

Enhanced Geothermal Systems

The U.S. Department of Energy's (DOE) Geothermal Technologies Program (GTP) research, development, and demonstration (RD&D) activities are carried out in partnership with industry, academia, and national laboratories to improve technologies for finding, characterizing, accessing, and producing geothermal resources. The Enhanced Geothermal Systems (EGS) subprogram pursues RD&D projects to improve performance, reduce cost, and facilitate technology validation and deployment. EGS RD&D projects will move industry along the learning curve toward technological readiness.

EGS Technologies Metrics and Milestones Roadmapping Information Exchange

In an effort to facilitate development of and overcome the challenges associated with EGS, GTP invited subject matter experts to take part in *EGS Technology Roadmapping Information Exchange* held in San Francisco, CA, August 3-4, 2011.

The meeting focused on translating high-priority technology needs into targeted technology improvements. The meeting broke into three subgroups to discuss technology needs specific to:

- Reservoir characterization,
- Reservoir creation, and
- Reservoir sustainability/operation.

Action

At this time GTP would like your input on the technology improvement areas identified at the meeting. Input from a diverse group of experts is paramount in developing a robust technology roadmap. Some questions to consider:

- Do you think there are other new or innovative technologies that were missed as part of this evaluation?
- Are there additional technology improvement areas that should be included?
- Do you have any comments on the timelines or metrics used to evaluate these technologies?

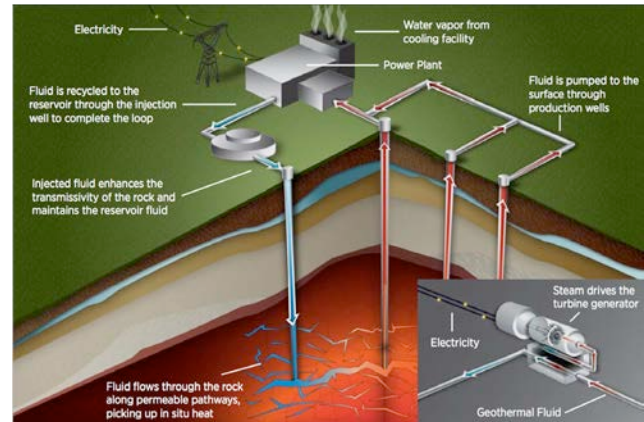
We would greatly appreciate your insight in order to further refine the final roadmap.

Comments

Please feel free to attach your comments to this document or email them to the address below for consideration before February 29, 2012.

Eric Hass (720.356.1558) Eric.Hass@go.doe.gov
Geothermal Technologies Program
Office of Energy Efficiency and Renewable Energy

EGS Reservoir Creation



From: <http://www1.eere.energy.gov/geothermal/>

Reservoir Creation Technology Improvement Areas Identified at the August 2011 Meeting

- 1) **Develop ability to isolate zones in a reservoir**
 - a) Cased-hole applications
 - b) Packers
 - c) Smart Well Technology
 - d) Diverters
- 2) **Develop new techniques to create/enhance flow paths**
 - a) Alternative fracturing methods
 - b) Advanced Hydraulic Stimulation
- 3) **Develop new and innovative drilling techniques**
 - a) Rock Reduction Technologies
 - b) Directional steering and mud motors for highly deviated wells
 - c) LWD/MWD
 - d) Geothermal Drilling Best Practices/Data Sharing
 - e) Well Completions
 - f) Microholes/Slim Hole/Sidetracks
- 4) **Develop new techniques/tools to identification flow paths during and post-stimulation**
 - a) Fracture-Specific Tracers
 - b) Induced seismicity as energy source to determine location of fractures
 - c) Tiltmeter
- 5) **Develop new stimulation design tools**
 - a) Field Deployable Reservoir Pressure and Microseismic Volume Tool
 - b) High-Performance Modeling Tools
 - c) Sensitivity Analysis to A Priori Knowledge
- 6) **Develop new stimulation monitoring techniques**
 - a) Microseismic Network Calibration
 - b) Microseismic Calibration From Drilling
 - c) Downhole microseismic tools
 - d) Relate Microseismic Data to Size/Volume of Reservoir
 - e) Tiltmeters
 - f) Advanced Downhole Sensing and Observation
 - g) Refracted/Reflected Energies

GEOTHERMAL TECHNOLOGIES PROGRAM

Zonal Isolation Technologies

Technology to isolate zones within a wellbore so that fractures can be produced at desired locations

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Cased-hole applications	Number of fracture zones in EGS stimulation	One fracture zone (uncontrolled)	Three fracture zone (uncontrolled)	2016
Packers	Pressure and Temperature	Unknown pressure and 175 - 200 °C	250 °C and ΔP 5,000 psi	2016
Smart well technology	Temperature and Time Limit	175 - 200 °C and unproven/unknown	175 - 200 °C and 30 years	2019
Diversers	Upper temperature limit and time limit	Unknown and unknown	300 °C and 1 week	2015

Create/Enhance Flow Paths

Technology that either creates/extends fractures and/or decreases near-wellbore impedance

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Alternative Fracturing Methods	Number of methods demonstrated	None	One new method	2017
Advanced hydraulic stimulation	Stimulated volume function of injection parameter	12% injection losses	Control fracture type	2017

Drilling

Drilling technologies to access the reservoir

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Rock reduction technologies	Bit Life (hrs) and rate of Penetration (ft/hr)	-30 hrs and 10 ft/hour	4X improvement in both	2017
Directional steering and mud motors for highly deviated wells	Temperature and operational drilling fluid limits	175 °C and mud/water	250 °C and air/mist	2016
LWD/MWD	Temperature and operational drilling fluid limits	175 °C with mud/water	250 °C with air/mist	2017 - 2020
Geothermal Drilling Best Practices/ Data Sharing	Number of operators sharing data	No sharing of drilling best practices	Ten participating operators	2014
Well Completions	Bit Life (hrs) and rate of Penetration (ft/hr)	-30 hrs and 10 ft/hour	4X improvement in both	2017
Microholes/Slim Hole/Sidetracks	Bit Life (hrs) and rate of Penetration (ft/hr)	-30 hrs and 10 ft/hour	4X improvement in both	2017

Identification of Flow Paths During and Post Stimulation

Locate, map and determine type of fractures relevant to stimulation activities

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Fracture-specific tracers	Quantitative analysis of tracer returns	Available in shale gas	EGS stimulation with multiple fracture zones and multiple tracers	2019
Induced seismicity as energy source to determine location	Validation of method against known geothermal data set	Possible applications outside geothermal	Validation of method using and existing data source	2016
Tiltmeter	Successfully used in EGS stimulation	Does not work	Success	2014

Stimulation Design Tool

Technology is modeling tools capable of predicting directionality, density and extent of fractures prior to stimulation

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Field Deployable Reservoir Pressure and Microseismic Volume Tool	Replicates the pressure and microseismic volume of the reservoir	Does not exist	Within +/- 20%	2014
High-Performance Modeling Tools	Ability to match history of empirical data (injected volume, pressure, and microseismic volume).	2D versions exist	Within +/- 20% in 3D	2015
Sensitivity Analysis to A Prior Knowledge	Identification of critical variables and tolerances	Limited results	Identification of critical variables and tolerances	2014

Monitoring Simulation

Technology that is capable of "seeing" where fractures are being formed during stimulation of the reservoir

Technology Advancement	Technology Metrics			
	Metric Unit for Advancement	2011 Status	Target	When
Microseismic Network Calibration	Useful depth and temperature	Not available	12,000 feet, 225 °C	2015
Microseismic Calibration From Drilling	Hypocenter accuracy (m)	Unknown	+/- 100 m	2015
Downhole microseismic tools	Temperature Limit/Time	150 °C. / - 1 year	225 °C. / 5 years	2015
Relate Microseismic Data to Size/Volume of Reservoir				
Tiltmeters	Successfully used in EGS stimulation	Does not work	Success	2014
Advanced Downhole Sensing and Observation	Successful deployment	DTS used in SAGD	Successful applications of DTS in other EGS sites	2013 for DTS, 2015 for other
Refracted/Reflected Energies	Identify location (m) and fluid content of fractures (%)	Validated against petroleum lab dataset	Validated	2014