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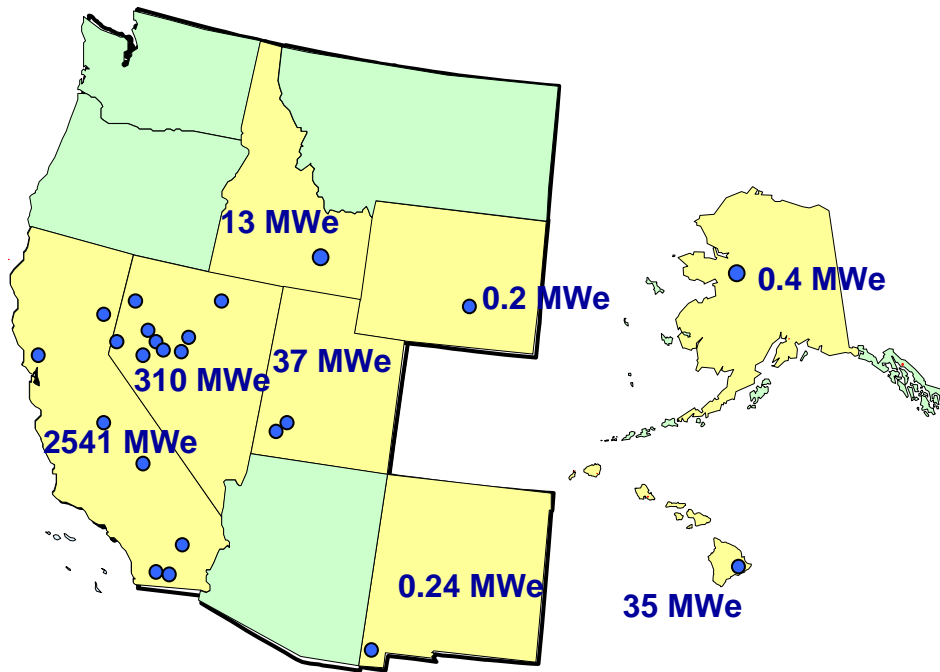
# The Geothermal Technology Program: *A Renaissance*



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**U.S Department of Energy**  
**November 20, 2008**

# U.S. Geothermal Energy Overview



● Geothermal Plant

## U.S. Market Facts\*

- The United States has a total installed capacity of 2957.94 MW
- 8 states generating electricity with geothermal energy.
- 103 projects are currently underway in 13 states
- Additional 3,300 MW will be developed by 2012
- Oil and gas co-production potential of 5,000 MW in 7 states
- Tax credits: \$0.02/kWh production tax credit or 10% investment tax credit extended through 2010

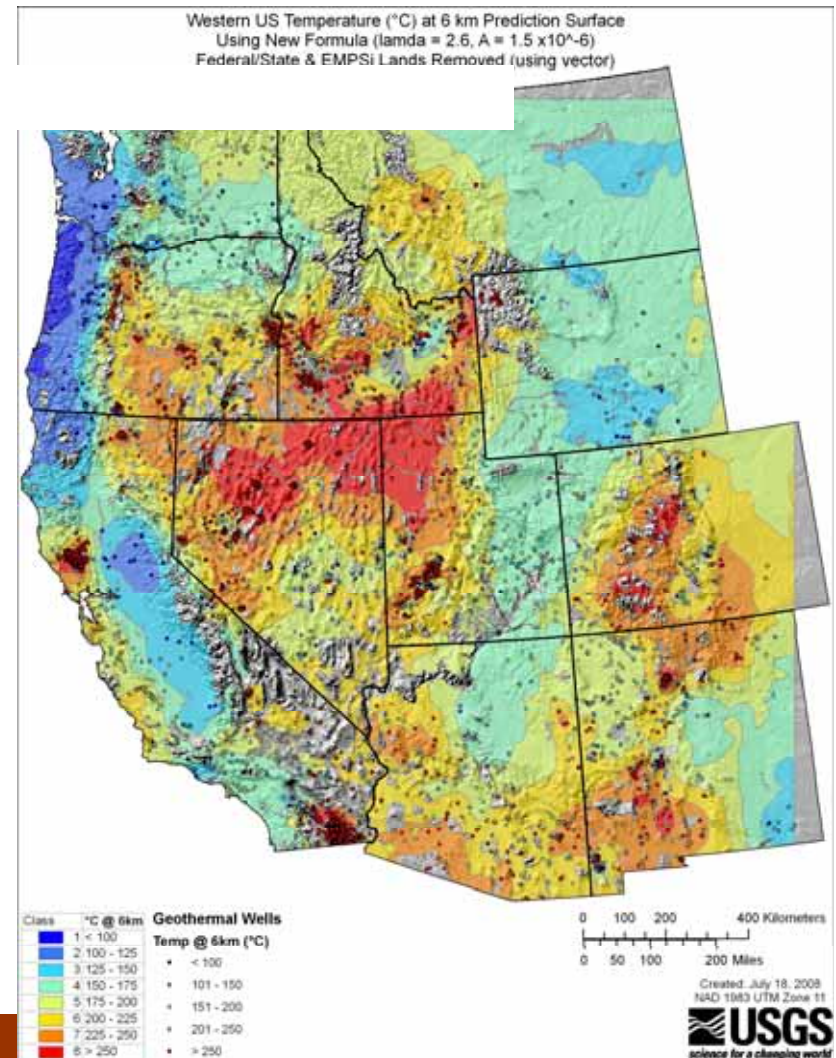
# Enhanced Geothermal Systems – USGS Deep Temperatures



USGS identified EGS Resources - 517,800 MWe

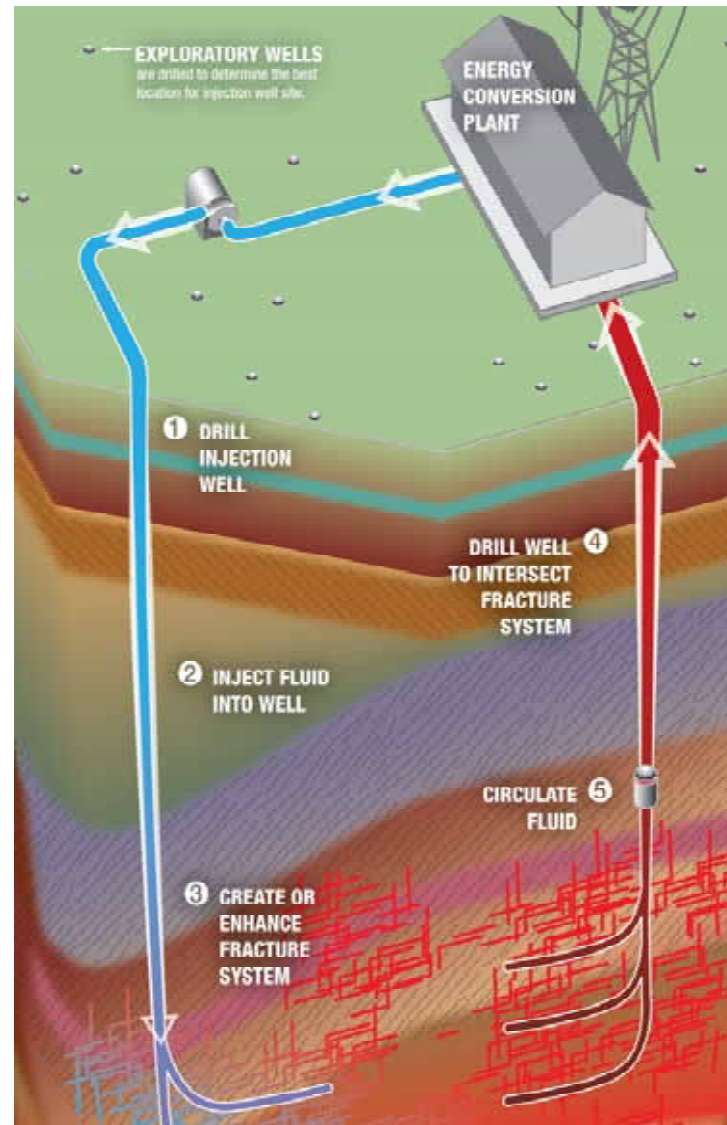
## Geothermal Resources in the US:

1. Discovered hydrothermal
2. Undiscovered hydrothermal
3. Enhanced Geothermal Systems



MIT study shows EGS as a national resource with 100,000 MWe of potential in the next 50 years

# EGS Development Cycle



**2015 – Demonstrate the ability to create an EGS reservoir capable of producing 5 MWe.  
2020 – Validate the ability to sustain an EGS reservoir capable of producing at least 5 MWe.**

# DOE Approach



1. R&D – Emphasis on EGS while supporting hydrothermal
2. Cost-shared step-out approach to Field Projects – Test EGS technologies starting at the marginal hydrothermal and progressing through the green field
3. Remove institutional barriers for all geothermal resources (ex. permitting and leasing)
4. Loan Guarantees for advanced geothermal technologies
5. Reduce upfront risk

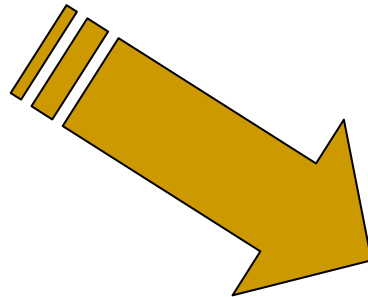
Goal: Develop the technology base that creates and sustains commercial-scale EGS Reservoirs.

*Challenges:* Sustaining current industry momentum while developing advanced technology which has greater national impact



### Portfolio Scope

1. Conventional Hydrothermal
2. Low Temperature Resource
3. Direct use/ groundsource
4. EGS

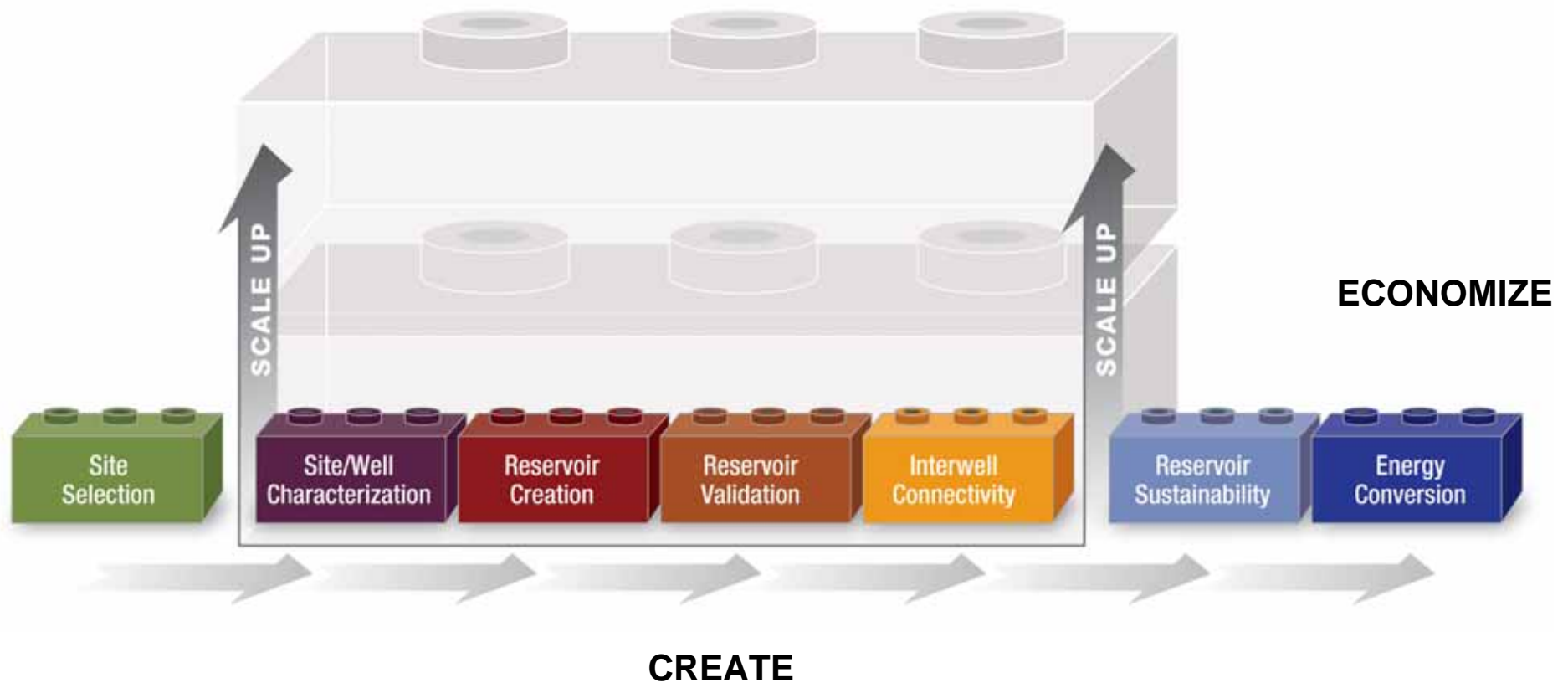


### Strategies

1. Research, Development & Deployment
2. Tax Policies
3. Loan Guarantees
4. Risk Reduction

DOE is trying maximize broad implementation of EISA with less than full appropriation of authorized amounts.

# Research, Development & Demonstration



R,D,&D goals are to engineer what nature failed to provide:  
Fluid and Permeability

# Tax Policy



- Production Tax Credit Extension through 2010
  1. The Emergency Economic Stabilization Act of 2008, passed by the House of Representatives, and signed into law by President George Bush, extends investment and production tax credits toward renewable energy industries.
  2. The tax credit package will extend the renewable energy production tax credit for nearly 3 years for geothermal projects
  3. The bill creates a new limitation on the amount of credits that can be claimed with respect to property placed in service after 2009.

Long-term extensions of the tax credits will help create a domestic geothermal industry

# DOE's Loan Guarantee Program (Title XVII)



## Primary objectives:

- Avoid, reduce or sequester air pollutants of anthropogenic emissions of greenhouse gases
- Employ new or significantly improved technologies as compared to commercial technologies in service in the United States at the time the guarantee is issued
- Provide a reasonable prospect for repayment
- Can be deployed commercially
  - Past the research and development, pilot and demonstration stages.



For application information please visit: <http://www.lgprogram.energy.gov>

**NEW Recently Extended Closing date: 02/26/2009**

## Risk Reduction



- **Data Center Funding Opportunity Announcement is now open**
  
- **Transmission Corridor collaborations with Wind and Solar to reduce risk**
  
- ***POTENTIAL* Geothermal Exploration Drilling Fund**
  - Fund exploration projects in hidden/undiscovered resources.
  - Provide upfront capital investment for wide-scale exploration projects.
  - Learning curve will improve exploration success rates.

## FY 2008 Accomplishments



- Low Temperature Hydrothermal Successes
- Awarded Geothermal Electricity Coproduced Demonstration Project at Jay field, FL
- Awarded 21 New EGS Awards including 13 first-time recipients
- Issued Funding Opportunity Announcement for National Geothermal Database
- Signed International Partnership on Geothermal Technologies (IPGT)
- DOE funded technologies receive National Energy Resources Organization (NERO) Award

DOE's Geothermal Program is well positioned to support the technology developments necessary to facilitate large-scale deployment of geothermal energy in the U.S.

# U.S. Applications- Low Temperature Hydrothermal



## ➤ Chena Hot Springs, Fairbanks, Alaska

1. PureCycle® geothermal systems in operation since 2006
2. The organic Rankine cycle-based power system is an advanced binary cycle system, driven by a simple evaporation process.
3. This system and project have attracted world-wide attention and recognition.
4. Lowest temperature geothermal resource (165° F) in the world ever used for commercial power generation.
5. Extremely low ambient air temperature



# U.S. Applications- Low Temperature Hydrothermal



## ➤ Various sites throughout New Mexico, Utah and now Wyoming

1. ORMAT Technologies and UTC Power conversion units
2. Rely on traditional low temperature resources: 90-150°C
3. Innovative low-temperature technology expands potential geothermal resources beyond high temp. hydrothermal
4. By expanding our geothermal technologies we grow the industry and advance our national goal of achieving energy independence



# Jay Oil Field Coproduction



- Chena Power, Quantum Resources Management, and UTC Power
- UTC's PureCycle® 200 binary organic Rankine cycle power plant
- ~95% of the liquid produced is hot water
- ~120,000 BPD of ~185°F water

Expected on line in FY2009

# 21 New EGS Awards including 13 first-time recipients



## R&D and Demonstration Projects

- **Topic 1 – Component Technologies R&D:**  
Downhole pumps; Fracture characterization; Image fluid flow; High-temperature logging tools and sensors; Stimulation prediction models; Tracers and tracer interpretation; Zonal isolation
- **Topic 2 – System Demonstrations:**  
Stimulating dry/unproductive geothermal wells at the existing hydrothermal fields to enhance the fracture network and circulate fluid through the wells to extract heat that is converted into electricity.

*For detailed information on the awardees:*

[http://www1.eere.energy.gov/geothermal/news\\_detail.html?news\\_id=12018](http://www1.eere.energy.gov/geothermal/news_detail.html?news_id=12018)

Many new awardees are comprised of outstanding multi-discipline teams from industry, universities and national laboratories.

# Component Technologies R&D

## Award Recipients



Award Recipient	Partners	Award Amount*
Baker-Hughes, Inc		\$3,139,364
Colorado School of Mines	Boise State University, Flint LLC, Mt. Princeton Geothermal LLC	\$867,564
Composite Technology	Wood Group ESP, New England Wire Technology	\$987,739
Foulger Consulting	U.S. Geological Survey, Geosystem, WesternGeco, US Navy, Magma Energy US Corporation, Lawrence Berkeley National Laboratory	\$561,729
GE Global Research	Auburn University, GE Energy	\$1,599,934
Hattenburg, Dilley, and Linnell	University of Utah/Energy and Geoscience Institute (EGI)	\$313,858
Hi-Q Geophysical Inc.	Ormat Technologies, Inc., Stephen Muir with Lawrence Berkeley National Laboratory	\$817,757
Massachusetts Institute of Technology	Chevron, Los Alamos National Laboratory	\$508,633
Massachusetts Institute of Technology	New England Research, ENEL North America	\$1,019,769

\* Includes Industry Cost-share

# Component Technologies R&D

## Award Recipients



Award Recipient	Partners	Award Amount
Perma Works	Frequency Management International, ElectroChemical Systems Inc, Draka Cableteq, Pacific Process Systems Inc, Tiger Wireline Inc, Viking Engineering, Kuster Company, Electronic Workmanship Standards Inc, Eclipse NanoMed, Honeywell SSEC	\$2,200,000
Schlumberger		\$1,245,751
Schlumberger		\$1,253,959
Stanford University		\$967,541
Texas A&M University	AltaRock, Lawrence Berkeley National Laboratory, University of Mississippi	\$820,198
Texas A&M University	AltaRock, Sandia National Laboratory, University of Mississippi	\$690,953
University of Utah		\$1,091,039
University of Utah		\$978,180

# System Demonstrations

## Award Recipients

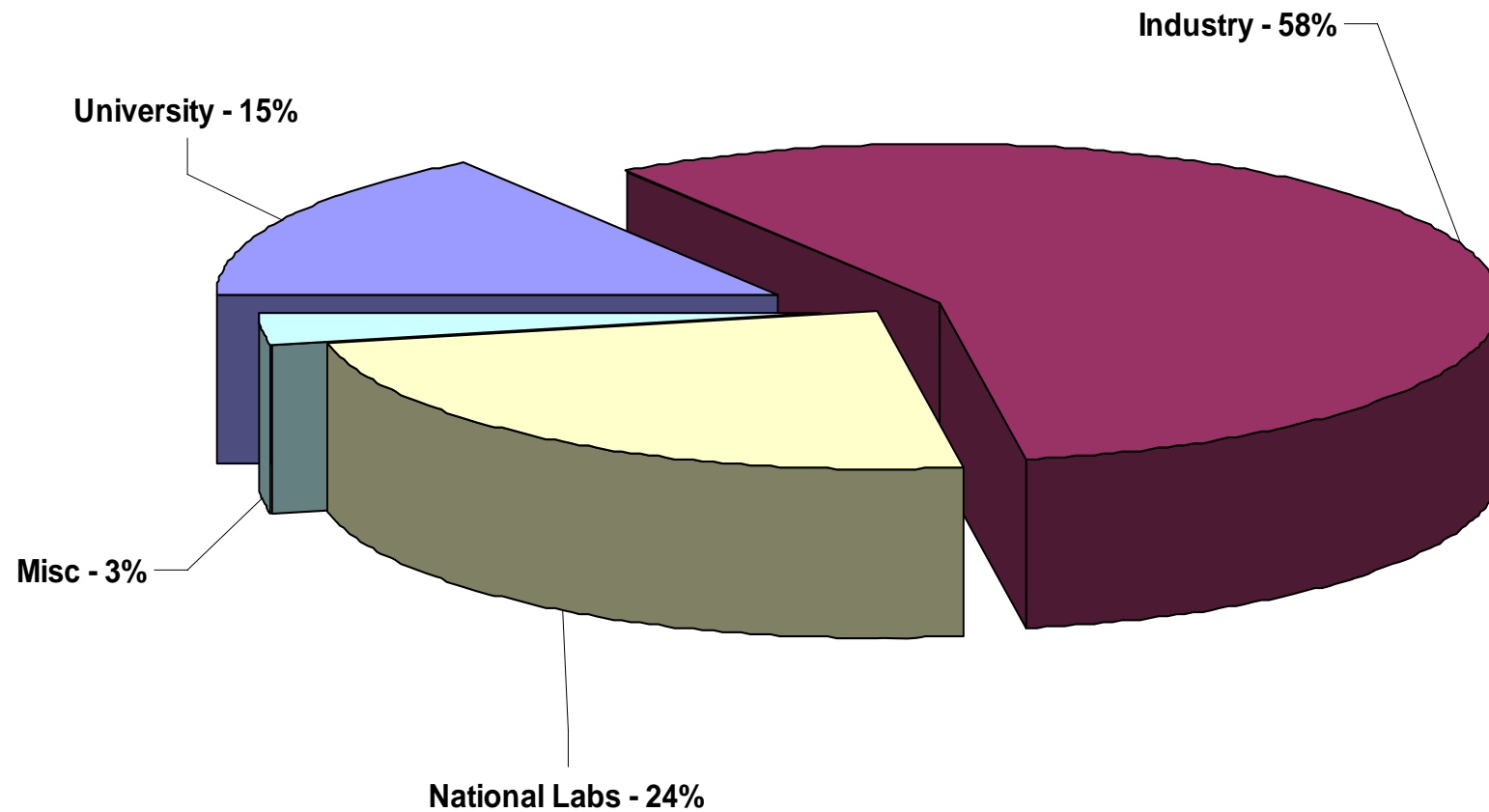


Award Recipient	Partnered With	Award Amount
AltaRock Energy Inc.	NCPA, University of Utah, TAMU, SAIC, Temple University	\$6,014,351
Geysers Power Co.	Lawrence Berkeley National Laboratory	\$5,697,700
ORMAT Nevada, Inc.	Geothermex, Lawrence Berkeley National Laboratory, University of Utah, Pinnacle Technologies, GeoMechanics International, UNR, TerraTek/Schlumberger	\$3,374,430
University of Utah	U.S. Geothermal, APEX Petroleum Engineering Services, HiPoint Reservoir Imaging, Chevron	\$8,928,999

Demonstration Projects Funding Total: \$ 24,015,480

# Fiscal Year 2008 Funding Distribution

Operating budget of \$20 million



FY09 Request = \$30 Million

## Currently open: FOA # 2 National Geothermal Database



- Web-based National Geothermal Database to house EGS RD&D performance data and provide vital links to current and historical geothermal data and maps throughout the U.S. and key international geothermal centers.
  
- Provide resource specific data to make more informed decision regarding geothermal energy development.
  - Utilize well temperature and geologic data for selection and assessment of sites with geothermal development potential
  - Include historical data to reduce the learning curve for EGS development
  - Include geothermal resource, power plant and institutional data to better track technology progress

Solicitation closes 02/03/2009

# The International Partnership for Geothermal Technology

*Signed August 28, 2008*



Founding Partners: Australia, Iceland, U.S.

## Partnership Goals:

- 1) Exchange of information on best practices and lessons learned
- 2) Accelerate RD&D
- 3) Identify and avoid blind alleys
- 4) Maximize our efforts, limit duplication



International  
Partnership for  
Geothermal  
Technology

Collaboration to accelerate the development of advanced geothermal technologies

# FY 2009 Priorities for Research, Development and Demonstration



## FOA #3

### ➤ Component Technologies R&D:

Fracture characterization; High-temperature logging tools and sensors; Image fluid flow; Revolutionary Drilling/ Low-Cost Drilling Technology; Rock/Fluid Interactions; ROP/Hydraulic Hammer; Seismic Risk; Stimulation prediction models; Temporary Sealing; Tracers and tracer interpretation; Zonal isolation; Alternate working fluids; Packers

**Total DOE Funding – \$TBD; TBD% industry cost share**

**Performance – up to 3 years**

## FOA #4

### ➤ System Demonstrations:

Enhance and engineer reservoirs at different depths and geologic settings

**Total DOE Funding – \$TBD; minimum 50% industry cost share**

**Performance – 2 years**

To be announced Fiscal Year 2009

## Current Activities for Risk Reduction



- **Loan Guarantee Program** (\$10B for EERE projects)
- **Production Tax Credit (extended through 2010)**
- **Expanded Bureau of Land Management (BLM) authority**
  - Allow for BLM to give broader geothermal production leases
- **Learning from international experts in geothermal energy**
- **Maximizing synergies with domestic investment firms**
- **Development and Demonstrations of Efficient New Technologies**
- **National Geothermal Data Center**
- **Establish programs to develop and retain a geothermal work force**

The program actively seeks opportunities to work with you to defray costs and reduce risks.

# The Time is Right!



- **Increased Financing**
  - Banks
  - Venture Capitalists
- **Industry Growth**
  - Geothermal Developers
  - Oil & Natural Gas Companies
  - Utilities
- **Government Support**
  - Federal (taxes, loan guarantees, leasing, EISA 2007)
  - State (renewable portfolio standards)
- **International Partnership**
  - Collaborative Agreements
  - EGS Projects



Let us set our sights higher, and move beyond incrementalism to tap this unrivaled and unlimited resource.