Geothermal ARRA Objectives – *Broad Portfolio*

- Reduce high upfront risk associated with geothermal development.
- Support discovery of the 30 GWe of undiscovered geothermal resources in Western United States identified by the USGS in 2008.
- Demonstrate cutting edge technology to advance geothermal energy production from oil and gas fields, geopressured fields, and low to moderate temperature geothermal resources.
- Conduct research and development, and demonstration to establish Enhanced Geothermal Systems (EGS) as a major contributor for baseload electricity.
- Address market barriers to increase the deployment of ground source heat pumps.

Total Geothermal Recovery Act Funding: $400 million

Geothermal Technologies Program Application Statistics

Topic	Applications Received	FOA Compliant	Selected	Total Funding (M)
Validation of Innovative Exploration Technologies	81	73	24	$ 98.1 M
EGS Component Research and Development and Analysis	168	137	45	$ 81.5 M
Enhanced Geothermal Systems	26	16	3	$ 51.4
Ground Source Heat Pumps	198	155	37	$61.9 M
Oil and Gas Co-production, Geopressured fields, and Low Temperature Resources	45	37	11	$ 20.7 M
Geothermal Data Development, Collection, and Maintenance	11	8	3	$ 24.7
Totals:	**529**	**426**	**123**	**$ 338.3**

ARRA Selection Brief: Geothermal Technologies Program

DE-FOA-0000109

Topic Area 2: Geothermal Energy Production from (A) Low Temperature Resources, (B) Coproduced Fluids from Oil and Gas Wells, and (C) Geopressured Resources

Department of Energy
Office of Energy Efficiency and Renewable Energy

November 3, 2009

Geothermal energy production from oil and gas fields, geopressured fields, and low temperature resources

Objective: Demonstrate geothermal energy production from oil and gas fields, geopressured fields, and low temperature resources throughout the United States.

Deployment Strategy: Funding opportunity announcement opened on May 27, 2009 to seek applications from consortia of industry, academia and Federal Labs.

Funding: Up to $50M in Recovery Act funds to rapidly commercialize technologies and reduce upfront risk

PureCycle® Development Funding

- DOE- $1.5M/UTC $1.5M
- Alaska Energy Authority & Denali Commission - $246K

- Chena Hot Springs Resort Infrastructure ~ $2M

Facts:

Diesel based electric ~ 30¢/kWhr in 2006
Seasonal loads 180kW – 380kW
1st unit commissioned July 2006
2nd unit commissioned December 2006
< 165ºF hot water resource
37 – 50°F cooling water available

UTC Power
A United Technologies Company

FOA: DE-FOA-0000109, **Close date:** 7/22/2009

Low Temperature, Coproduced & Geopressured

Objective: The primary focus of this ARRA funded Topic Area is to technically and economically demonstrate energy production (i.e. electricity generation or direct use) from nonconventional geothermal resources, up to $50 M in awards was available.

Eligibility: Open to all entities

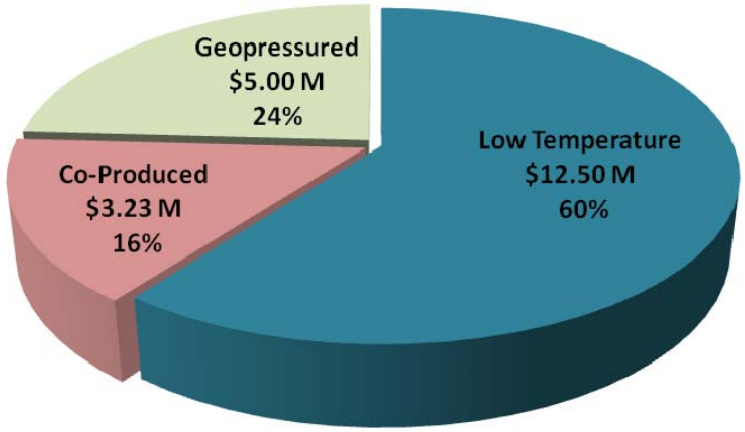
Topic	Est Awards	Est Award Size	Required Output	Shared Requirements
Subtopic Area A: Low Temperature Resources	Up to $2M	$1.5M	Install, operate, and report on the performance of geothermal energy projects with: Geothermal Fluids at temperatures between 150-300° Fahrenheit (F) (66-149°C)	Located in United States It is NOT the intent of this Topic Area to fund the drilling of new exploratory, production, or injection wells, nor bore holes for geothermal heat pumps.
Subtopic Area B: Geothermal Fluids Coproduced from Oil and/or Gas Wells	Up to $2M	$1.5M	Install, operate, and report on the performance of geothermal energy projects with: Geothermal Fluids Coproduced from productive, unproductive, or marginal oil and/or gas wells	
Subtopic Area C: Geopressured Gas Resources	Up to $5M	$5M	Install, operate, and report on the performance of geothermal energy projects with: Geopressured Gas Resources that show potential for economic recovery of the heat, kinetic energy, and/or gas.	

Low Temperature, Coproduced & Geopressured

Project Objectives:

- To promote the ***near-term development*** of energy production from:
  - ***Low-Temperature Geothermal Fluids*** at temperatures between 150-300° Fahrenheit (F)
  - Geothermal ***Fluids Coproduced*** from productive, or marginal ***oil and/or gas wells*** (or other hydrocarbon production - i.e. coal-bed methane).
  - ***Geopressured Gas Resources*** that show potential for economic recovery of the heat, kinetic energy, and/or gas.
- To demonstrate the energy production capability of low temperature resources in various geological, geographical and environmental conditions

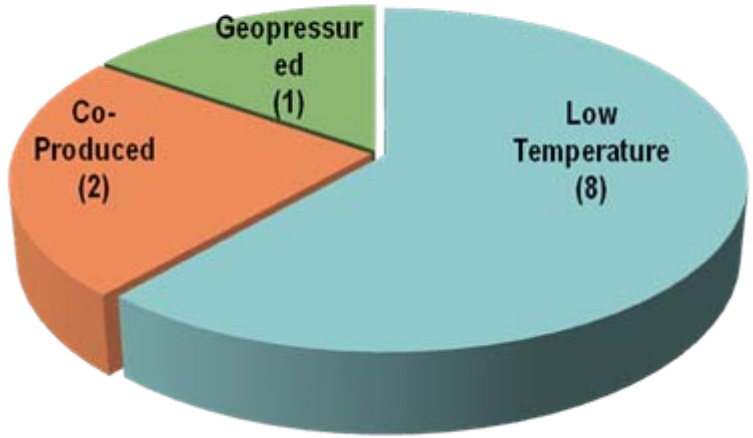
Amount of Awards by Topic Area



Project Highlights & New Ideas:

- *Immediate impact of over $68 M invested, 175 estimated jobs created and 20 MW of energy potentially produced*
- *Near-term possible impact of 7,800 MW energy produced and 75,000 additional jobs created in Oil & Gas sector alone*
- *Speedy, modular plant construction* has been demonstrated
- Osmotic Heat Engine for bottom-cycling energy production from Low Temperature resources funded by ARRA
- Hybrid plant design utilizing heat, kinetic and chemical energy

Number of Awards by Topic Area



Total Projects: 11

Total Funding: $20.7 M

ARRA Awards

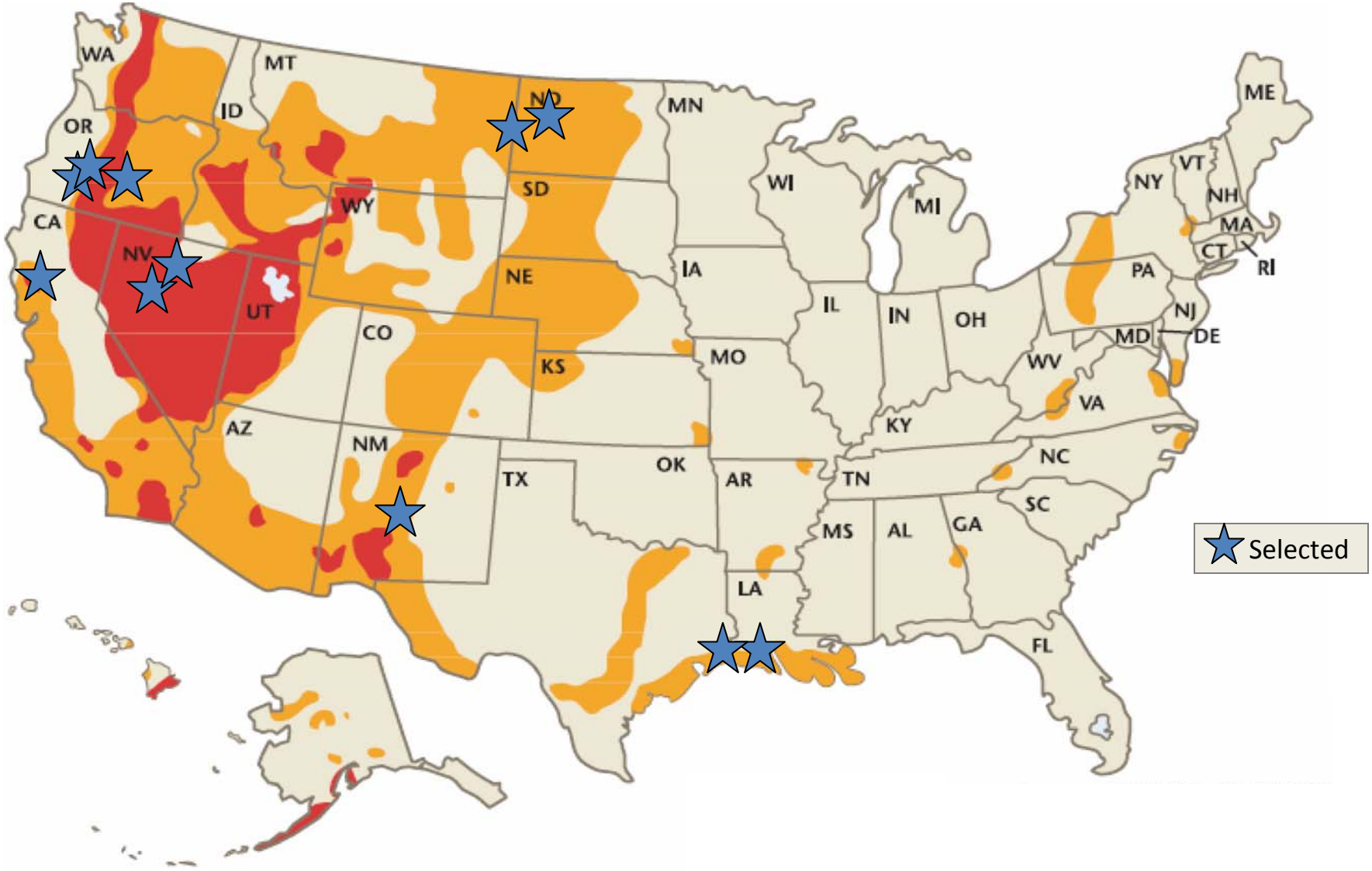
ARRA Topic	Grantee	Project Title	"Short" Description	DOE Award Amount*
Geothermal Demo	**Beowawe Power, LLC**	Beowawe Bottoming Binary Project	Beowawe Power, LLC will install a new low temperature binary unit that will be attached to an existing plant to provide 10% additional power.	$2,000,000
Geothermal Demo	**City of Klamath Falls**	Klamath Falls Geothermal Low Temperature Power Plant	This funding will faciliate construction of a low temperature power plant combined with a district heating system to help power the city of Klamath Falls, OR.	$816,100
Geothermal Demo	**Johnson Controls, Inc.**	Novel Energy Conversion Equipment for Low Temperature Geothermal Resources	Johnson Controls, Inc. will install a low temperature unit on the Oregon Institute of Technology Campus.	$1,047,714
Geothermal Demo	**New Mexico Institute of Mining and Technology**	A Geothermal District Heating System and Alternative Energy Research Park on the NM Tech Campus	New Mexico Institute of Mining and Technology will construct a district heating system at the NM Tech Campus.	$1,999,990
Geothermal Demo	**University of North Dakota**	Electric Power Generation from Low-Temperature Geothermal Resources	The University of North Dakota will construct a power plant in Bowman County, ND, that will run off of low temperature (not coproduced) fluids.	$1,733,864
Geothermal Demo	**Oasys Water**	Osmotic Heat Engine for Energy Production from Low Temperature Geothermal Resources	Oasys Water plans to develop a new method for utilizing low temperature geothermal fluids to produce power.	$910,997

ARRA Awards

ARRA Topic	Grantee	Project Title	"Short" Description	DOE Award Amount*
Geothermal Demo	**Surprise Valley Electrification Corporation**	Rural Cooperative Geothermal Development Electric and Agriculture	Surprise Valley Electification Corporation will build a binary power plant utilizing low temperature fluids and enable the construction of a local aquaculture facility.	$2,000,000
Geothermal Demo	**Terra-Gen Sierra Holdings, LLC**	Dixie Valley Bottoming Binary Project	Funding for Terra-Gen Sierra Holdings will facilitate the installation of a low temperature binary unit that will add to power generation from the existing 60 MW Dixie Valley power plant.	$2,000,000
Geothermal Demo	**Universal GeoPower LLC**	**Technical Demonstration and Economic Validation of Geothermally-Produced Electricity From Coproduced Water at Exisiting Oil/Gas Wells in Texas**	**Universal GeoPower LLC will utilize a modular low temperature binary unit to produce power from oil and gas wells in Liberty County, Texas.**	**$1,499,288**
Geothermal Demo	**University of North Dakota**	**Electric Power Generation from Coproduced Fluids from Oil and Gas Wells**	**The University of North Dakota will utilize a low temperature binary unit to produce power from oil and gas wells in Bowman County, North Dakota.**	**$1,733,864**
Geothermal Demo	**Louisiana Tank, Inc.**	Demonstrating the Commercial Feasibility of Geopressured – Geothermal Power Development at Sweet Lake Field Cameron Parish, Louisiana	Louisiana Tank, Inc. will demonstrate the feasibility of a geopressured power plant in Cameron Parish, Louisiana.	$5,000,000

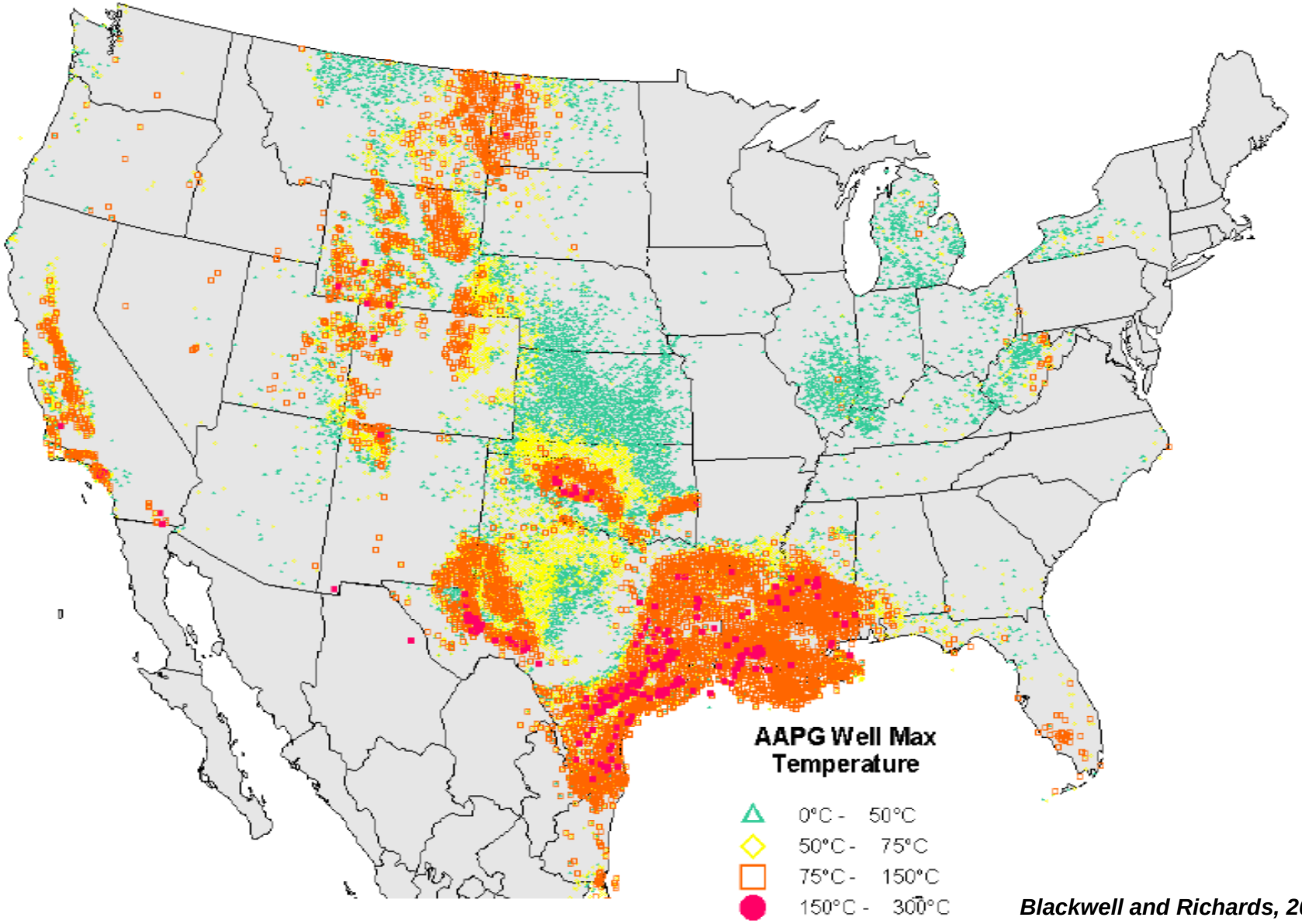
*Actual Award Amount Subject to Negotiation

Geographical Location of LowTemp, Geopressured, Coproduced Selections

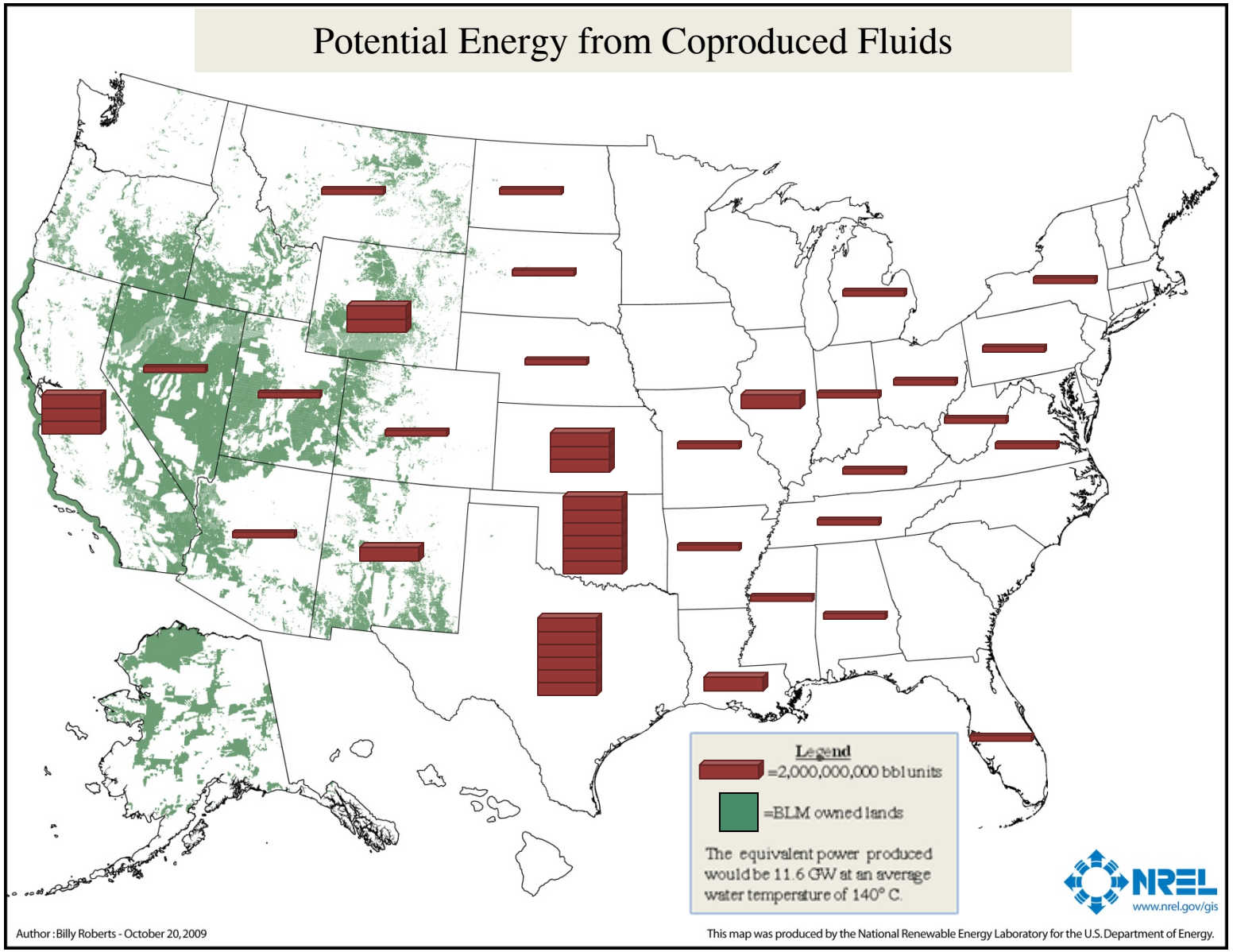


Future Outlook

Hydrocarbon Drilling in the US



Blackwell and Richards, 2005



(Water production from oil and gas wells based off of Curtice and Dalrymple, 2004)

Co-producing Energy from the Large Amounts of (hot) Water in the US

- In certain water-flood fields in the Gulf Coast region of the United States, the produced water/oil cut is 95%.
  - Some of these fields produce 50,000 barrels/day of fluid (20-40 wells)
  - Paid for (in terms of pumping costs), by existing operations.

- Collecting and passing this fluid through a binary electrical plant is readily performed
  - Most produced fluid is already passed to a central collection facility for hydrocarbon separation and water disposal
  - Piggy-backing on existing infrastructure eliminates the need for expensive drilling and hydro-fracturing operations that are often required for EGS
  - Reducing the majority of the upfront cost of geothermal electrical power production is critical to its widespread use

What can DOE do to help?

- FOA was undersubscribed – especially in the Co-produced and Geopressured subsections (only 9 compliant applications)
  - Possible result of Davis-Bacon obligations, difficulty of application process for first-time applicants or other disincentives to apply?

- Industry input is needed to improve the process
  - How does DOE making Funding Opportunity Announcements (FOAs) more appealing to would-be applicants?

For more information:

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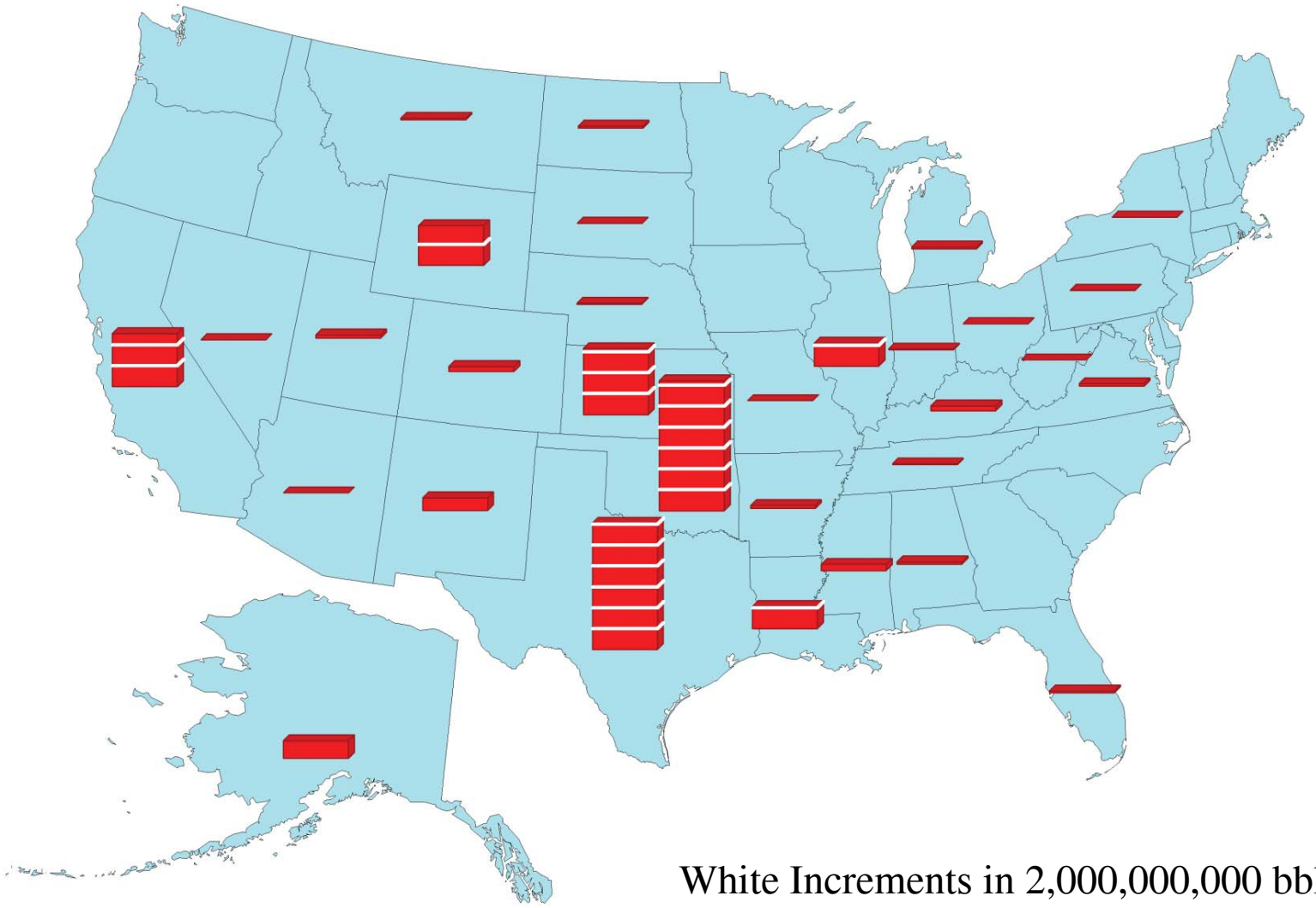
Back-up Slides

Water Production from Oil & Gas Wells



White Increments in 2,000,000,000 bbl units

Water production from oil and gas wells (Curtice and Dalrymple, 2004).