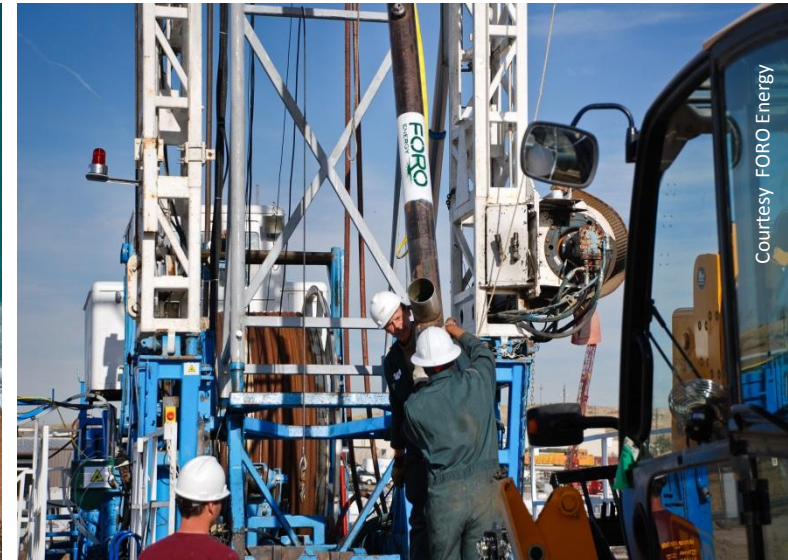


Department of Energy Update

National Geothermal Summit | August 5-6, 2014 | Reno, Nevada



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Douglas Hollett, Director
Geothermal Technologies Office

GTO Major Initiatives

New Geothermal Opportunities

- “Play Fairway” FOA
- Pathway to next-step drilling validation

Accelerating EGS

- Build upon R&D and demonstration project successes
- EGS R&D FOA
- Frontier Observatory for Research in Geothermal Energy (FORGE) FOA

Tackling Deployment Barriers

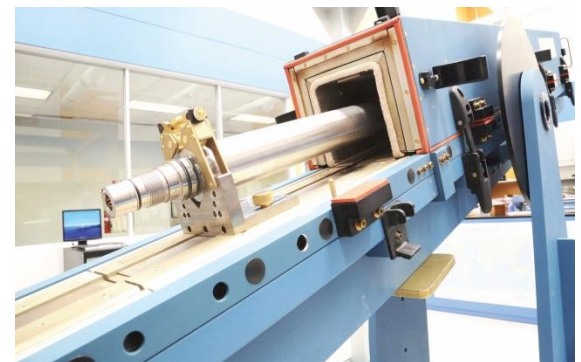
- Regulatory Roadmap
- National Geothermal Data System: leveraging access to data

Additive Value

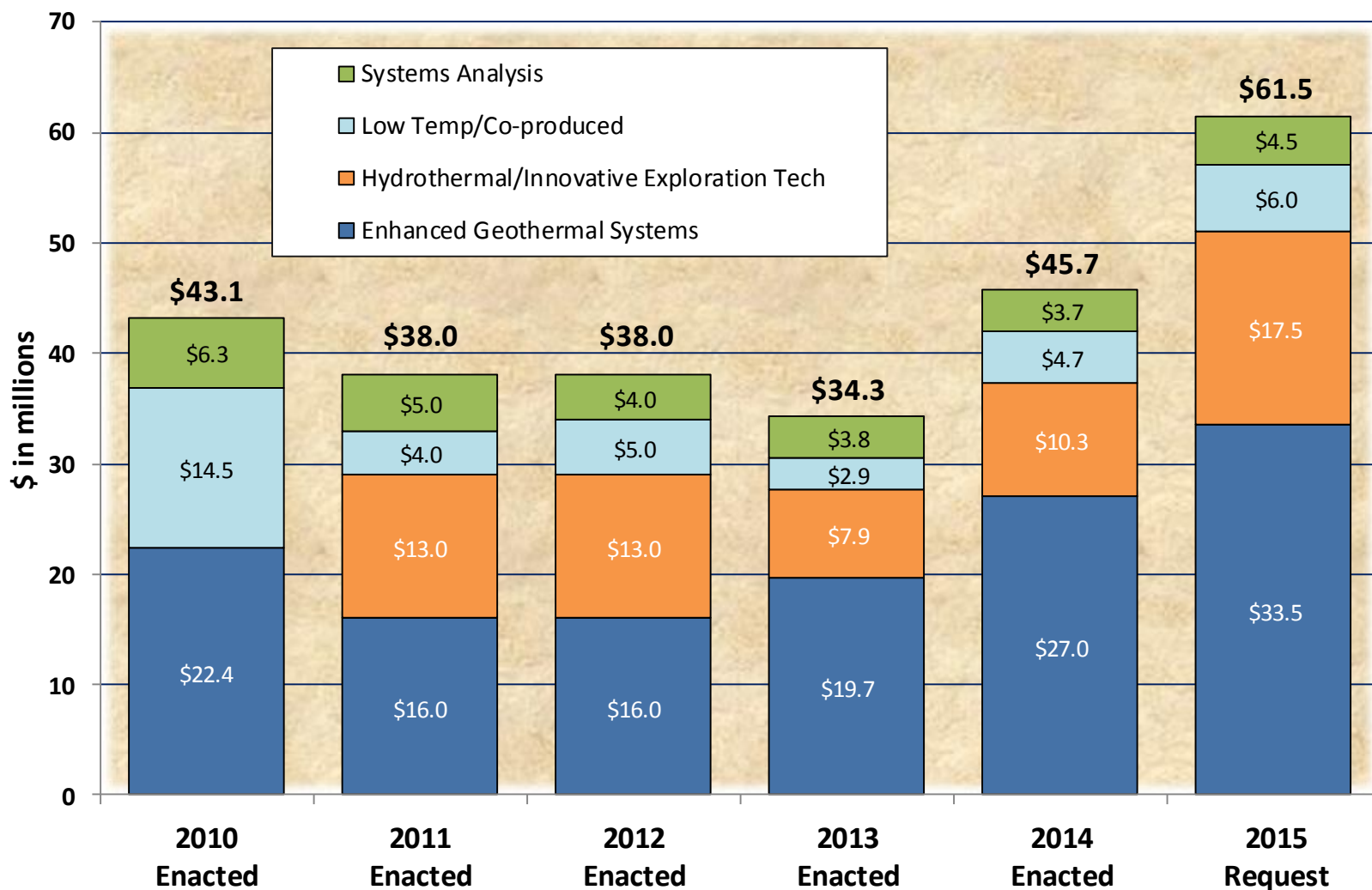
- Low Temp Mineral Recovery FOA
- Hybrid systems

NEW: Subsurface Engineering Crosscut

- Intra- and inter-agency effort to address common subsurface challenges and better leverage DOE R&D



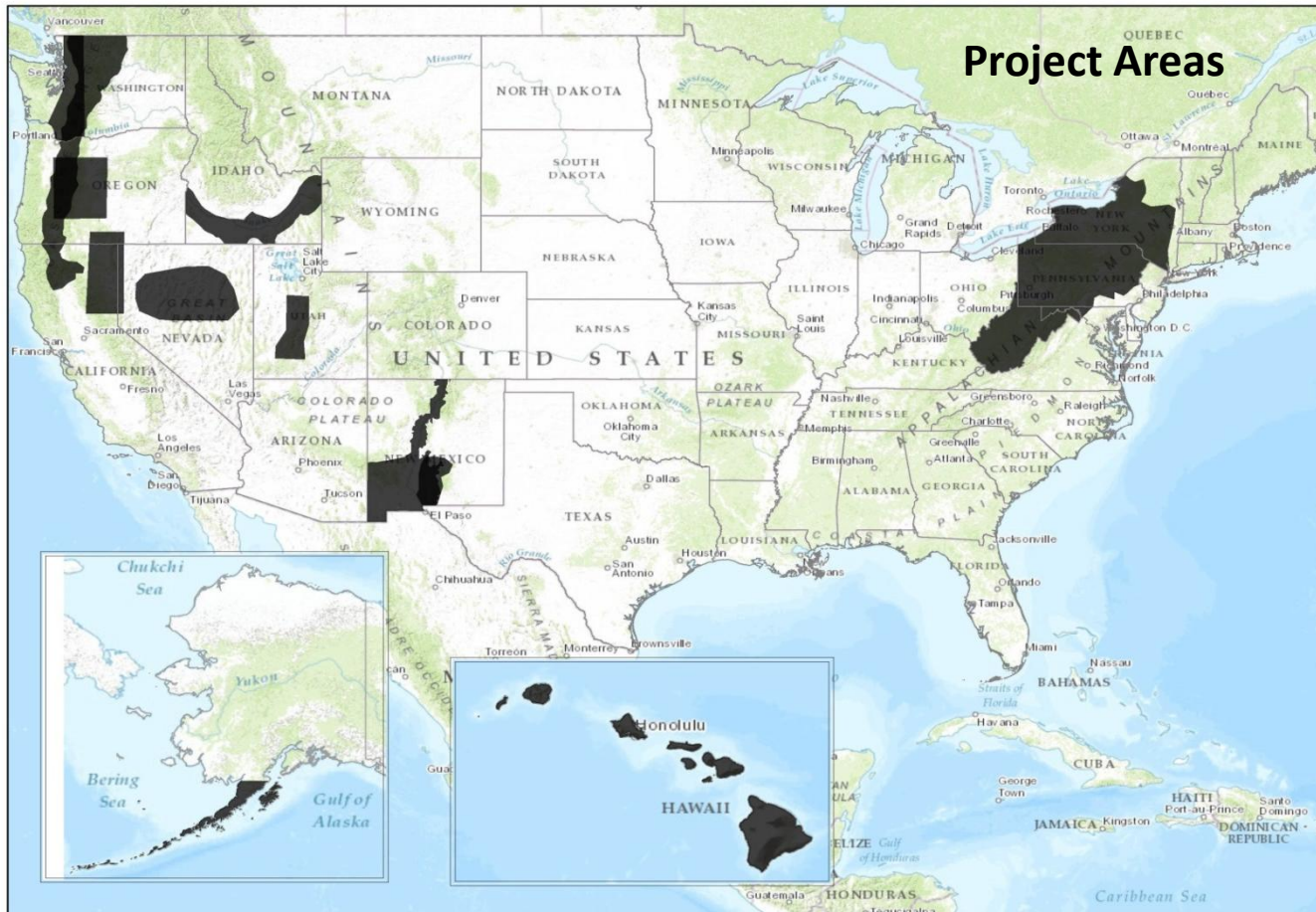
GTO Budget – FY 2010 to present



Geothermal Play Fairway Analysis FOA (Hydrothermal Program)

FOA Objective:
















Address the overarching theme of uncertainty quantification and reduction, specifically through the development of Geothermal Play Fairways.



- Define levels of confidence/uncertainty with respect to the presence and utility of geothermal system elements, and translate into maps
- High-grade the geographic areas over which the most favorable combinations of heat, permeability, and fluid are thought to extend



Play Fairway Analysis FOA (*Hydrothermal Program*) Selectees

FOA Federal Funding Total: \$4,072,161 (11)

Selectee	Partner(s)	Title
	 	Geothermal Potential of the Cascade and Aleutian Arcs, with Ranking of Individual Volcanic Centers for their Potential to Host Electricity-Grade Reservoirs
	 	Low Temperature Geothermal Play Fairway Analysis for the Appalachian Basin
	 	Structurally Controlled Geothermal Systems in the Central Cascadia Arc-BackArc Regime, Oregon
	   	Geothermal Play-Fairway Analysis of Washington State Prospects
		Comprehensive analysis of Hawaii's geothermal potential through Play Fairway integration of geophysical, geochemical, and geological data












Play Fairway Analysis FOA (*Hydrothermal Program*) Selectees, *CONT'D*

FOA Federal Funding Total: \$4,072,161

Selectee	Partner(s)	Title
	  	The Convergence of Heat, Groundwater, & Fracture Permeability: Innovative Play Fairway Modelling Applied to the Tularosa Basin
	  	Discovering Blind Geothermal Systems in the Great Basin Region: An Integrated Geologic and Geophysical Approach for Establishing Geothermal Play Fairways
	    	Play Fairway Analysis of the Snake River Plain
		Structurally Controlled Geothermal Systems in the Eastern Great Basin Extensional Regime, Utah
		Geothermal Play Fairway Analysis of Potential Geothermal Resources in NE California, NW Nevada, and Southern Oregon:
		Hydrogeologic windows: regional signature detection for blind and traditional geothermal play fairways











LT Mineral Recovery Program FOA (*Low Temp Program*) Selectees

FOA Federal Funding Total: \$4,064,628 (9)

Selectee	Partner(s)	Title
 <p>SOUTHERN RESEARCH INSTITUTE</p>	   	<p>Geothermal Thermoelectric Generation (G-TEG) with Integrated Temperature Driven Membrane Distillation and Novel Manganese Oxide for Lithium Extraction</p>
 <p>SRI International</p>		<p>Selective Recovery of Metals From Geothermal Brine</p>
 <p>BERKELEY LAB</p>		<p>Engineering Thermophilic Microorganisms To Selectively Extract Strategic Metals From Low Temperature Geothermal Brines</p>
	 	<p>Maximizing REE Recovery in Geothermal Systems</p>


















LT Mineral Recovery Program (*Low Temp Program*) Selectees, *CONT'D*

FOA Federal Funding Total: \$4,064,628

Selectee	Partner(s)	Title
 Pacific Northwest NATIONAL LABORATORY		Magnetic Partitioning Nanofluid for Rare Earth Extraction from Geothermal Fluids
 Pacific Northwest NATIONAL LABORATORY	  UNIVERSITY OF OREGON	Recovery of Rare Earths, Precious Metals and other Critical Materials from Geothermal Waters with Advanced Sorbent Structures
		Chelating Resins for Selective Separation and Recovery of Rare Earth Elements from Low Temperature Geothermal Water
		Determination of Rare Earths in Geothermal Brines and Evaluation of Potential Extraction Techniques
 Tusaar Corp	 	Environmentally Friendly Economical Sequestration Of Rare Earth Metals From Geothermal Waters
















Integrated EGS R&D FOA (*EGS Program*) Selectees

FOA Federal Funding Total: \$9,668,674 (12)

Selectee	Partner(s)	Title
	     	<p>Poroelastic Tomography by Adjoint Inverse Modeling of Data from Seismology, Geodesy, and Hydrology</p>
		<p>Surface and Subsurface Geodesy Combined with Active Borehole Experimentation for the Advanced Characterization of EGS Reservoirs</p>
		<p>Leveraging a Fundamental Understanding of Fracture Flow, Dynamic Permeability Enhancement, and Induced Seismicity to Improve Geothermal Energy Production</p>
	 	<p>Radioisotope Tracers and Fracture Attributes for Enhanced Geothermal Systems</p>
		<p>Phase I Project: Fiber Optic Distributed Temperature Sensing for Periodic Hydraulic Tests</p>
		<p>A reactive tracer method for predicting EGS reservoir geometry and thermal lifetime: development and field validation</p>

Integrated EGS R&D FOA (*EGS Program*) Selectees, *CONT'D*

FOA Federal Funding Total: \$9,668,674

Selectee	Partner(s)	Title
		Laboratory-scale Characterization of EGS Reservoirs
	 	Push-pull well testing using CO2 with active source geophysical monitoring
	Hi-Q Geophysical   	Joint Active and Passive Seismic Imaging of EGS Reservoirs
		Seismic Analysis of Spatio-Temporal Fracture Generation During EGS Resource Development
	 	Quantifying EGS Reservoir Complexity with an Integrated Geophysical Approach- Improved Resolution Ambient Seismic Noise Interferometry
		Tagged Nanoparticles for Fluid Flow Monitoring

FORGE Funding Opportunity Announcement

\$31 M for Initial Phases



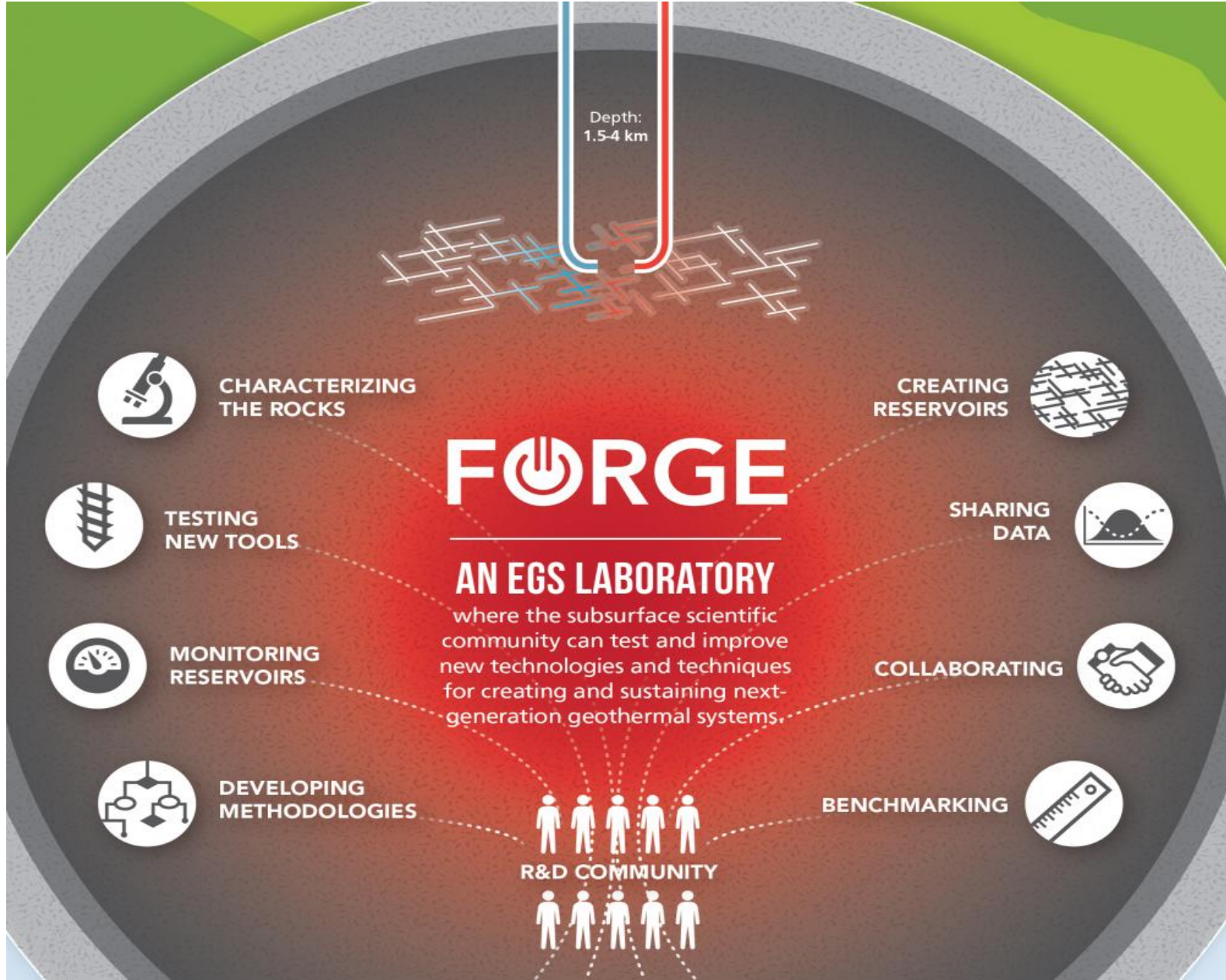
FOA Issue Date:	7/17/2014
FOA Informational Webinar:	8/05/2014
Submission Deadline for Applications:	10/01/2014
Submission Deadline for Replies to Reviewer Comments:	11/25/2014
Expected Date for EERE Selection Notifications:	1/30/2015
Expected Timeframe for Award Negotiations:	2/1/2015-3/31/2015

FORGE Project Website: energy.gov/forge

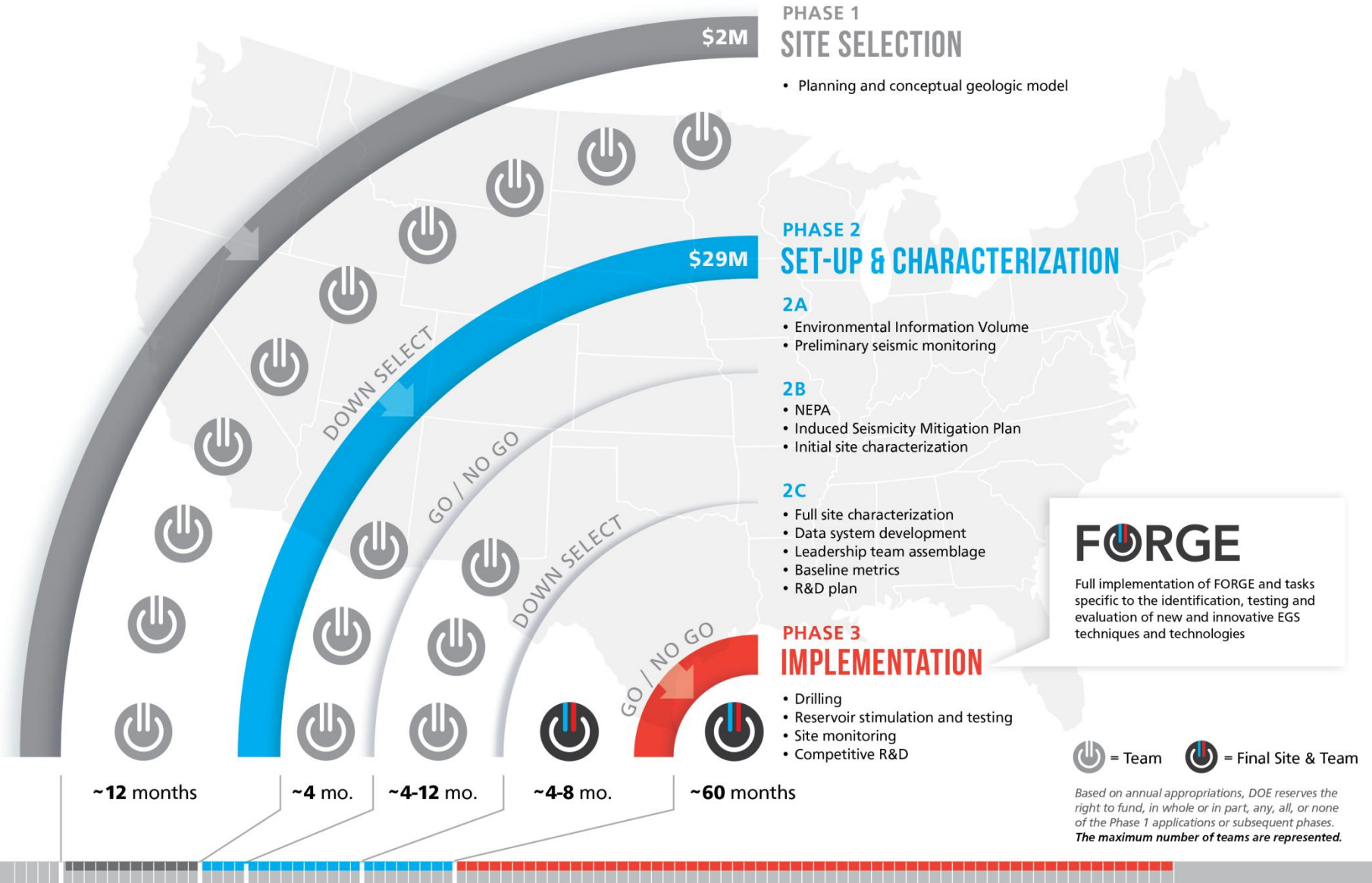
Questions?

Email: DE-FOA-0000890-FORGE@netl.doe.gov

FORGE Overview



FORGE Structure – Phased Approach



Select Results on Funded Projects 2014

Oregon Institute of Technology: Commissioned **1.5 MW** of newly-installed geothermal power on campus, from a \$1 million GTO award with \$4 million match by Johnson Controls.

Pagosa Verde: GTO's \$3.9 million **geothermal exploration project in Colorado** is being matched by a \$1.98 million state bond, with a bill signing by Colorado Gov. Hickenlooper on May 30.

National Geothermal Data System: Deployed **“best-in-class”** geothermal data system June FY14, and GEA recognition.

FastCAP: GTO's \$2.2 million investment has succeeded in **development and commercialization** of a cutting-edge power system for geothermal exploration in high vibration, extreme drilling environments.

Surprise Valley Electrification Corp:* Non-profit rural cooperative, plans to go online with a low-temperature, **3 MW geothermal power plant** later this year, funded with \$2M in GTO Recovery Act funds, matched by a \$3M Oregon Department of Energy Business tax credit. **Waste heat from the plant will be used for aquaculture, green house farming, and district heating.**

* Expected

Select Results on Funded Projects 2014, *CONT'D*

SNL Drilling: Sandia developed and licensed a **first-of-a-kind, high-temperature** (480°F), elastomer-free drilling motor for use with pneumatic down-the-hole-hammers, for drilling in high temperature geothermal formations.

Raft River (Idaho) EGS Demonstration Project:* Will complete two phases of thermal stimulation that commenced in FY 2013, and will complete a **large injection volume hydraulic stimulation** of an existing sub-commercial well. Through combination of wellbore thermal conditioning and hydraulic stimulation, is targeted to become a commercial production/injection well.

Bradys (Nevada) EGS Demonstration Project:* Will have completed **final stimulation stages** by the end of FY.

AltaRock EGS (Oregon) Demonstration Project:* Plan to accomplish **re-stimulation of an existing well** and complete a production well into the stimulated reservoir.

* Expected

SubTER Crosscut: Pillars and Themes

Adaptive Control of Subsurface Fractures and Fluid Flow

Intelligent Wellbores

Materials: adaptive cements, muds, casing

Real time, in-situ data acquisition and transmission system

Diagnostics tools, remediation tools and techniques

Quantification of material/seal fatigue and failure

Advanced drilling and completion tools (e.g., anticipative drilling & centralizers)

Well abandonment analysis/ R&D

Subsurface Stress & Induced Seismicity

Stress state beyond the borehole

Signal acquisition and processing and inversion

Localized manipulation of subsurface stress

Risk assessment

Permeability Manipulation

Physicochemical rock physics, including fluid-rock interactions

New approaches to remotely characterize in-situ fractures and to monitor fracture initiation/branching and fluid flow

Manipulating (enhancing, reducing and eliminating) flow paths

Novel stimulation methods

New Subsurface Signals

Diagnostic signatures of system behavior and critical thresholds

Autonomous acquisition, processing and assimilation approaches

Integration of different measurements collected over different scales to quantify critical parameters and improve spatial and temporal resolutions

Energy Field Observatories: (Wells, Ops and Logistics)

SubTER: Alignment with Industry and Stakeholder Priorities

HALLIBURTON

- *Nanotechnology*
- Photonics
- *Interfacial Chemistry*
- *Complex Fracture Modeling in Real-time*
- Spectroscopy at the Bit
- Green Chemistry

the Bernard M. Gordon Center
for Subsurface Sensing & Imaging Systems



- *Subsurface Sensing and Imaging*
- *Physics-Based Signal Processing and Image Understanding*



- Recognizing the signal within the natural variability
- *Identifying feedback between natural and perturbed systems*
- Quantifying consequences, impacts, and effects
- *Effectively communicating uncertainty and relative risk*



Society of Petroleum Engineers



- *Higher Resolution Subsurface Imaging*
- Challenges in Reusing Produced Water
- *In-Situ Molecular Manipulation*
- Increasing Hydrocarbon Recovery Factors
- *Carbon Capture and Sequestration*

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

Grand Challenges for Earth Resources Engineering

- *Make the earth transparent*
- *Understand engineering control of coupled subsurface processes*
- *Minimize environmental footprint*
- Protect people

Upcoming

Vacancy Announcements Posted for EGS Program

- GS-12/13 Physical Scientist (to backfill for Greg Stillman, departing for graduate school) – see www.USAJobs.gov (now closes August 30)
- GS-15 Geophysicist - coming soon!

Geothermal Technologies Office Peer Review, Spring 2015

Geothermal Industry Vision Project

