead>
<tr>
<th>FY12 Phase I</th>
<th>22 Application in review</th>
<th>2-4 awards expected</th>
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<tbody>
<tr>
<td>Phase II</td>
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<tr>
<td>MagiQ Technologies</td>
<td>Downhole High Temperature Seismic Sensor (Year 2)</td>
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<tr>
<td>Physical Optics Corporation</td>
<td>Fiber Optic High Temperature Seismic Sensor (Year 2)</td>
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<tr>
<td>Advanced Cooling Technologies, Inc.</td>
<td>Vortex Enhanced Direct Contact Heat Exchanger for Geothermal Cooling (Year 1)</td>
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</tr>
<tr>
<td>United Silicon Carbide, Inc.</td>
<td>High Temperature Smart Sensor for Downhole Logging and Monitoring (Year 1)</td>
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<tr>
<td>Phase III</td>
<td></td>
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<tr>
<td>Composite Technology Development, Inc.</td>
<td>Improved High-Temperature ESP Motor Insulation Materials – in partnership with Van Roll and GE (Wood Group) (Year 2)</td>
<td></td>
</tr>
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</table>
Advanced Research Projects Agency - Energy

Scientific Understanding Produces Improved or New Technologies

Overcoming Technological Barriers Needs New Scientific Understanding

Basic Science Research → Feasibility Research → Technology Development → Technology Demonstration → Small Scale Deployment → Large Scale Deployment

High Risk, High Payoff

Low Risk, Evolutionary

RISK

Office of Science

ARPA-E

EFRCs

Energy Innovation Hubs

Venture Capital & Small Businesses

Energy Efficiency & Renewable Energy

RISK

Loan Guarantee Program

Private Equity/Capital & Large Corporations

Govt. Procurement

Scale up of Business-Ready Technologies by Private Industry

EERE
To support transformational research in all areas of energy R&D, including resource identification, extraction, and energy generation.

At the end of the project, the transformational technology shall be sufficiently advanced and well defined in terms of performance and risk to promote next-stage development or transfer of the project to next-stage developers.

- Total funding $150 million
- Awards will range from $250k to $10 million
- 1 – 3 year projects
- Letter of Intent Submission Deadline: March 30th
- [https://arpa-e-foa.energy.gov/](https://arpa-e-foa.energy.gov/)
Future RD&D Needs
Subject to Appropriations

No Funding Opportunities in FY12

- Congress directed the Program not to put out any funding opportunities until mortgages are less than half of appropriations.
- Mortgages cannot be paid until projects pass go/no-gos.

EGS RD&D

- Initiate EGS field test site activities and R&D
- Balance between funding infrastructure development versus specific projects is fully conditional on actual site selections and designated operating model.

Systems Analysis

- Topic areas may include: R&D impacts on LCOE, identification of critical technology gaps, and calibration of oil and gas temperature data.

Resource Characterization

- Regional data gathering and analysis to identify new hydrothermal prospects and opportunities.

You can sign up to receive notifications when FOAs are released:
www.geothermal.energy.gov
Geothermal Technologies Program 2012 Peer Review
The Westin Westminster Hotel
Westminster, Colorado

- Principal investigators will present the results of their projects for peer review
- Approximately 169 projects will be presented, representing a total DOE investment over $340 million
- Learn and network with other stakeholders and program staff
- The meeting is open to the public and there is no registration fee but you need to register

For more information and to register, visit: geothermal.energy.gov/peerreview
Open now: Physical Scientists

- Two positions located in Washington D.C.
- Serve as a technical expert for the Program
- Direct a complex research program for developing the technology base needed for hydrothermal resources and enhanced geothermal systems
- Develops specific requirements, long-term goals and objectives, and schedules
- **Deadline is March 21, 2012**

www.usajobs.gov

Post Doc Research

- Post Doc Research opportunities to work on collaborative applied research with the host facility and the Program
- Awards administered by Oak Ridge Institute for Science and Education (ORISE) in collaboration with EERE
- **Deadline May 1, 2012**

www.eere.energy.gov/education/post doctoral
## Program Management

<table>
<thead>
<tr>
<th>Area</th>
<th>Staff Lead</th>
<th>Email</th>
<th>Telephone</th>
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<tbody>
<tr>
<td>Geothermal Program</td>
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<td><a href="mailto:Douglas.Hollett@ee.doe.gov">Douglas.Hollett@ee.doe.gov</a></td>
<td>202-586-1983</td>
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<td>Eric Hass</td>
<td><a href="mailto:Eric.Hass@go.doe.gov">Eric.Hass@go.doe.gov</a></td>
<td>720-356-1558</td>
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<tr>
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<td>Hidda Thorsteinsson</td>
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<td>202-287-1806</td>
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<td>Systems Analysis</td>
<td>Jay Nathwani</td>
<td><a href="mailto:Jay.Nathwani@ee.doe.gov">Jay.Nathwani@ee.doe.gov</a></td>
<td>202-586-9410</td>
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**Geothermal Program Office: 202.287.1818**