

An aerial photograph of a geothermal field. The landscape is a mix of green hills and brownish-grey terrain. Several thick, white plumes of steam or smoke rise vertically from the ground, creating a dramatic contrast against the natural colors. The sky is a pale, hazy blue.

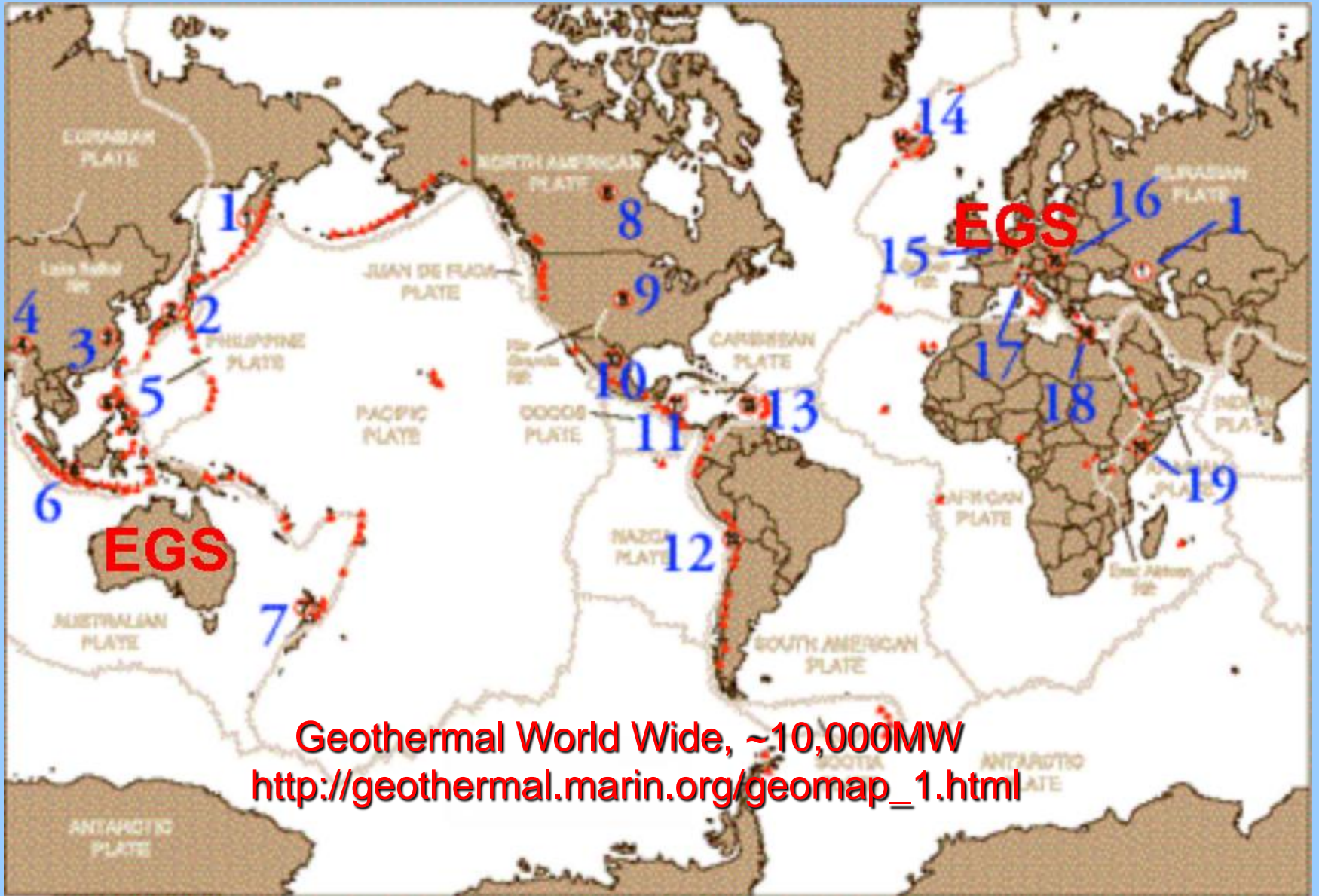
# Geothermal Energy-Power for Texas in the 21<sup>st</sup> Century

**ERCOT Presentation**

***September 24, 2010***

**David Blackwell**

**SMU Geothermal Laboratory**



Geothermal World Wide, ~10,000MW  
[http://geothermal.marin.org/geomap\\_1.html](http://geothermal.marin.org/geomap_1.html)



## Historical Perspective

Geopressure Geothermal : DOE Spends \$200MM  
1975-1990

Approximately 10,000 MW installed world wide,  
mostly high temperature hydrothermal (>150 °C,  
300°F) in the ring of fire

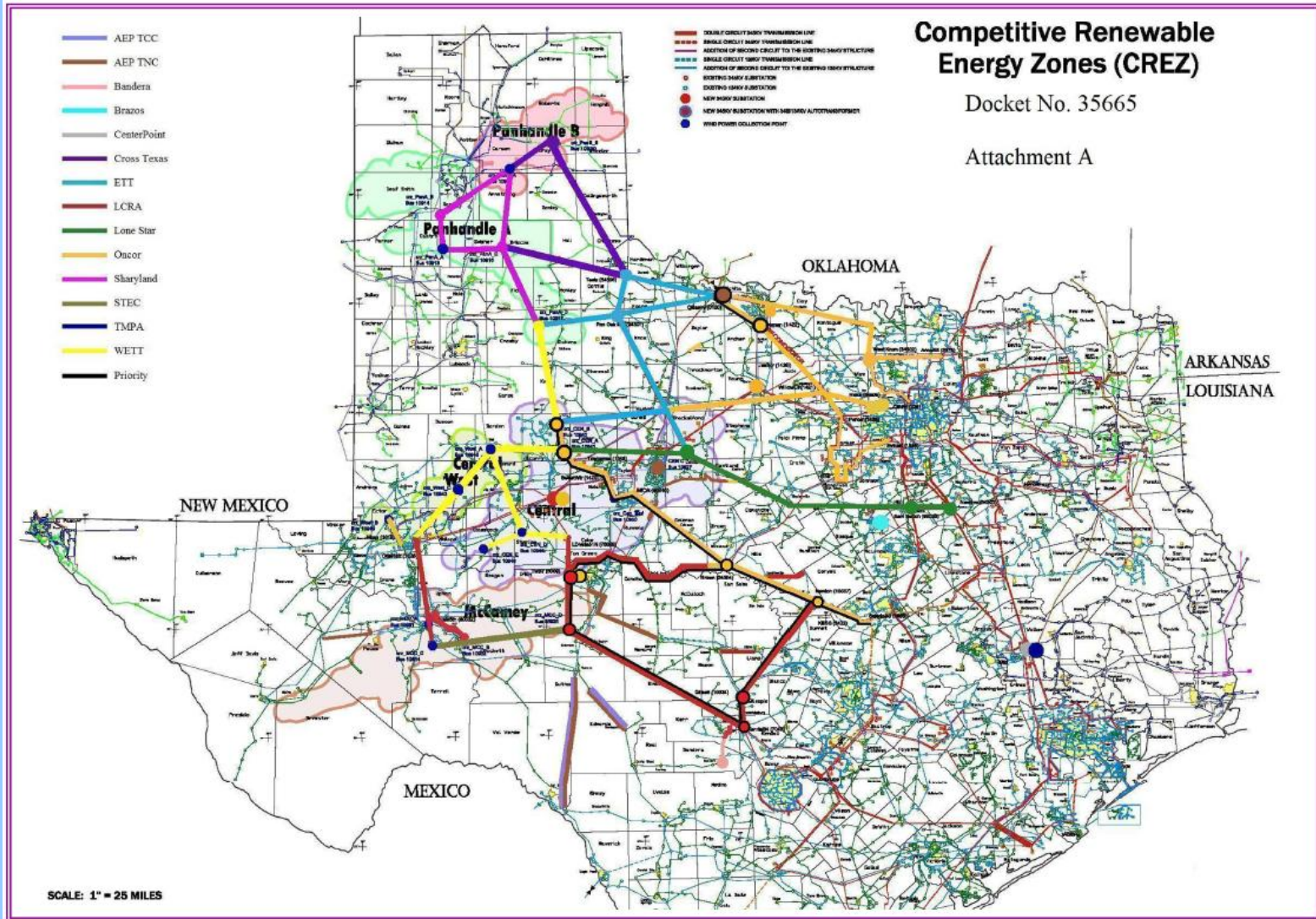
EGS from US to Japan to Europe/Australia

Lower temperature technology developed

Geothermal is Scalable

Geothermal is “baseload”

# \$5,000,000,000 will build 1,500 to 2,500 MW Geothermal installed (1,350 to 2,250 MW at 90 % load factor)





# Conventional Hydrothermal

- Cost \$2-4,000,000/MW
- Pay for “fuel” up front, difficult to finance
- 2 wells drilled for every producer, i.e. reservoir uncertainty
- Wells 30% of cost
- Land access problems (Federal)
- Market limited to some extent
- Localized in west

# SMU Web site: <http://smu.edu/geothermal>



Southern Methodist University  
**Geothermal Laboratory**  
*"Bringing The Earth's Energy Into Your Community"*

P.O. Box 750395  
 Dallas, TX 75275

Voice: 214-768-2749  
 Fax: 214-768-2701

## Site Map

(Click on plus signs for subcategories or words to link)

- + [SMU Geothermal Databases](#)
- + [Geothermal Heat Pumps](#)
- + [Geothermal Resources](#)
- + [Informative Links](#)
- + [Oil & Gas](#)
- + [Publications](#)
- + [SMU Geothermal Degree](#)
- + [Teacher - Educational Materials](#)
- + [Temperature Logs](#)
- + [Texas Geothermal Outreach and Networking Program](#)

## Conference News

**Geothermal Energy Utilization  
 Associated with  
 Oil & Gas Development**  
 June 17-18, 2008

[Conference Details](#)  
**June 18-19, 2011**  
*Previous Conferences*

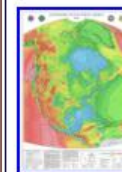
[Texas Renewables '07](#)  
**Conference Presentations**  
 Abilene; November 13-14 2007

### Geothermal talks:

[Geothermal Energy \(GSHP\)](#), Shawn Beard -  
*Energy America Geothermal;*

[A Ground Source Heat Pump Initiative in the  
 Blue Skyways Collaborative](#), James  
 Yarbrough - *U.S., EPA*

## Hot Topics



[Geothermal Map of  
 North America](#)

### Recent Press

Google to Invest in Geothermal  
 New York Times [8/19/08](#)

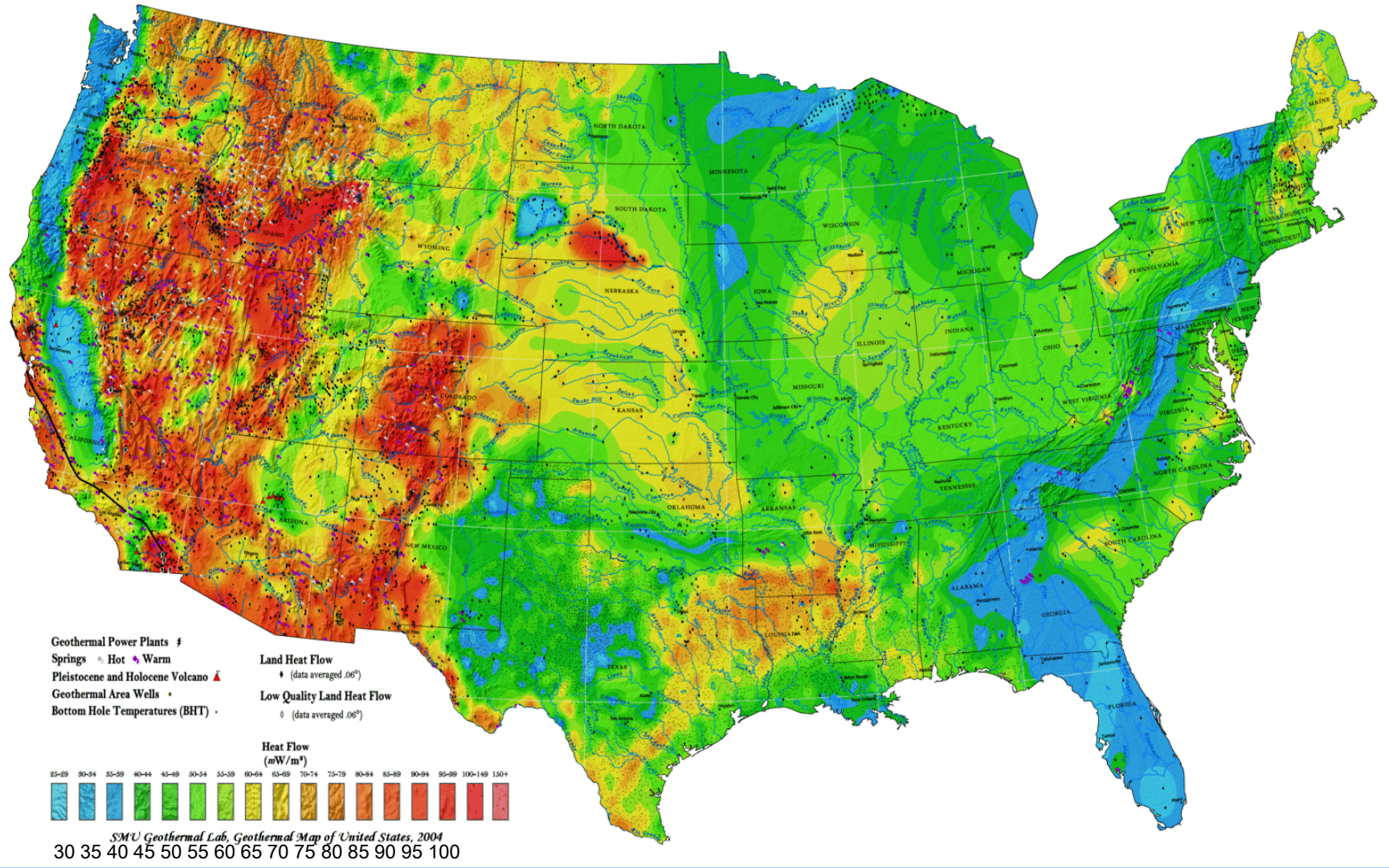
Google.org announcement [8/19/08](#)

Free to be Green  
 DFW Chanel 33 News [7/25/08](#)

In the Push for Alternative Energy,  
 What Happened to Geothermal?  
 US News and World Report [7/21/08](#)

Oil, Gas and Geothermal Energy  
 SMU Press Release [6/19/08](#)





# 2004 Geothermal Map of North America (Blackwell & Richards)

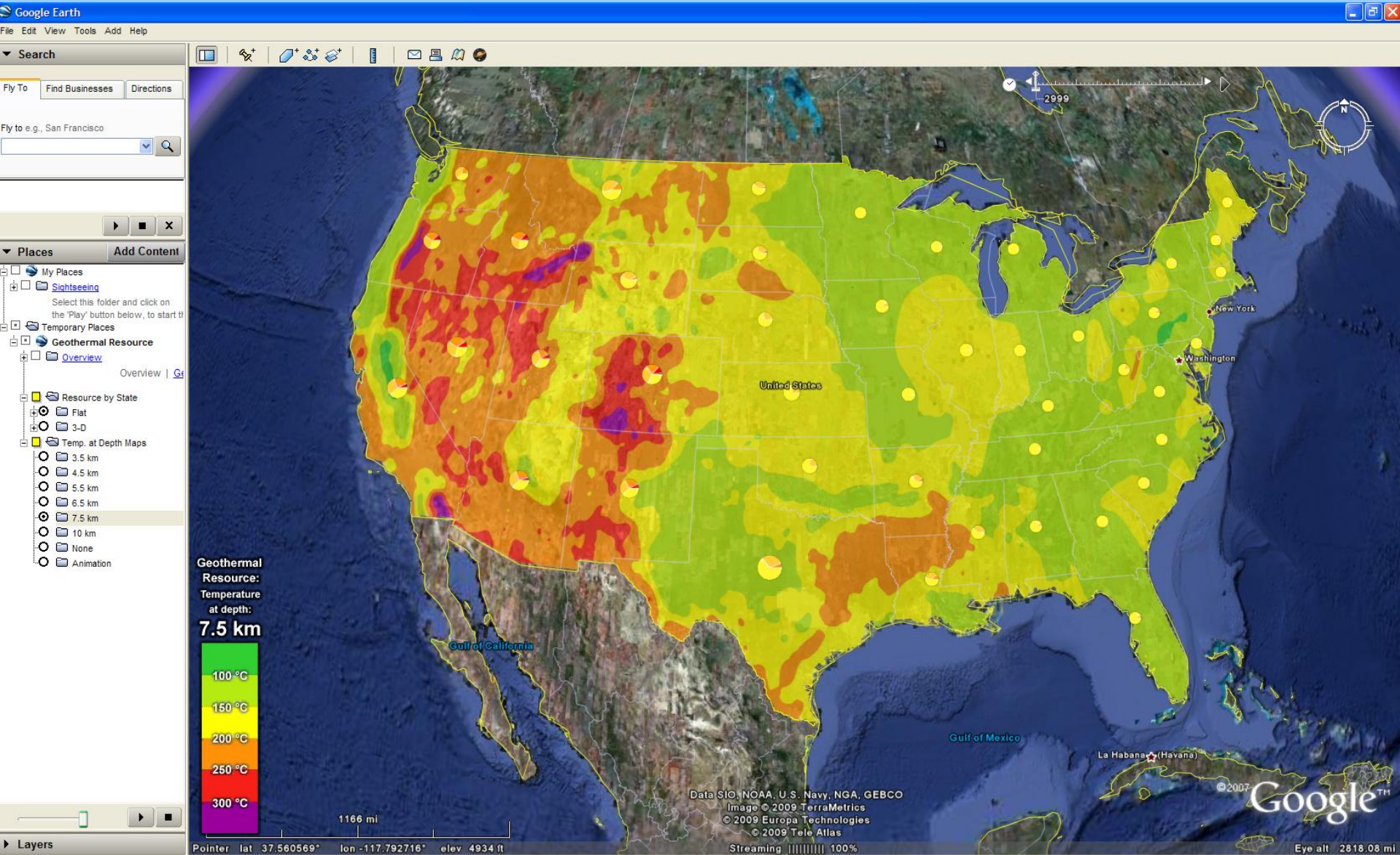
# The Future of Geothermal Energy

Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21<sup>st</sup> Century

**THE EGS SYSTEM**  
**Introduction of water into rock of limited permeability (either tight sediment or basement) in a controlled fracture setting so that this water can be withdrawn in other wells for heat extraction, i.e. heat mining**  
*also*  
*Unconventional approaches*

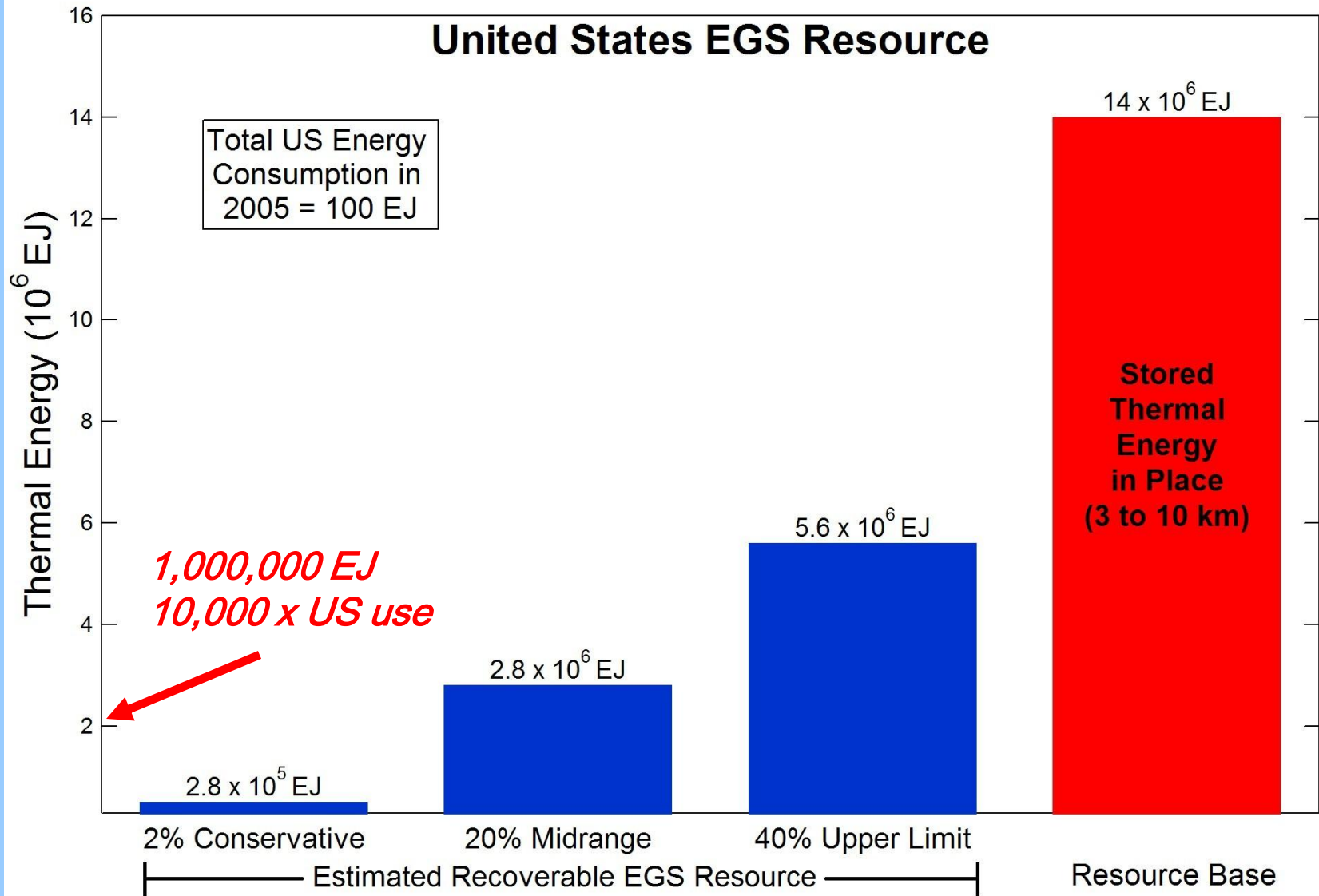


# Google.org/egs



**Invested \$15,500,000 in AltaRock, Potter Drilling, SMU Geothermal Lab**

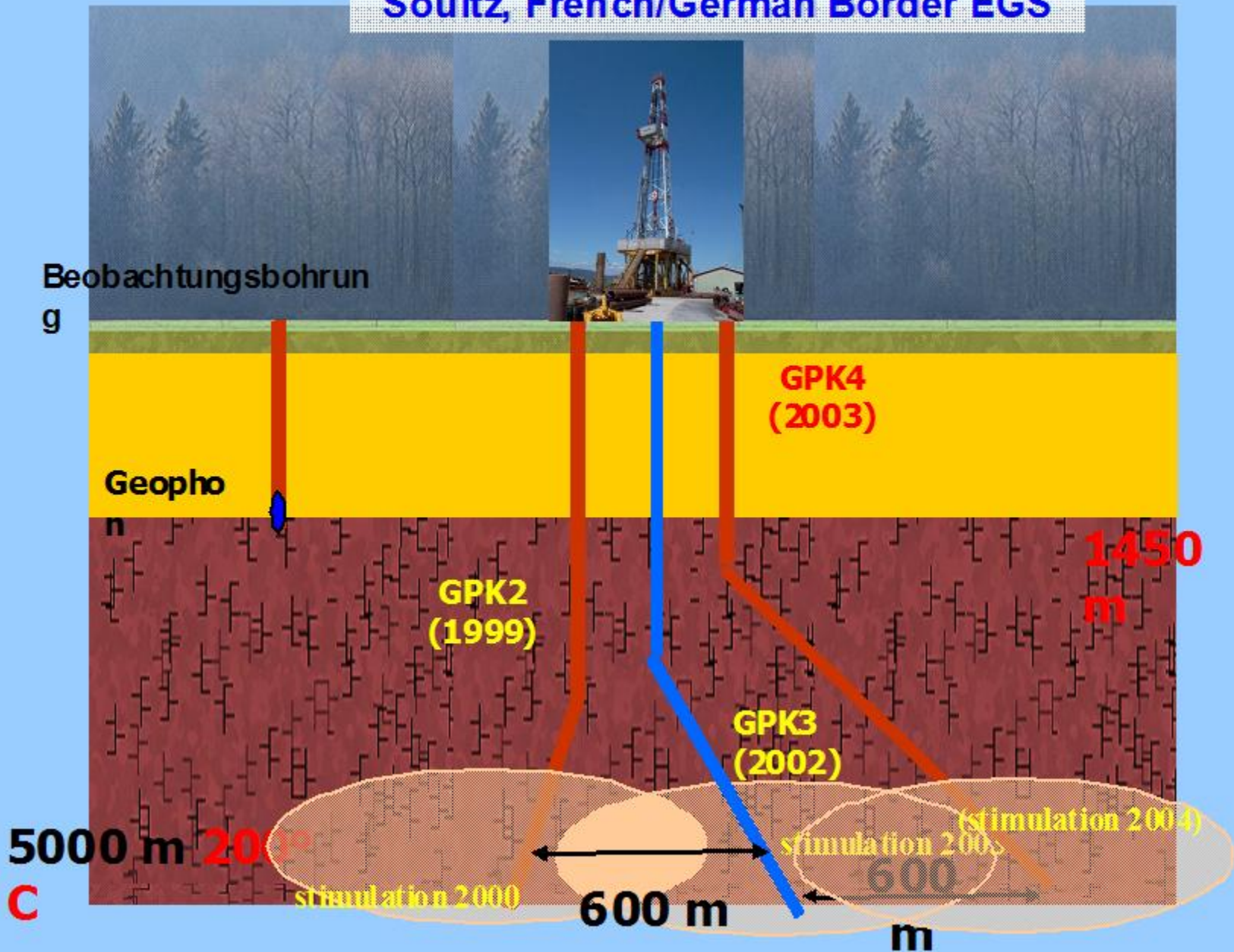
# United States EGS Resource



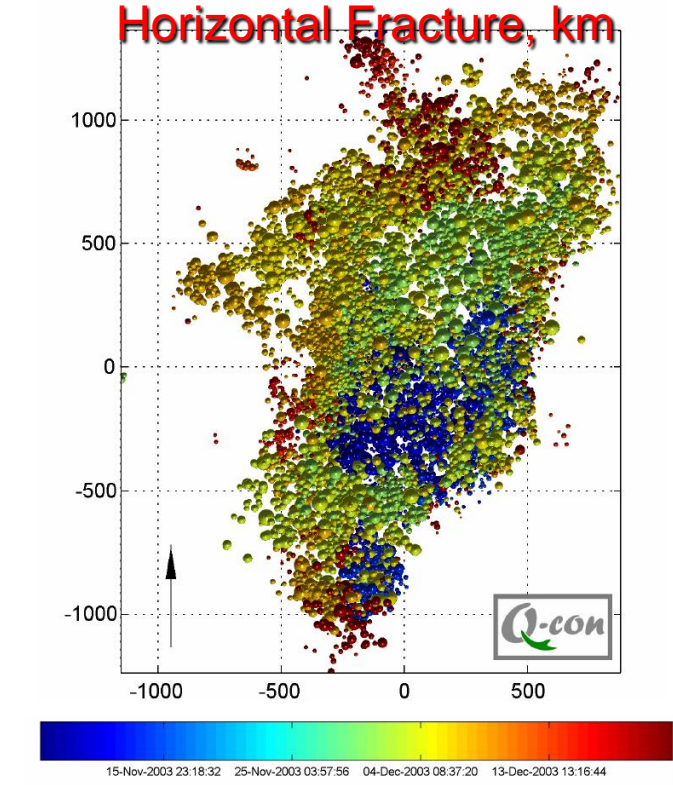
**Estimated total geothermal resource base and recoverable resource given in EJ or  $10^{18}$  Joules.**



# Soultz, French/German Border EGS



# GeoDynamics Ltd South Australia Project Cooper Basin



Habenero #1, 2008



\$400 Million Australian Committed 2010



# From Hot Water to Hydrogen

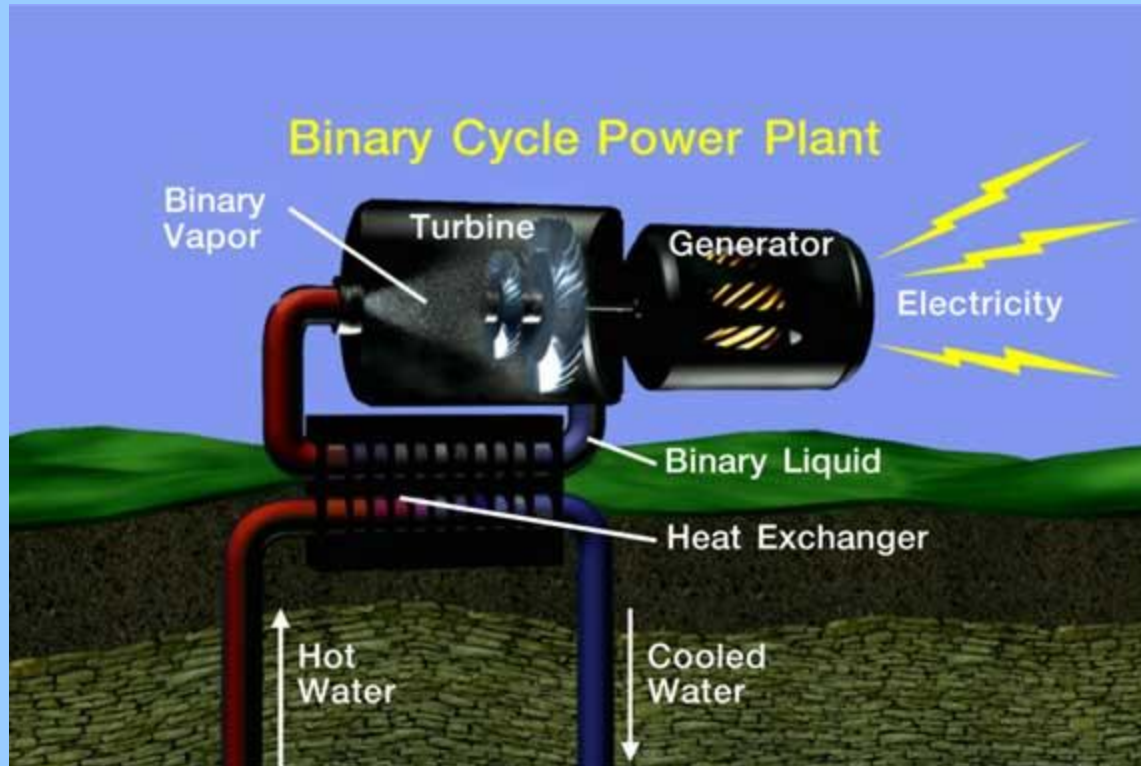
## *Bringing Geothermal Power to Alaska*



*Presented by: Bernie Karl*

**SMU Geothermal Conference June 12<sup>th</sup>, 2007**

# Binary Cycle Moderate Temperature Power Plant



- Basically and A/C Unit Run Backwards:
- Closed Loop System
- Can operate as low as 160°F





UTC



**Raser Thermo, Utah  
12.5 MW Geothermal  
Development-  
Cascaded UTC 250kW  
Units**



Aerial view of the 50-unit power generation network.



A panorama from the day of the ribbon cutting ceremony.

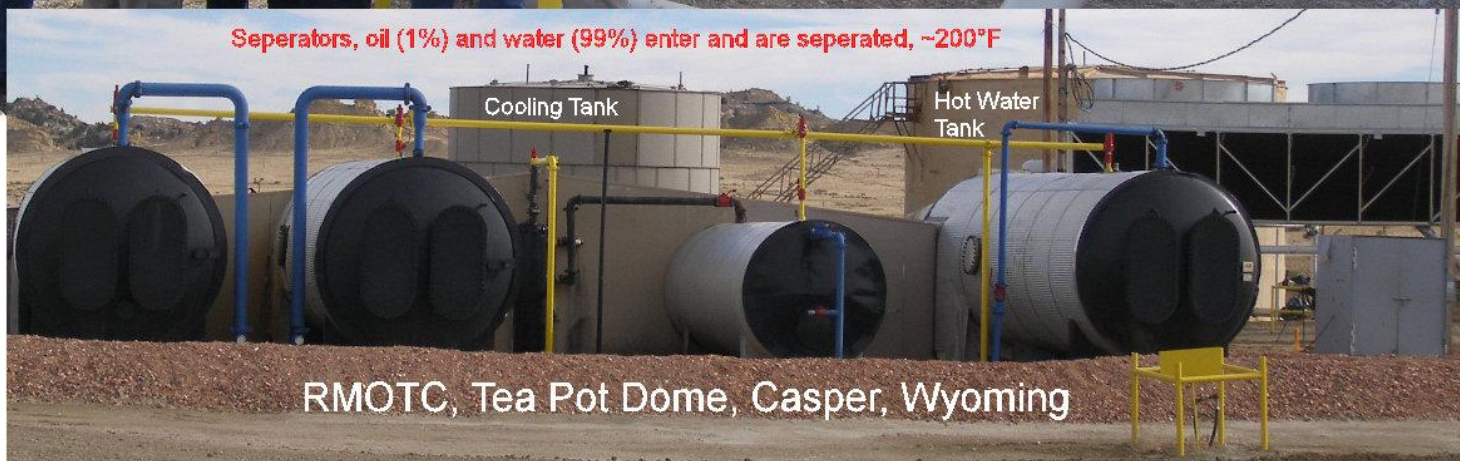




Hot Water Storage Tank, 195°F

250 kW Turbine and Generator

Spent Water, 170°F  
to cooling tank



Separators, oil (1%) and water (99%) enter and are separated, ~200°F

Cooling Tank

Hot Water Tank

RMOTC, Tea Pot Dome, Casper, Wyoming



# Denbury Resources & Gulf Coast Green Energy



RPSEA.org Demonstration Project

Mississippi Summerland Field

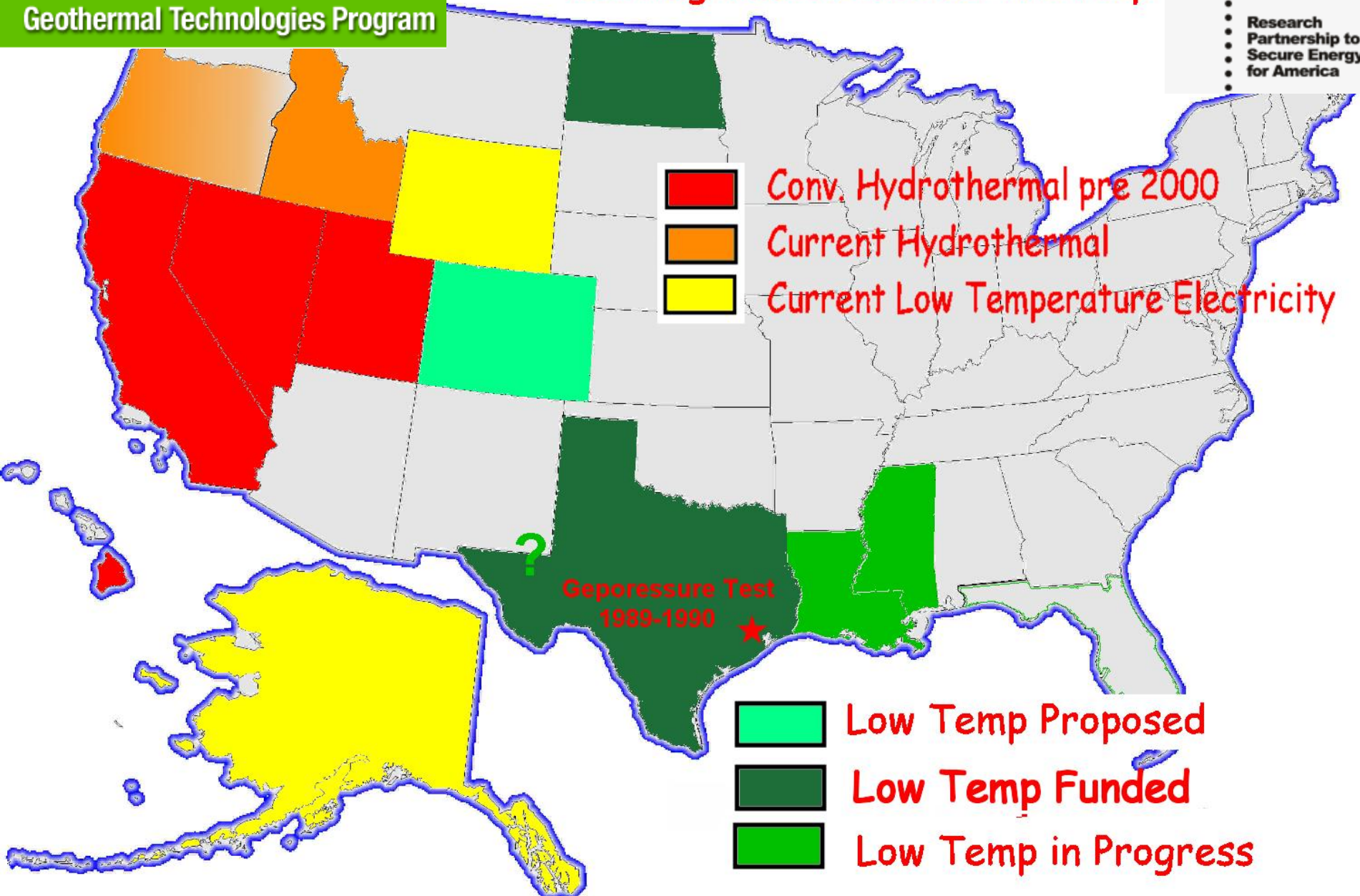
190°F current surface temperature



# Chena Mobile Power System



# Getting Geothermal on the Map





## Types of Resources

- Coproduced (waste heat)-RMOTC
- Geopressure-Gulf Coast/East Texas
- Tight gas sands-NE Texas-Sed EGS
- Basement EGS
- Conventional Hydrothermal in West Texas



# **Final Report**

**Texas Geothermal Assessment for the I35 Corridor East**

**FOR**

**Texas State Energy Conservation Office Contract CM709**

**Dr. David Blackwell, Maria Richards, and Patrick Stepp**

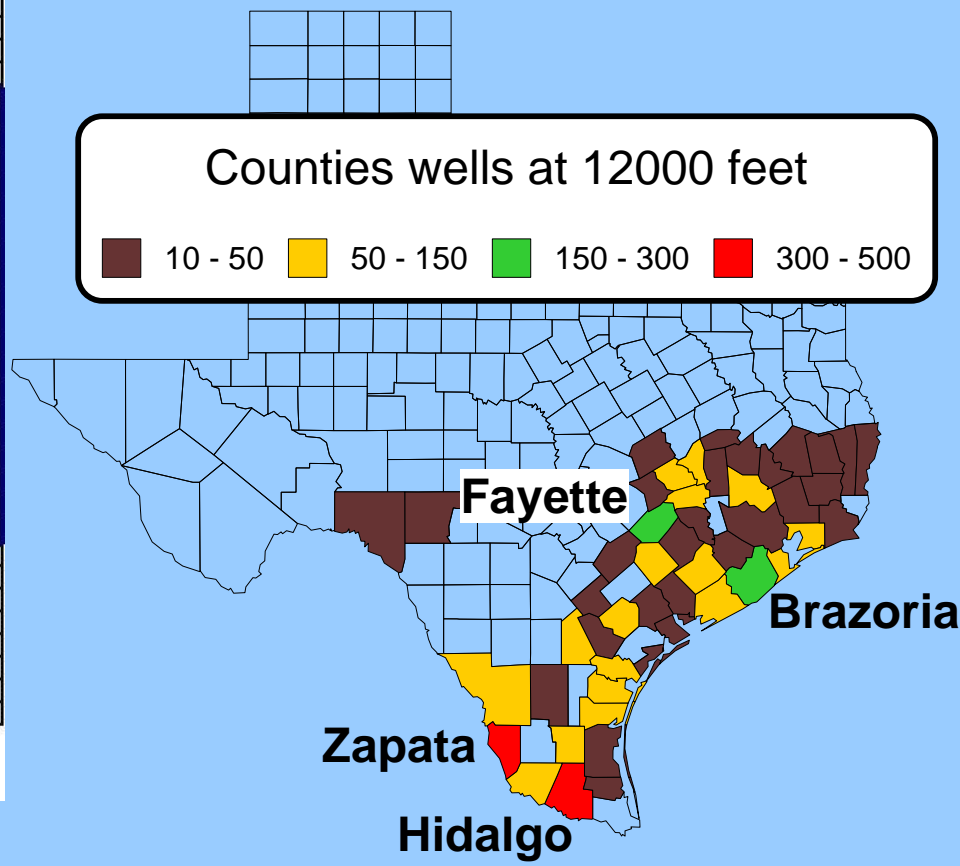
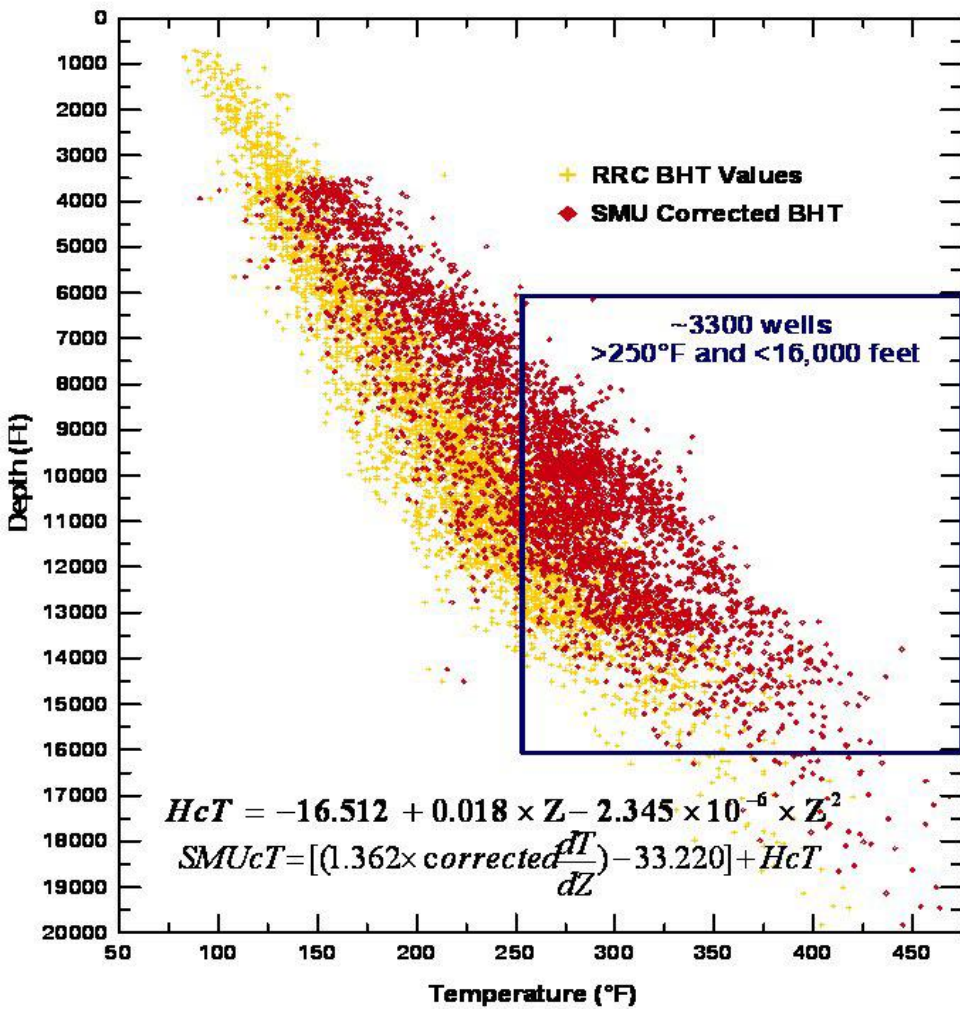
**Southern Methodist University  
Roy M. Huffington Department of Earth Sciences  
SMU Geothermal Laboratory  
PO Box 750395  
Dallas, Texas 75275-0395**

**March 29, 2010**

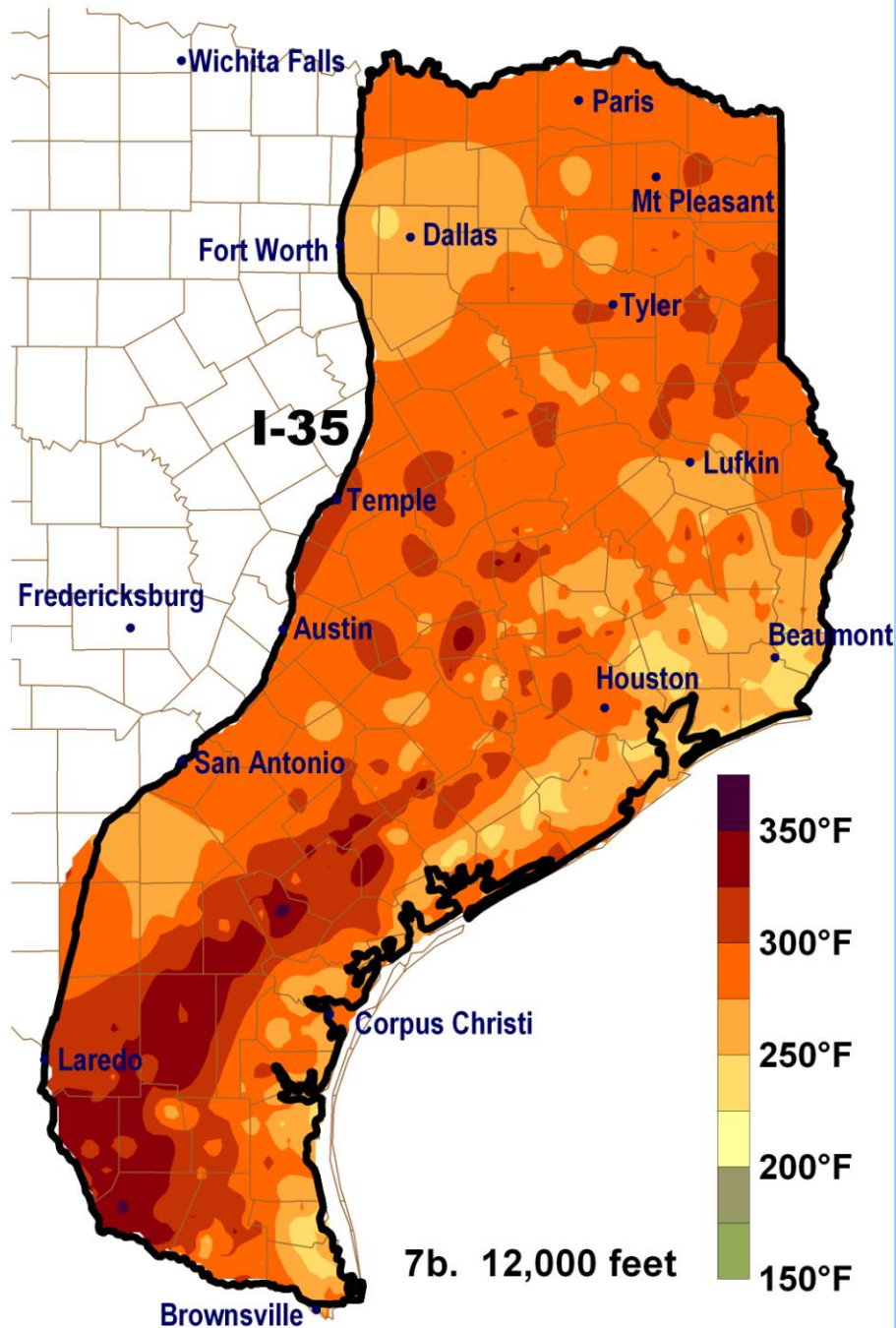


**SMU** | **GEOHERMAL  
LABORATORY**





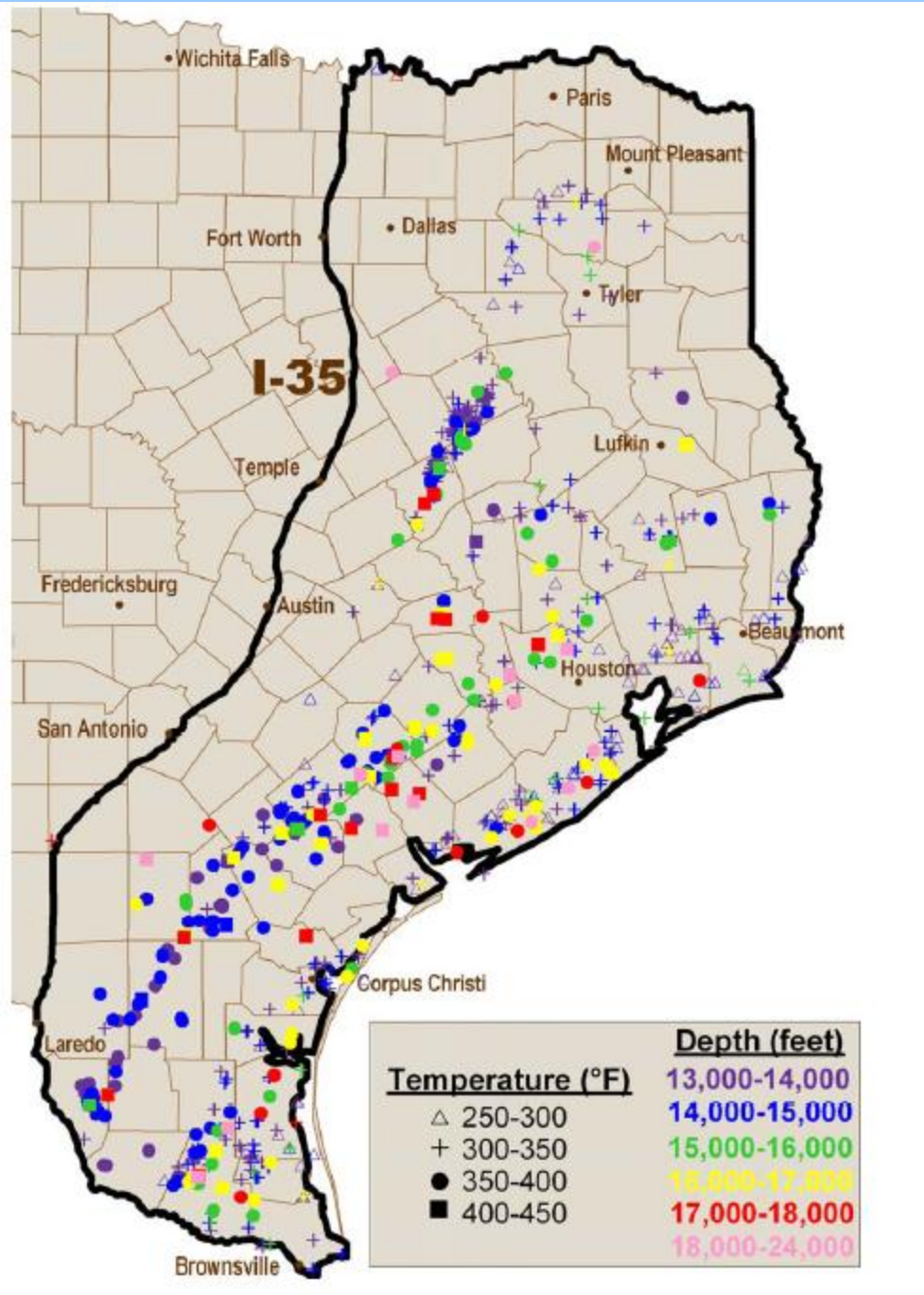
**3648 wells**  
**Gulf Coast Wells active in 2000 - 2005**  
**Total Wells 18,224**



Detailed corrected temperature map at 12,000 feet

7b. 12,000 feet



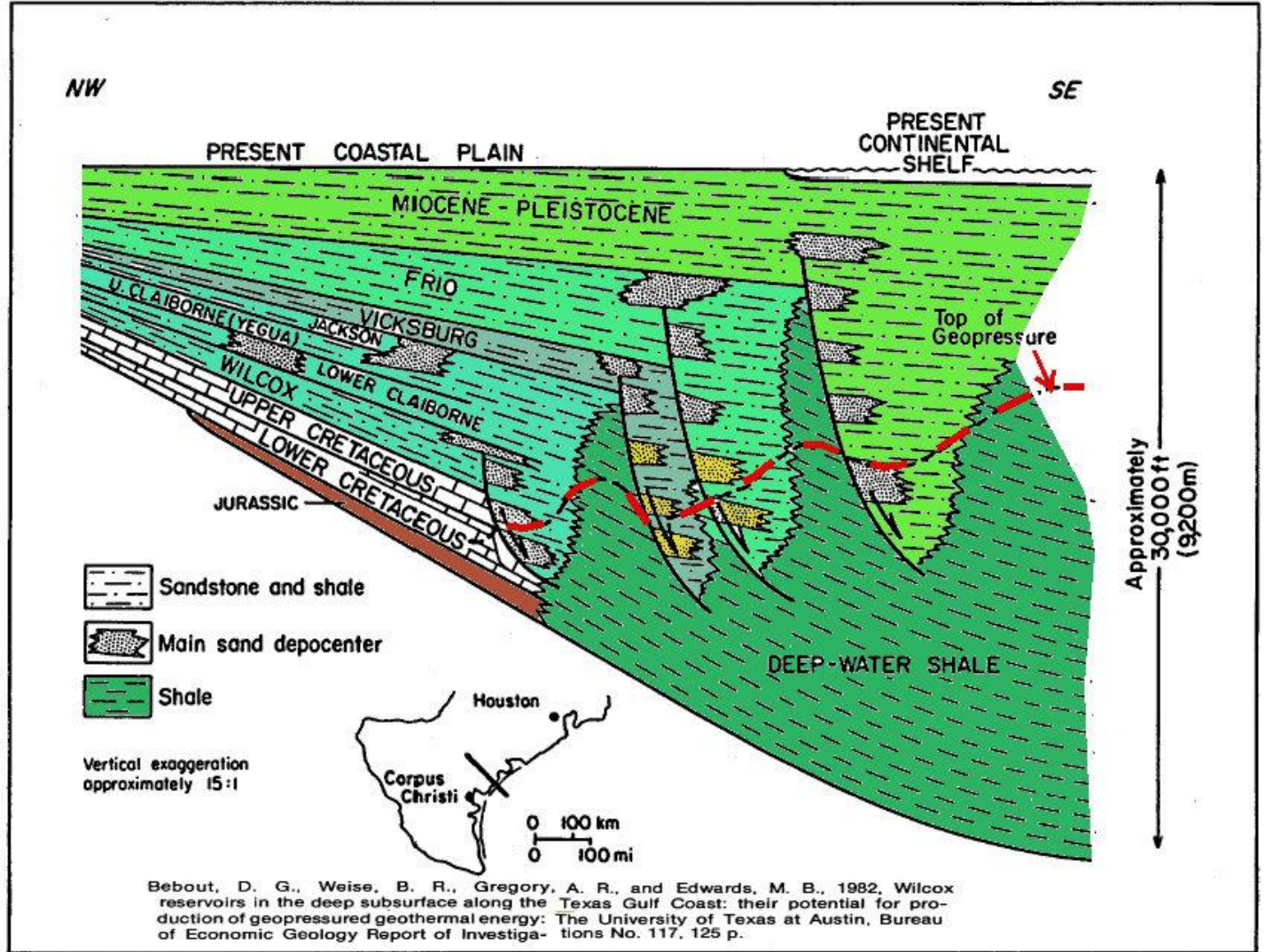


# GeoPressure

- Pleasant Bayou, Brazoria, Texas
  - 1989-1990
  - DOE Project with Ben Holt Company
  - Geopressure-Geothermal Hybrid Cycle plant
  - A mixture of methane and geothermal used
  - This 1 MW facility was not optimized for electricity generation. Despite this, from November 1989 until May 1990, the facility generated 3,445 MWh, and cycled 1.4 MMstb of brine and 39.2 MMscf of natural gas through the facility [40].
  - Net Power 980kW (1/2 gas, 1/2 temperature)

[40] Chacko, J.J., Maciasz, G, Harder, B.J.: "Gulf Coast Geopressured – Geothermal Program Summary Report Compilation", Work performed under U.S. Department of Energy Contract No. DE-FG07-95ID13366. June 1998.





Schematic cross section, central Texas Gulf Coast, showing relationship among major growth faults, expansion of section, sand depocenters, and top of geopressure (after Bebout and others, 1982).

**Gulf Coast Geology and Geopressure Geothermal Resource Setting: USGS (1979) estimates 70 to 170 MW resource potential (gas & heat)**

Table 1. Estimates of Total Geopressured Resource, onshore/offshore the Texas-Louisiana Gulf Coast, in Quads \*One quad equals 10<sup>15</sup> Btu or one trillion cu gas.

Source	Thermal	Mechanical	Gas	Total
Brown—Hudson	—	—	60,000 100,000	60,000 100,000
Dorfman—Texas	—	—	5,735	5,735
Hawkins—LSU (Louisiana only),*	19.5	1.2	13.6	34.3
Jones—LSU (sands & shales)	—	—	100,000	100,000
(sands only)	—	—	49,000	49,000
Papadopoulos — U.S.G.S. Circ. 726 (sands & shales assessed onshore only)	43,331	198.0	23,927	67,456
(unassessed only)	<i>One and one-half to two and one-half times the assessed quantities</i>			
Wallace — U.S.G.S. Circ. 790 (assessed onshore sandstone only)	5,800	—	3,220	9,100
(assessed offshore sandstone only)	5,200	—	2,800	8,000
* Recoverable amounts only calculated				



## **“The Future of Geothermal”**

**Table 1.1 Estimated U.S. geothermal resource base to 10 km depth by category**

Category of Resource	Thermal Energy, in Exajoules (1EJ = 10 <sup>18</sup> J)	Reference
<b>Conduction-dominated EGS</b>		
Sedimentary rock formations	>100,000	This study
Crystalline basement rock formations	13,900,000	This study
Supercritical Volcanic EGS*	74,100	USGS Circular 790
<b>Hydrothermal</b>	2,400 – 9,600	USGS Circulars 726 and 790
<b>Coproduced fluids</b>	0.0944 – 0.4510	McKenna, et al. (2005)
<b>Geopressured systems</b>	71,000 – 170,000**	USGS Circulars 726 and 790

\* Excludes Yellowstone National Park and Hawaii

\*\* Includes methane content

**Note: 100 EJ =US 1 year use**

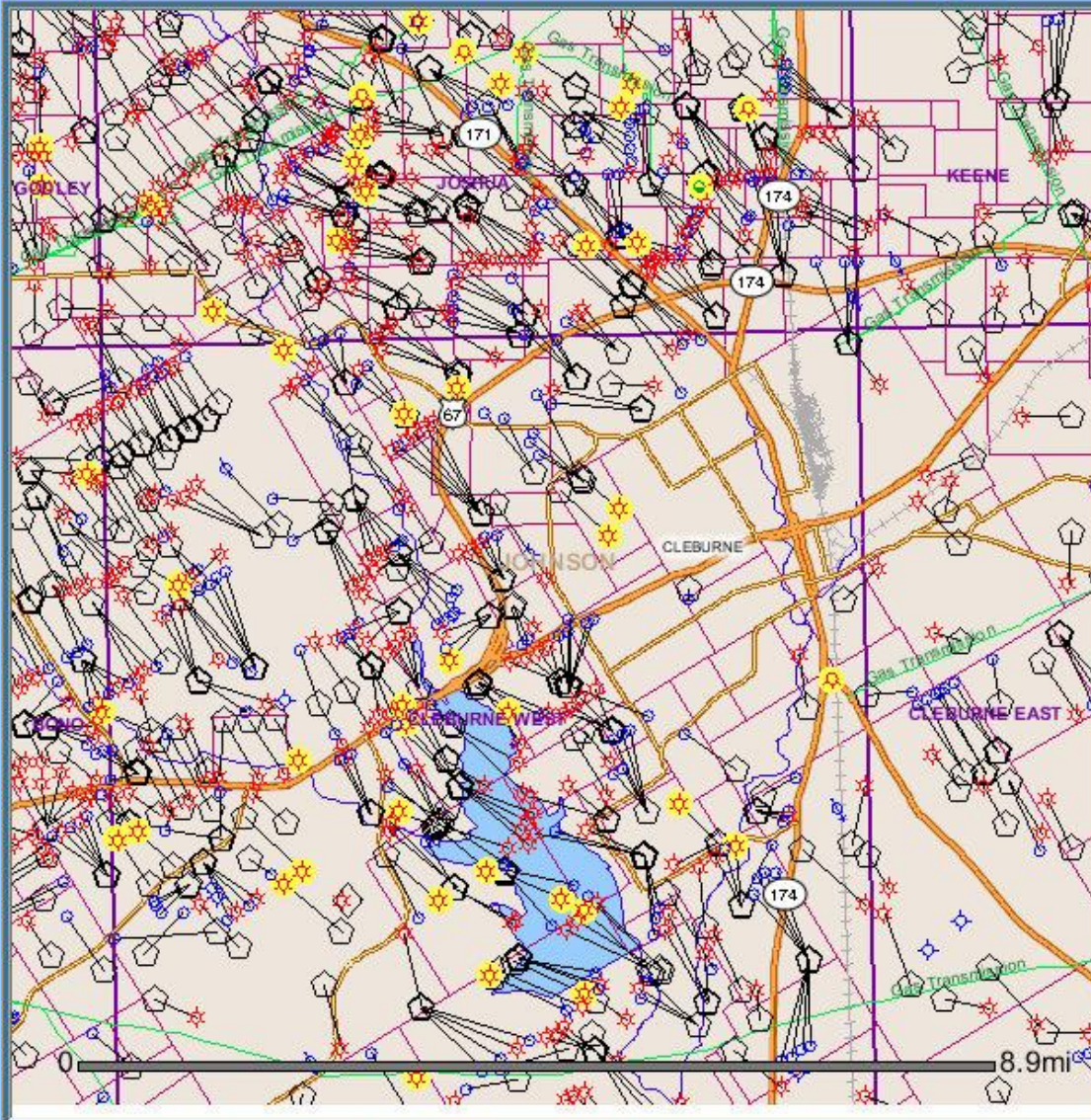


**Pleasant Bayou, Brazoria County Texas Power Plant  
USDOE Geothermal Project, ½ gas ½ Geothermal  
1 MW produced between mid 1989 and mid 1990,**



# Tight Gas Sands

- Hard, abrasive rock
- Mild geopressure
- Low natural permeability
- Temperatures of 150 to 225 °C
- Fracture treatments & horizontal wells
- Limited reservoir uncertainty



**SCREEN PAN**

↑ ↑ ↑  
← → →  
↓ ↓ ↓

ZOOM IN 1.5X  
ZOOM OUT 1.5X  
ZOOM IN 3X  
ZOOM OUT 3X  
ENTIRE STATE

**DISPLAY**

- Wells
- Pipelines
- Surveys
- User Graphics

Refresh

Print  
Legend  
Help

**MAP TOOLS** --- Select Map Tool---

Go to County/Offshore Area/Bay  
251 Johnson

**SEARCH BY:**  
Wellbore API Number  
251 - >

Lease/Id  
Survey/Abstract  
Places...  
Pipelines

Long. -97.40507 Lat. 32.34637 >

# Cleburne

**Horizontal Wells as EGS Heat Exchangers  
Giddings Austin Chalk Play, Haynesville Shale Play, etc**



# Geothermal Energy from Oil and Gas Fields

- ❖ Base Load
- ❖ Green, no emissions
- ❖ Located in industrialized areas
- ❖ Financing by long term loans
- ❖ Lowers cost of production
- ❖ Multibillion dollar market in Texas alone
- ❖ Large scale gas resources developed with geopressure

# Green Oil/Gas Fields

## Existing Gulf Coast Field Conditions

- Many wells with BHT's at over 250 °F at 15,000 ft or less
- Water produced from wells, stripped of hydrocarbons, and reinjected (paid for by disposer!)
- In-place infrastructure of power lines, roads, pipelines
- Possible continued stripping of gas and oil in otherwise non-economic wells (3,200 TCF natural gas, USGS, 1979)
- Existing o/g infrastructure and business expertise

## Direct Costs to Develop a Texas Water-Flood Field-payout ~ 3 yrs

- Build power station
- Minor surface infrastructure upgrades (i.e., insulating collection pipes)
- Redevelop wells for water production (dissolved gas)



# DOE Stimulus Funding Announced October 28, 2009

## 2) Coproduced, Geopressured, and Low Temperature Projects

Universal GeoPower LLC	\$1,499,288	Liberty County	TX	Universal GeoPower LLC will utilize a modular low temperature binary unit to produce power from oil and gas wells in Liberty County, Texas.
Louisiana Tank, Inc.	\$5,000,000	Cameron Parish	LA	Louisiana Tank, Inc. will demonstrate the feasibility of a geopressured power plant in Cameron Parish, Louisiana.

## 5) Geothermal Data Development, Collection and Maintenance

Southern Methodist University	\$5,250,000	Dallas	TX	Southern Methodist University will help populate the NGDS with geothermal related data from various sources.
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**TEBG, Texas Tech, Texatherm, Siemens, Cornell, etc**

**Wind Power Grants: Texas**

- Bull Creek: \$ 91,390,497
- Pyron Farm: \$121,903,906
- Penascal: \$114,071,646
- Barton Chapel: \$ 72,573,627

## Geo Texas wins geothermal leases offshore Texas

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4/7/2009 10:30:10 PM GMT



AUSTIN, TEXAS: The Texas General Land Office and the School Land Board have awarded three geothermal leases off the Texas coast to Eugene, Oregon-based Geo Texas Co. at its April 7 lease sale. Geo Texas was the only bidder for the geothermal leases.

The company now has the rights to produce geothermal energy on 128,758 acres of state land off the coasts of Galveston, Brazoria and Matagorda counties.

The terms of the bid require Geo Texas to pay US\$2 an acre bonus and US\$3 an acre annual rental for the state submerged land. Once Geo

Texas begins to produce electricity, the state's Permanent School Fund will earn a 2.05 percent royalty for the first 10 years of the lease, and 3.8 percent for years 11 through 30. Even without any energy production, the state's Permanent School Fund will earn more than US\$386,000 a year.

Texas Land Commissioner Jerry Patterson said, "Texas is the nation's new frontier for renewable energy and today's lease sale is more evidence of that. These leases should earn the state's school fund millions and show that renewable energy is profitable in Texas."



# Geothermal Incentives and Financing

## Texas H.B. 4433 Hydrocarbon Tax Exemption from Geothermal Wells (effective September 1, 2009)

*“Exempts from severance taxes oil and gas incidentally produced in association with the production of geothermal energy.”*

### Severance Taxes *Exemption* if produced with Geothermal Energy

Gas (7.5%)

Oil (4.6%)

2.1 % Federal Tax Credit or  
30% Investment Tax Credit



# Geothermal Development Scenarios:

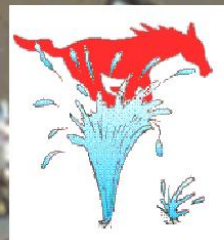
- Water flood fields 200-300°F - MW's each
- Redevelop Deep Gas fields 300-400°F - 10's MW each
- Direct Development of Deep Massive Sands (Wilcox)
  - with mild Geopressure or gas drive
- Development of Hard Geopressure
- Offshore Platforms
- On site use or wheeling
- Cycling scenarios
- Mobile small scale generation stations

## Technical aspects:

Bigger Wells

Larger Fracs

More reservoir modeling/monitoring





**If Life Gives You Hot Water**



**Make Ice!**