U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

The Geothermal Technologies Program Overview

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Jay Nathwani
Acting Program Manager
Geothermal Technologies Program
Office of Energy Efficiency and Renewable Energy

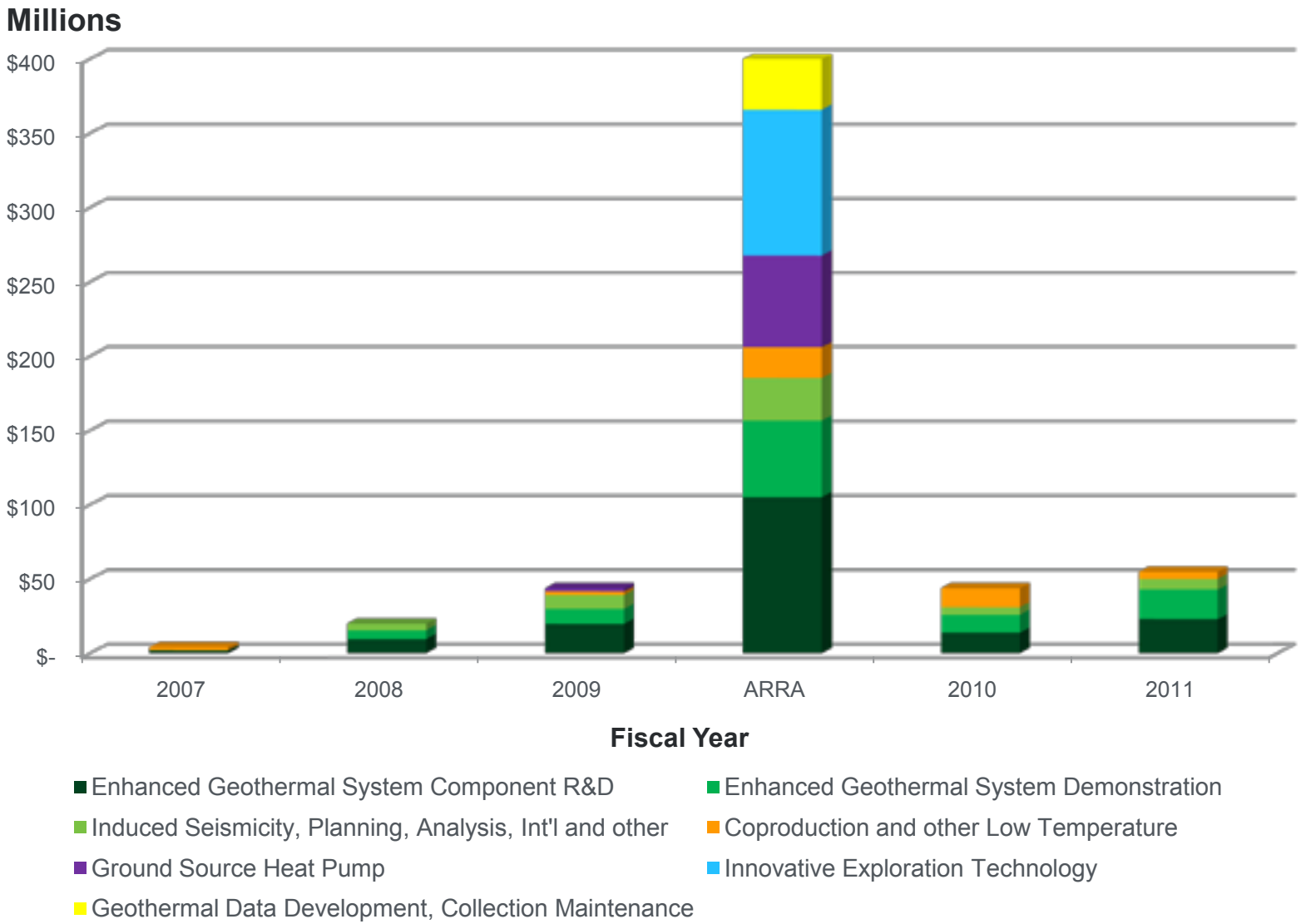
Program Topic Areas

- Low Temperature, Geopressured and Coproduced Resources
- Innovative Exploration Technologies
- National Geothermal Data System
- System Demonstrations (including EGS)
- Component R&D

National Goals

- Economy
  Putting people to work in the near-term, and in the future
- Security
  Developing and expanding energy here at home
- Environment
  Offsetting greenhouse gas emissions

GTP Budget Trend



American Recovery and Reinvestment Act (ARRA)

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- **$2 B** in ARRA funding to the Department of Energy's Office of Energy Efficiency and Renewable Energy
- Of that Geothermal Technologies Program received **~$400 M**
- Funding a Broad Portfolio of technologies through competitive solicitations
  - **~150** awards spanned **38** states and the District of Columbia
  - Estimated to create **~3,500** jobs
- Addressing Key Barriers

Opportunity Areas	Existing GWe	Potential GWe	Applicable FOAs	Key Barriers Addressed
Conventional hydrothermal	3 (+3 under development)	34	- Innovative Exploration Technologies (IET) - Database	- Demonstrate innovative exploration technologies to reduce the upfront risk and cost of finding and proving out new fields - Aggregated data on potential new fields
Enhanced Geothermal Systems (EGS)	0	100-500 (MIT, USGS)	-EGS Components R&D - EGS Demonstrations - Database	- Develop high temperature components - Demonstrate field stimulation techniques
Low-Temperature / Geopressured / Co-Produced	0	100 (NREL)	- Low Temp / Geopressured - Database	- Demonstrate early projects and approaches for these as-yet undeveloped resources
Ground Source Heat Pumps	0.9 (NREL)	120 (NREL)	-Ground Source Heat Pumps - Database	- Demonstrate replicable pilot projects for a variety of building types and customer types - Develop info that customers can use for decision-making

Low Temperature, Geopressured, Coproduced Resources

Issue:

- Numerous resources too cool for flash steam generation.
- An estimated 10 barrels of water are produced per barrel of oil in North America.
- Facilities have lower cost, shorter lead time, broader geographic distribution than conventional geothermal.

Objective:

- Demonstrate production from oil and gas fields, geopressured fields, and low temperature resources across the U.S.
- Expand geographic area of geothermal utilization in near-term
- Improve power plant efficiency
- Address use of water as a working fluid

Action:

- Up to $18.7M in ARRA funds for 10 near-term energy projects including new hybrid plants, and speedy modular plant designs.

Validation of Innovative Exploration Technologies

Issue:

- Upfront costs for early development and associated risk are prohibitively high.
- According to the USGS, there is a mean of 30GWe of undiscovered hydrothermal in 13 western states.

Objectives:

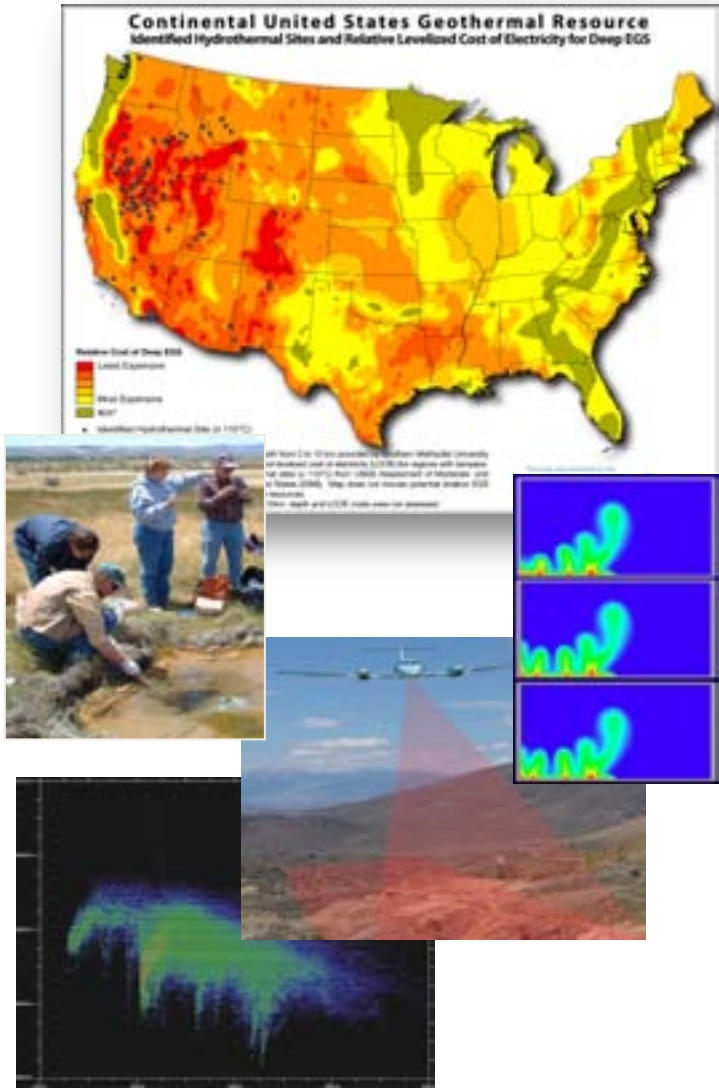
- Validate innovative exploration technologies to improve discovery success rate.
- Confirm new geothermal capacity.
- Provide data to the National Geothermal Database (NGDS).

Action:

- Up to $98.1 M in ARRA funds invested in 24 awards to develop new, innovative methods of exploration and to contribute data to NGDS for resource assessment.

Barriers Addressed:

- Reduce exploration risk
- Near-term power generation while developing tools for EGS and other geothermal resources.



National Geothermal Data System, Resource Assessment & Classification

Issue:

- Upfront exploration costs for and associated risk are extremely high.
- There is a need to standardize and centralize geothermal information
- Classification standards need to be updated

Objectives:

- Reduce exploration costs and risk!
- Expand geothermal resource assessments including:
  - High/moderate/low temp resources
  - EGS, coproduced fluids, geopressured
  - Entire U.S., including AK and HI
- Develop new geothermal resource classification standards

Action:

- Up to $33.6M in ARRA funds
- Implement three step strategy:
  - **Step 1:** *System Design, Development and Testing*: Distributed web-based system design by Boise State University
  - **Step 2:** *Data Development, Collection & Maintenance*: Populate NGDS by linking to data sets in partnership with 46 state geological surveys and other geothermal data providers including Southern Methodist University and GTP technology partners.
  - **Step 3:** *National Resource Assessment and Classification:* Inter-Agency Agreement with U.S. Geological Survey.

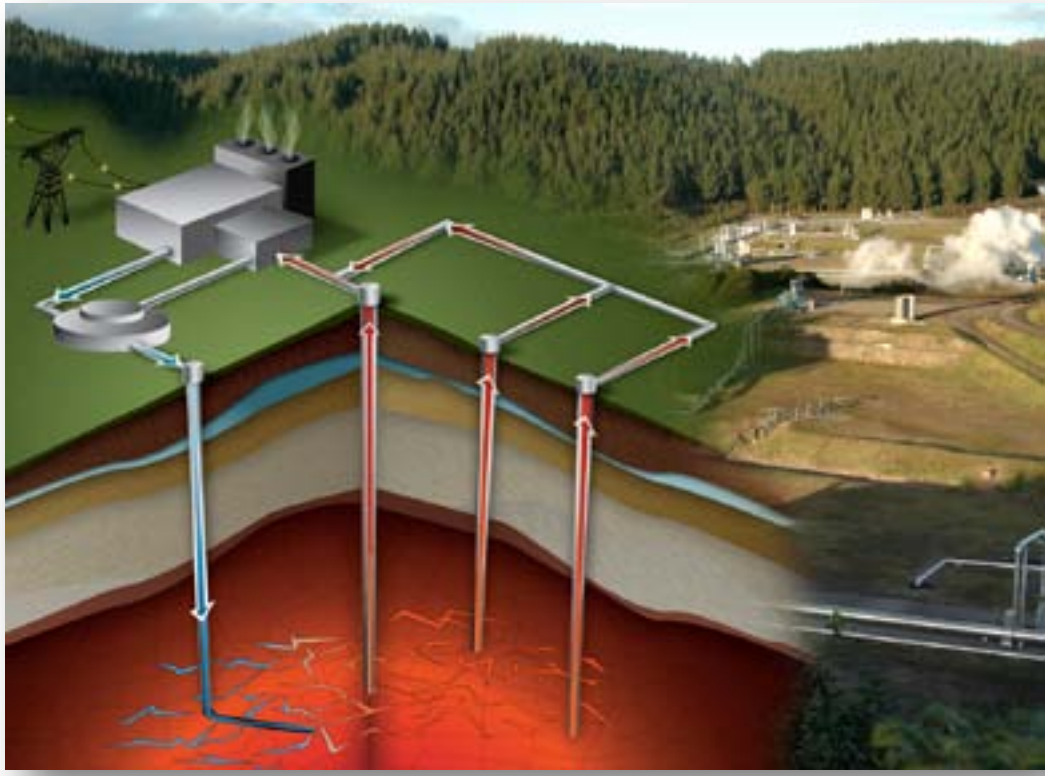
Enhanced Geothermal Systems

Issue:

- EGS has the highest potential payback, but is the highest risk technology in GTP portfolio.

Objective:

- Demonstrate EGS reservoir creation technology in various geologic formations and geographic regions.
- Quantitatively demonstrate and validate stimulation techniques that sustain fluid flow and heat extraction rates.
- Show that EGS can be scaled up to produce power economically.
- Cause and effect of induced seismicity
- Characterize, map and control fracture networks



Action:

- Four EGS projects underway in California, Nevada and Idaho.
- Up to $44.3M in ARRA funds for three more demonstration projects in Nevada, Oregon and Alaska to rapidly commercialize technologies, help reduce upfront risk and pave the way for commercialization.

Component Research and Development

Issue:

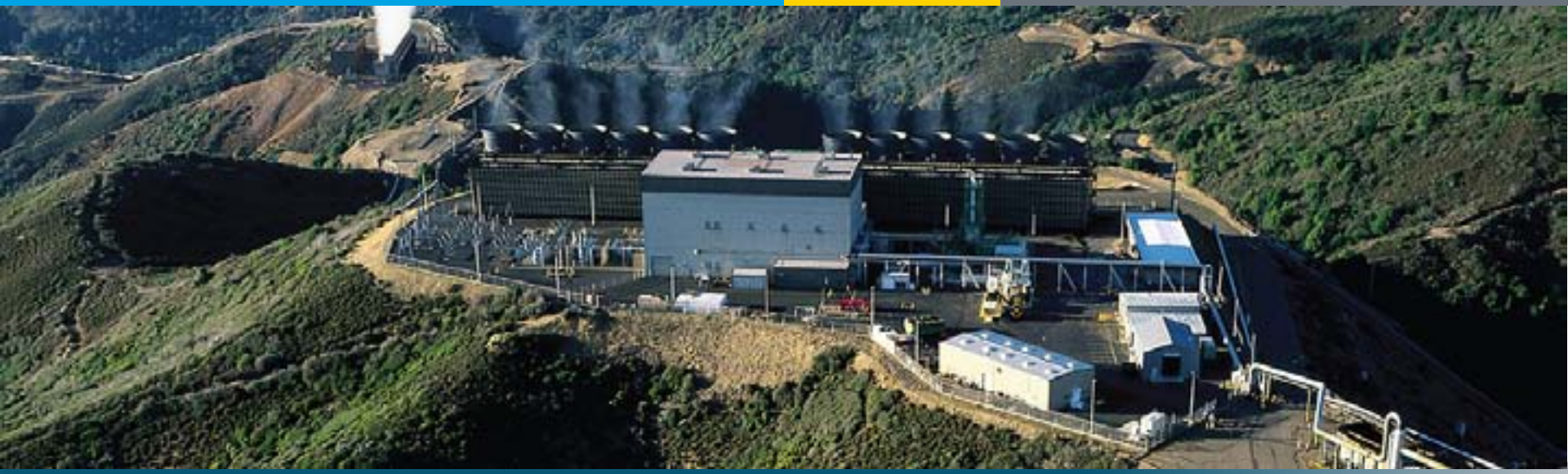
- High cost of component development limits the progress of geothermal technology.
- Oil field tools need to be adapted for hotter, more rigorous environments

Objective:

- Support cost-shared R&D for both EGS and conventional geothermal to accelerate technology.
- Develop and adapt tools for higher temperatures and higher pressures.
- Increase ability to drill deeper in hotter and more difficult geological formations
- Characterize, map and control fracture networks.

Action:

- Up to $111.9M in ARRA funds to R&D at labs, universities and private companies.
- Applications received for 21 of 23 key technology areas.
- R&D Projects in many technologies new to the Program, including:
  - Spallation drilling to increase drill speeds
  - Tracers
  - Thermo-hydro-chemo-mechanical modeling
  - CO_2 as heat mining fluid
  - Modeling and predicting induced seismicity
  - Measurement While Drilling tools for direction drilling



Thank you

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Jay.Nathwani@ee.doe.gov