



U.S. Department of Energy
Energy Efficiency and Renewable Energy

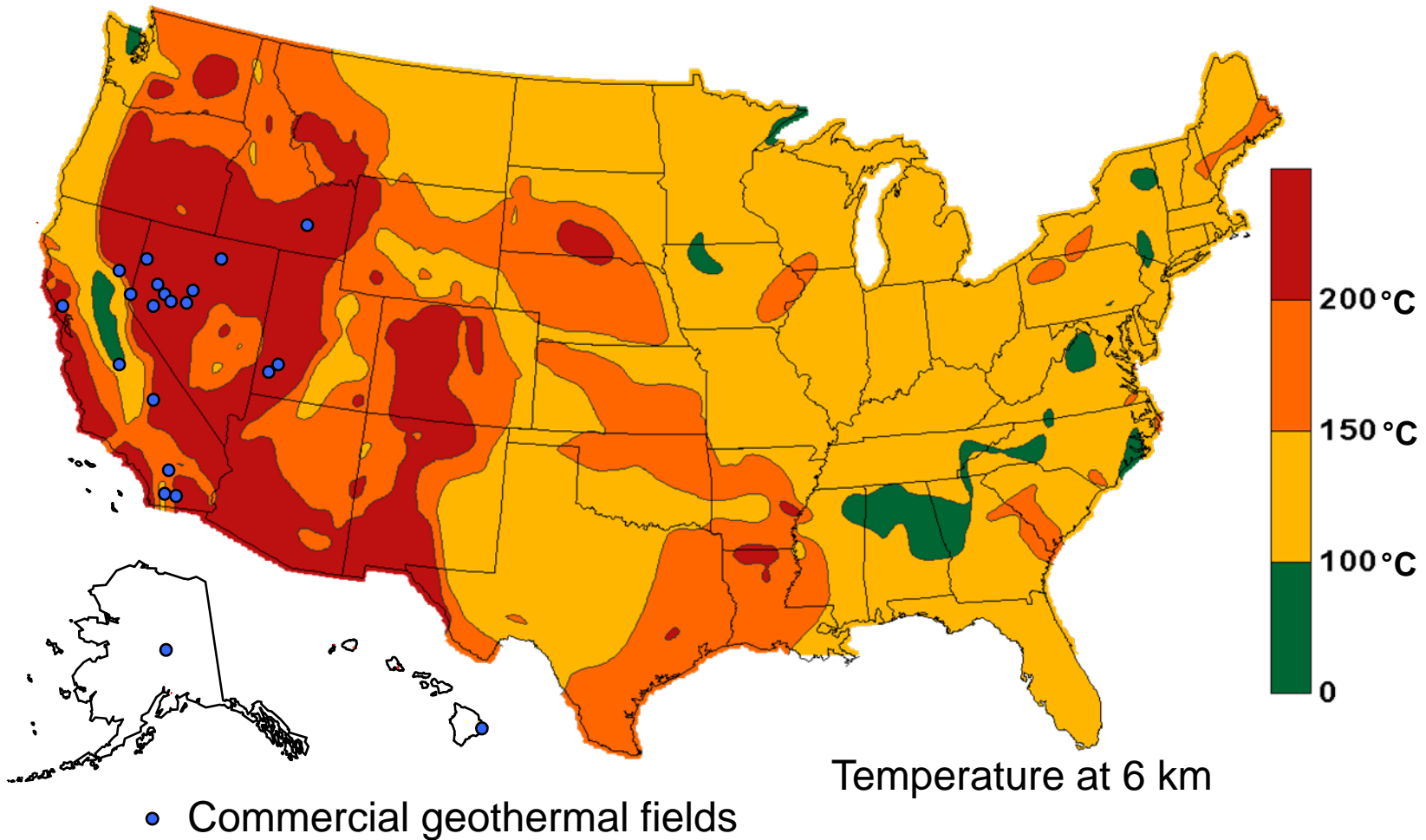
Geothermal Pre-Solicitation Meeting Geothermal Program Overview

Geothermal Technology Program
U.S. Department of Energy
April 25, 2008



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Geothermal Resource





Benefits of Geothermal Development

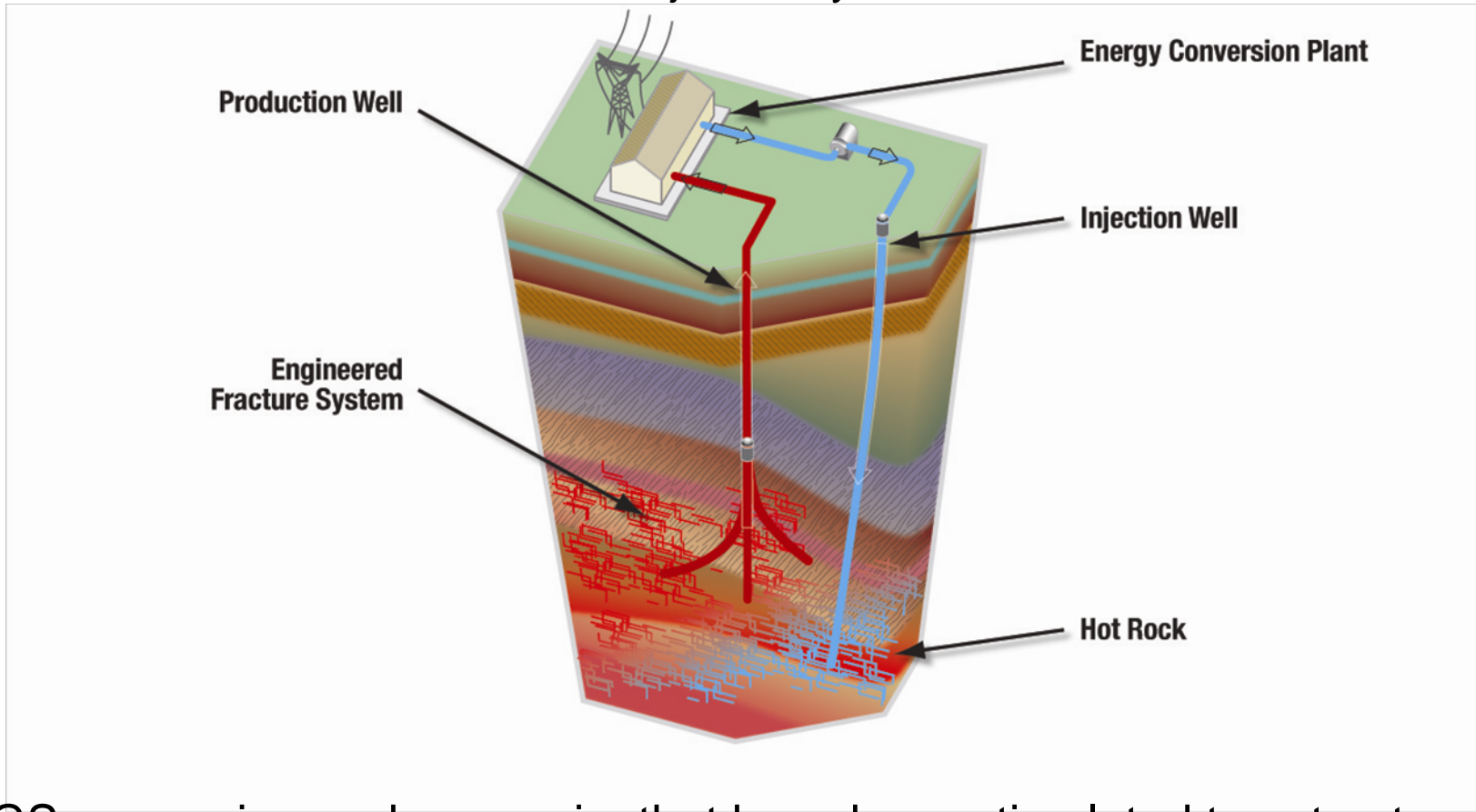
- Energy Reliability and Security
 - Baseload fuel-free power generation
 - Grid stability – sizing and siting flexibility
- Economic Expansion
 - Every \$1 investment is \$2.5 into the U.S. economy (source: Geothermal Energy Association)
- Environmental Quality
 - Avoided gaseous emissions, especially carbon dioxide
 - Little to no liquid and solid emissions
 - Minimal land use per unit power generation



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Enhanced/Engineered Geothermal Systems (EGS)

EGS Major Subsystems



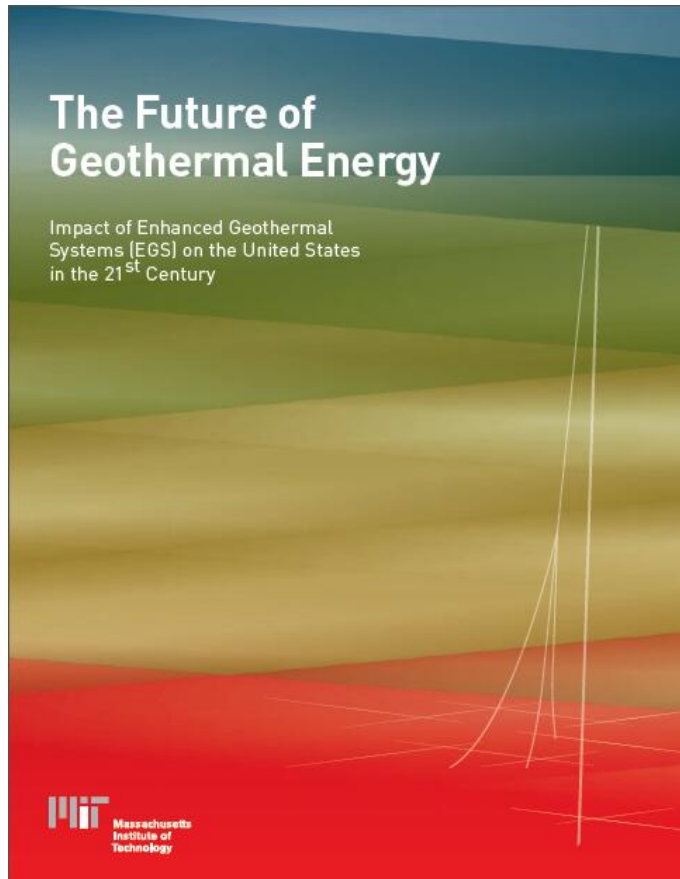
EGS are engineered reservoirs that have been stimulated to extract economical amounts of heat from unproductive geothermal resources.



U.S. Department of Energy
Energy Efficiency and Renewable Energy

The Future of Geothermal Energy

Landmark Study of Enhanced Geothermal Systems (EGS)
by MIT-Led Panel of Experts



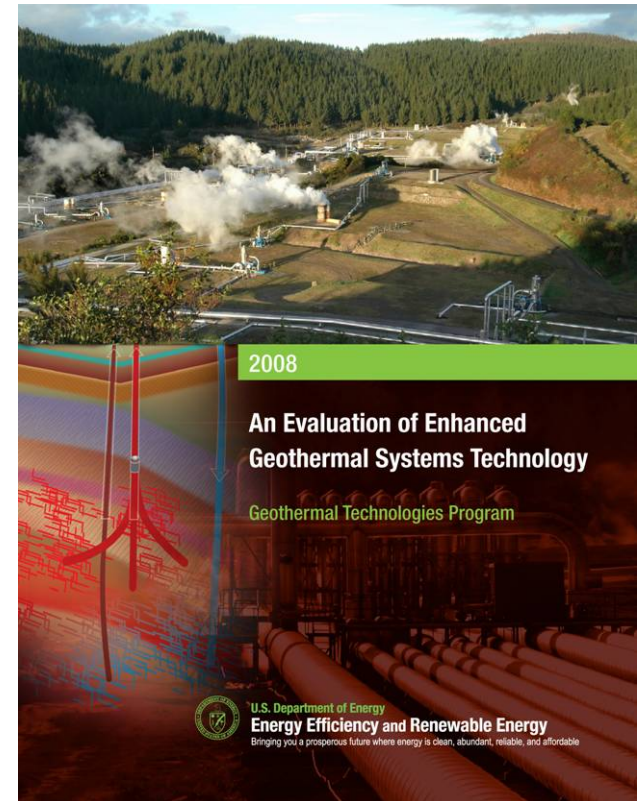
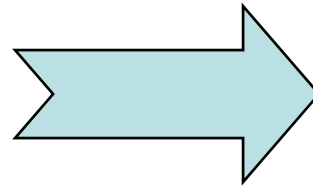
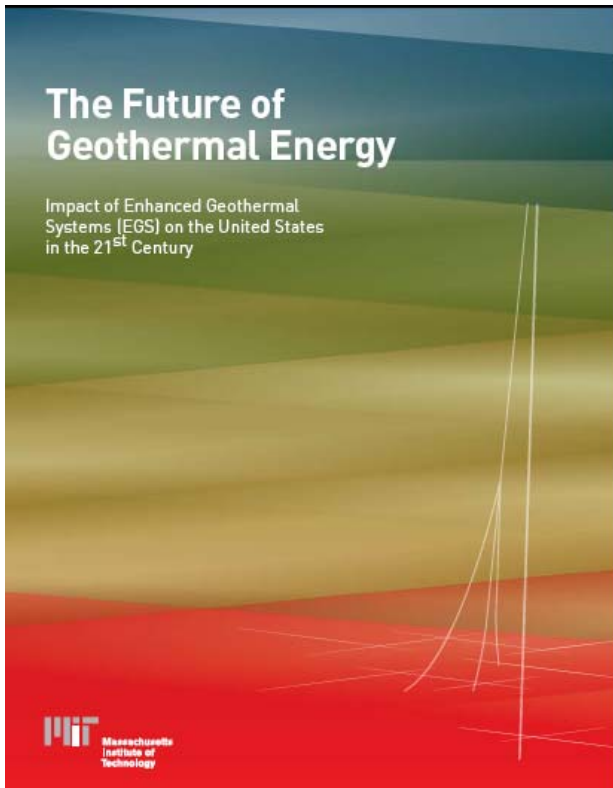
Key Findings/Recommendations

- Extractable geothermal resource exceeds 2000 times the annual energy consumption of the United States
- EGS are versatile, modular, and scalable from 1 to 50 MWe unit sizes
- Technical issues are surmountable – no showstoppers
- Cumulative EGS capacity of 100,000 MWe can be achieved in the United States within 50 years
- Public/private investment of \$800 million to \$1 billion over 15 years would produce 100,000 MWe by 2050



U.S. Department of Energy
Energy Efficiency and Renewable Energy

EGS – The Future Is Now





U.S. Department of Energy
Energy Efficiency and Renewable Energy

EGS Development Steps

Step 1: Locate Site
Characterize and
Select Site



Drill and Log
Exploratory Well

Steps 2-3: Create Reservoir

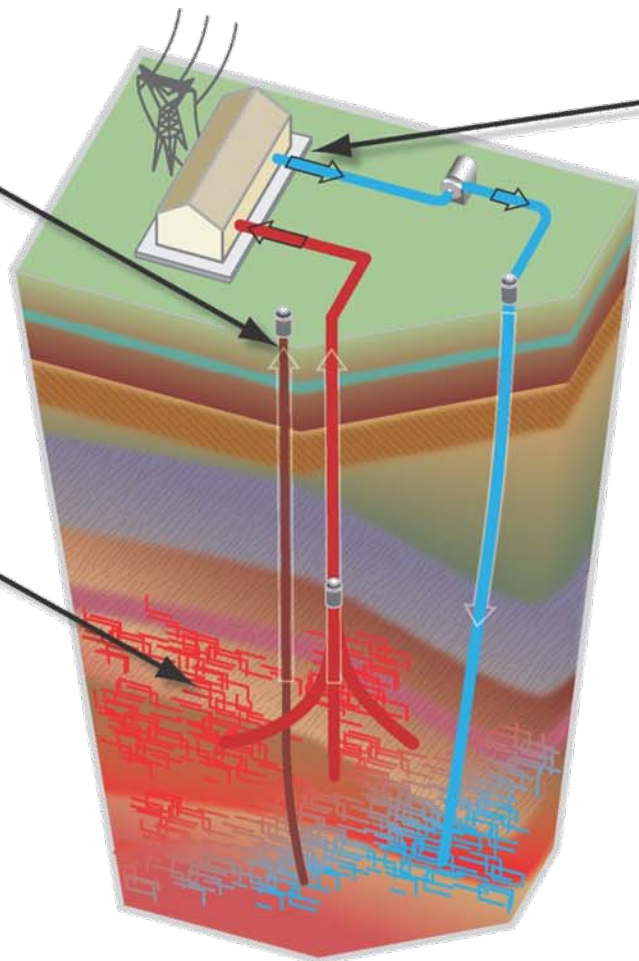
Drill
Injection Well



Stimulate/Create
Reservoir



Drill
Production Well



Steps 4-5: Operate System

Complete and Verify
Circulation Loop

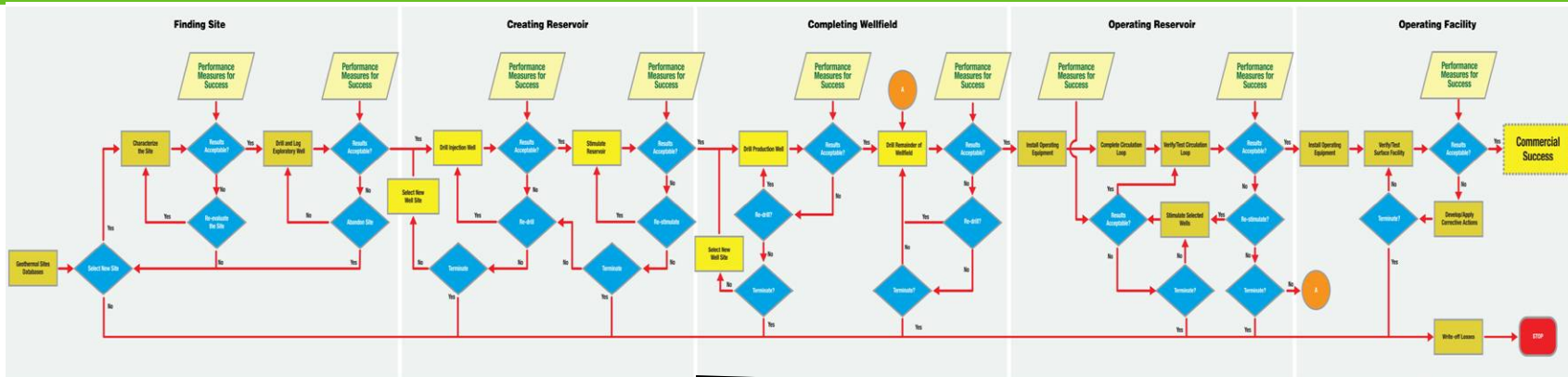


Install
Operating Equipment

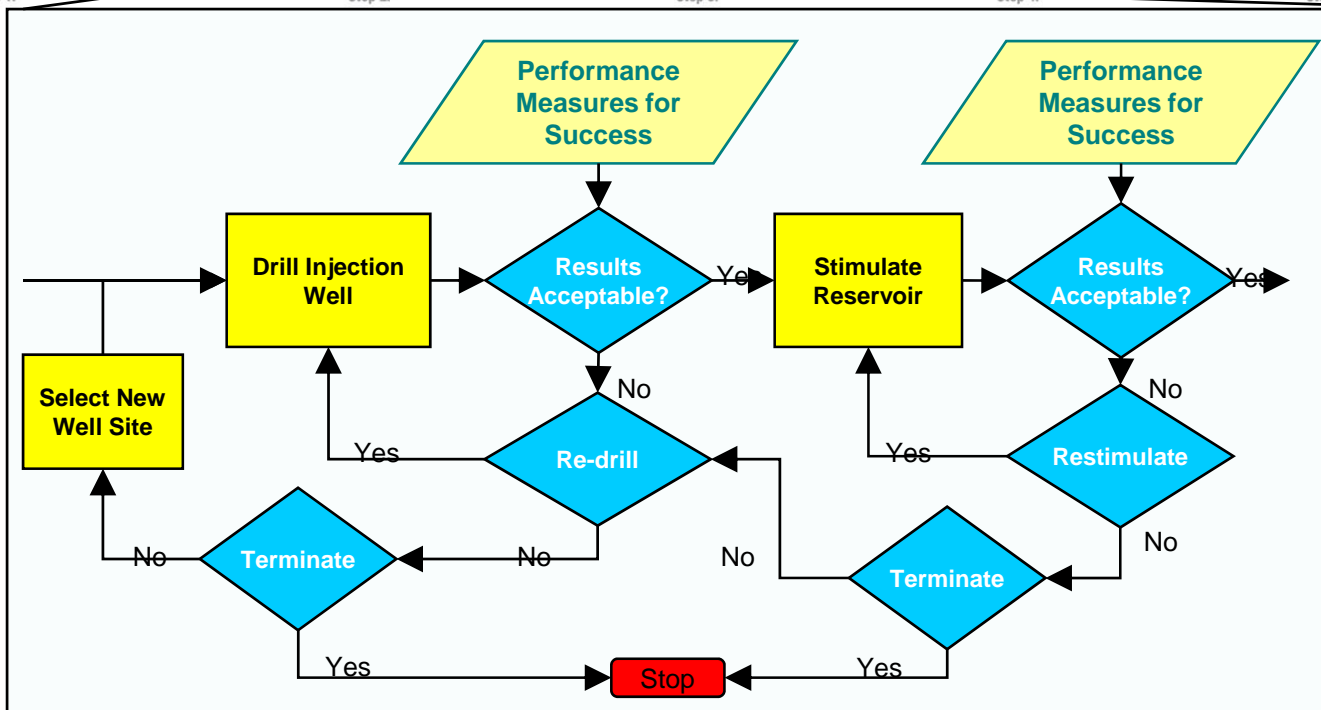


U.S. Department of Energy
Energy Efficiency and Renewable Energy

EGS Project Development Logic



Step 1. Step 2. Step 3. Step 4. Step 5.





EGS Technology Adequacy

■ = Most Adequate ■ = Some Degree of Adequacy ■ = Least Adequate

REQUIRED TASK	AVAILABLE TECHNOLOGIES	TECHNOLOGY STATUS	ADEQUACY	
			Short Term	Long Term
Plan and design stimulation (e.g., zones, pressures, volumes, fluids, proppants)	Stimulation models for oil and gas; basic numerical models for geothermal applications	Stimulation modeling techniques for geothermal systems are not a mature technology.	YES	NO
Imaging and mapping of fractures	Microseismicity, gravimetry, self potential, tiltmeter arrays	Surface microseismic and gravity tools are adequate for most purposes, but the resolution may be insufficient for EGS. Self-potential is not proven for this purpose. Tiltmeter results are difficult to interpret in zones of multiple fractures.	YES	NO
Identification of flow paths during and post-stimulation	Microseismicity, gravimetry, SP, tiltmeter arrays	The utility of existing techniques for tracking fluid flow has not been demonstrated. Microseismic techniques are not hardened for downhole use.	NO	NO



EGS Technology Adequacy

Effective real-time decision-making capability for stimulation	Oil and gas industry stimulation modeling and control technology	The oil industry has modeling and control capability for petroleum environments, but experience in geothermal systems is lacking.	YES	NO
Zonal isolation for stimulation	Stimulation packers, slotted liners	Packers that can operate at stimulation pressures and temperatures are not available. Slotted liners and related technologies may not perform adequately for EGS	NO	NO
Create/enhance flow paths	Hydraulic stimulation; chemical stimulation; and rate controlled explosives	Geothermal stimulations for EGS use water or water weighted with dense chemicals such as barium sulfate salts. Chemical and other stimulation methods have been used in hydrothermal systems.	YES	NO
Keep flow paths open	Proppants for both near well bore and far field use scaling, dissolution, and permeability control	Proppants are typically used in oil and gas stimulations. Temperature-hardened proppants have not been evaluated in geothermal environments. Scaling and dissolution control technologies are available, but may not be adequate for EGS conditions.	YES	NO



Evaluation Results

- MIT Study Findings Corroborated
- Technology Gaps Identified
 - Fracture Detection Capability
 - Stimulation Prediction Models
 - Zonal Isolation Technology
 - Flow Path Identification
 - Submersible Pumps
 - Tracer and Tracer Interpretation
 - High-Temperature Monitoring Tools and Sensors
- Field Demonstrations Required



U.S. Department of Energy
Energy Efficiency and Renewable Energy

DOE Approach

- R&D – Emphasis on EGS while supporting hydrothermal growth
- Field Demonstrations – EGS reservoir stimulation using marginal hydrothermal and oil & gas fields
- Institutional Barriers – Affecting all geothermal technologies
- Loan Guarantees – Advanced geothermal technologies



Near-Term Activities

- EGS technology R&D
 - Priority Technology Development (Solicitation)
- EGS Field Demonstrations
 - Desert Peak
 - EGS Cost-shared Stimulation Projects (Solicitation)
- Technology Transfer
 - Institutional (Risk Reduction) Activities (Solicitation)
 - Education
 - Data Center
- Collaborative Agreements
 - International
 - Interagency



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Geothermal Program FY2008 Spend Plan

