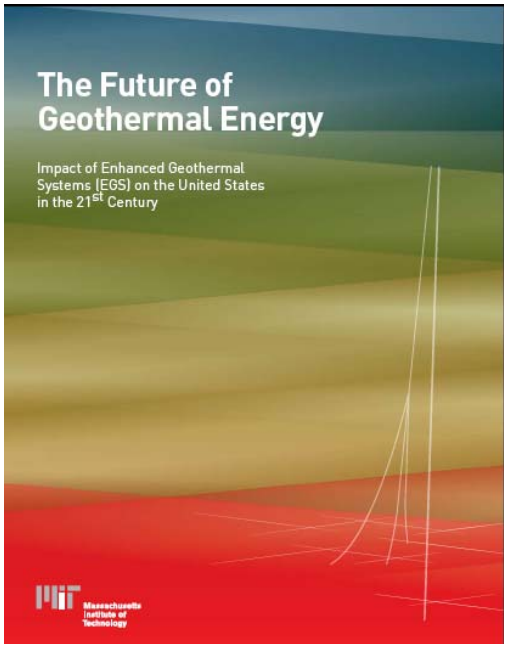
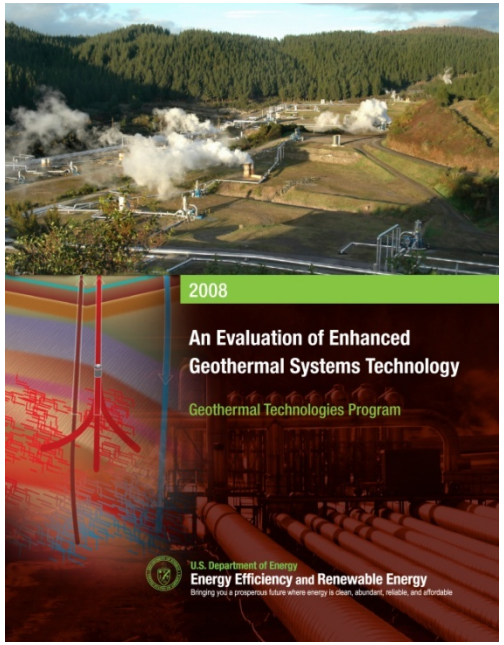
Enhanced Geothermal Systems Research and Development

Funding Opportunity Concept

Path to EGS goes through Hydrothermal



1. **Enhance Rock's Transitivity Property**
2. **Avoid Short Circuits/Cooling**
3. **Increase Swept Area**
4. **Increase Residence Time**



Critical Assumptions to Validate

Following critical assumptions require thorough evaluation and testing before the economic viability of EGS can be confirmed:

1. Demonstration of commercial-scale reservoir – This requires stimulation and maintenance of a large volume of rock (equivalent to several cubic kilometers) in order to minimize temperature decline in the reservoir. Actual stimulated volumes have not been reliably quantified in previous work.
2. Sustained reservoir production – The MIT study concludes that 200°C fluid flowing at 80 kg/sec (equivalent to about 5 MWe) is needed for economic viability. No EGS project to date has attained flow rates in excess of ~25 kg/sec.
3. Replication of EGS reservoir performance – EGS technology has not been proven to work at commercial scales over a range of sites with different geologic characteristics.

Industry Focused R,D & D Program

1. Test and Validate Today's Technologies
    1. Hydrothermal
    2. Oil and Gas
    3. Mining
2. Develop and enhance EGS Tools
    1. Temperature-hardened submersible pumps
    2. Smart tracers - Hydrothermal
    3. Monitoring and logging tools - Hydrothermal
    4. Coupled models to predict reservoir development and performance
3. Test and Validate High Risk R&D
4. Technology Transfer

Final Deliverable: An advanced tool box to create, maintain and operate natural and engineered geothermal reservoirs

Funding Opportunity Announcement (FOA)

1. FOA #1 – (Technology Evaluation Report)
    1. Topic 1 - EGS Technologies R&D – EISA Sec. 613, 614 & 615
    2. Topic 2- EGS Reservoir Stimulation – EISA Sec. 615

2. FOA #2 – (Deloitte Risk Mitigation Report)
    1. Institutional Barriers – EISA Sec. 618, 620 & 619

Objective 1: Meet Critical R&D Needs

1. Downhole pumps;
2. Fracture characterization;
3. High-temperature logging tools and sensors;
4. Image fluid flow;
5. Stimulation prediction models;
6. Tracers and tracer interpretation; and
7. Zonal isolation.

The research is also applicable to hydrothermal growth

Topic Area 1: Technology R&D

Total Estimated Federal Funding: $40 million

Estimated FY08 Funding: $4.4 million

Recipient Cost Share: 20% overall

Anticipated Award Type: Grants or Cooperative Agreements

Expected Number of Awards: 15-30 awards

Anticipated Award Size: $750,000 - $1 million

Award Ceiling/Floor: $2 million/$750,000

Period of Performance: Up to 3 years

Eligibility: Domestic and Foreign entities except other Federal agencies, Federally Funded Research and Development Center (FFRDC) Contractors, and nonprofit organizations. Additionally, FFRDCs are not allowed as sub-recipients on awards made under this Topic Area.

Research and Development Areas

1. **Zonal isolation** – isolate wellbore zones in high pressure and temperature environments in open (uncased) and cased holes using packers, expandable tubulars or other methods capable of providing zonal isolation

2. **Downhole pumps** – augment flow rates by using downhole pumps to add hydraulic head at depth

3. **Fracture characterization** – accurately detect and characterize rock mass fracture systems

4. **Image fluid flow** – accurately image fluid in created and/or pre-existing fractures so as to map flow through the reservoir

Subtopic Areas (cont'd)

5. **Tracers and tracer interpretation** – adapt or develop reservoir tracers and/or tracer interpretation techniques that provide information beyond well-to-well connectivity such as fracture surface area or fracture spacing

6. **High-temperature logging tools and sensors** – downhole instruments to detect fractures and log or monitor temperature, pressure, flow rates, and seismic events in wellbores

7. **Stimulation prediction models** – accurately simulate a reservoir's response to a stimulation

Objective 2: Increase the knowledge necessary for enhanced geothermal systems to advance to a state of commercial readiness

Meeting this objective will involve following strategies:

1. **Stimulate a reservoir in hydrothermal fields**
   - Criteria would consider enhancing the non productive wells --- recovering lost investment and reducing overall LCOE --- increasing the success rate of failed exploration
2. **Engineered a reservoir on the margins of known geothermal fields**
   - Expanding the boundaries of hydrothermal fields— continuum of hydrothermal—expanding the industry
3. **Create a Geothermal Reservoir at a given depth in different stress, depth, and variety of geologic settings**
   - Increase the exploration success rate to 100% some

Topic Area 2: EGS Reservoir Stimulation

1. **Total Estimated Federal Funding:** $50 million
2. **Estimated FY08 Funding:** $10 million
3. **Recipient Cost Share:** 20-50% overall
4. **Anticipated Award Type:** Cooperative Agreements
5. **Expected Number of Awards:** 4-6 awards
6. **Anticipated Award Size:** $12 million
7. **Award Ceiling/Floor:** $15 million/None
8. **Period of Performance:**
    1. Stimulation First 2 years 90% cost
    2. Data Collection,& Monitoring next 3-5 years 10% cost
9. **Eligibility:** Domestic entities except other Federal agencies, Federally Funded Research and Development Center (FFRDC) Contractors, and nonprofit organizations. Additionally, FFRDCs are not allowed as sub-recipients on awards made under this Topic Area.

Phase I: Pre-Stimulation

1. Task 1: Characterization - create a complete geologic model in support of a plan for well stimulation; development a concise stimulation plan.

2. Task 2: Planning and Permitting - secure necessary permits and approvals, performing necessary site, archaeological and other surveys, and maintaining compliance with all environmental, health, safety, NEPA and legal restrictions.

3. Task 3: Reporting and Technology Transfer - obtain sufficient information and permission to stimulate the well in Phase II. This information shall be documented in a Phase I report.

Deliverable: Baseline study of a target well

Phase II: Stimulation

1. **Task 1: Well Work-over - complete the candidate well with minor work-over and other appropriate well-related activities so that it is ready for stimulation work.**
2. **Task 2: Stimulation - complete stimulation of the candidate geothermal well via hydraulic or other means to demonstrate the effectiveness of the stimulation by establishing inter-well connectivity.**
3. **Task 3: Reporting and Technology Transfer – provide data from stimulation of the well and prepare for subsequent Phase III data collection and assessment work. This information shall be documented in a Phase II report.**

Deliverable: Engineered Reservoired

Phase III: Post-Stimulation

1. Task 1: Data Collection (first two years) - DOE intends to be actively involved in the data collection process with the assistance of DOE National Laboratories.
2. Task 2: Data Collection (final three years) - if selected for the final three years of data collection, the applicant is expected to continue collecting well data for analysis. Applicants should expect this data to be consistent with the data required during the first two years.
3. Task 3: Reporting and Technology Transfer – provide short and long tern flow test reports. At the end of Phase III, the recipient shall submit a final technical report that includes all Phases of the award.

Deliverable: Greater Knowledgebase

Recipient Cost Share Requirements

1. **Phase I – Pre-Stimulation**
   1. *Characterization, Planning and Permitting* – the recipient cost share must be at least 80% of the total project costs for all activities under this Task.
   2. *Reporting and Technology Transfer* – the recipient cost share for all reporting, publishing and technology transfer must be at least 50%. This cost share requirement includes all reporting requirements for Phase I.
2. **Phase II - Simulation**
   1. *Well Work-Over* – the recipient cost share must be at least 50% of the total project costs for all well work-over and related activities.
   2. *Stimulation* – the recipient cost share must be at least 20% of the total project costs for all stimulation and related activities.
   3. *Reporting and Technology Transfer* – the recipient cost share for all reporting, publishing and technology transfer must be at least 50%. This cost share requirement includes all reporting requirements for Phase II.

Recipient Cost Share Requirements (cont'd)

1. Phase III – Post-Stimulation

1. *Data Collection, first two years* – the recipient cost share for the first two years of data collection and analysis must be at least 50%.
2. *Data Collection, final three years* – for the anticipated final three years of data collection, DOE will not provide funding.
3. *Reporting and Technology Transfer* – the recipient cost share for all reporting, publishing and technology transfer must be at least 50%. This cost share requirement includes all reporting requirements for Phase III.

Industry Cost-shared Field Projects

1. Develop Critical Knowledge Base on Stimulation Techniques and Applicability (at Fields with Infrastructure)
   1. Gather information from field projects at hydrothermal fields
   2. Apply historical experience from oil and gas fields and mining industry
   3. Gather information from the margins of hydrothermal fields

International partnerships will be formed for technology development (EISA Sec. 624) and education

Geothermal Development Processes