

# Geothermal Energy

## Roadmap to Developing Geothermal Energy in Texas

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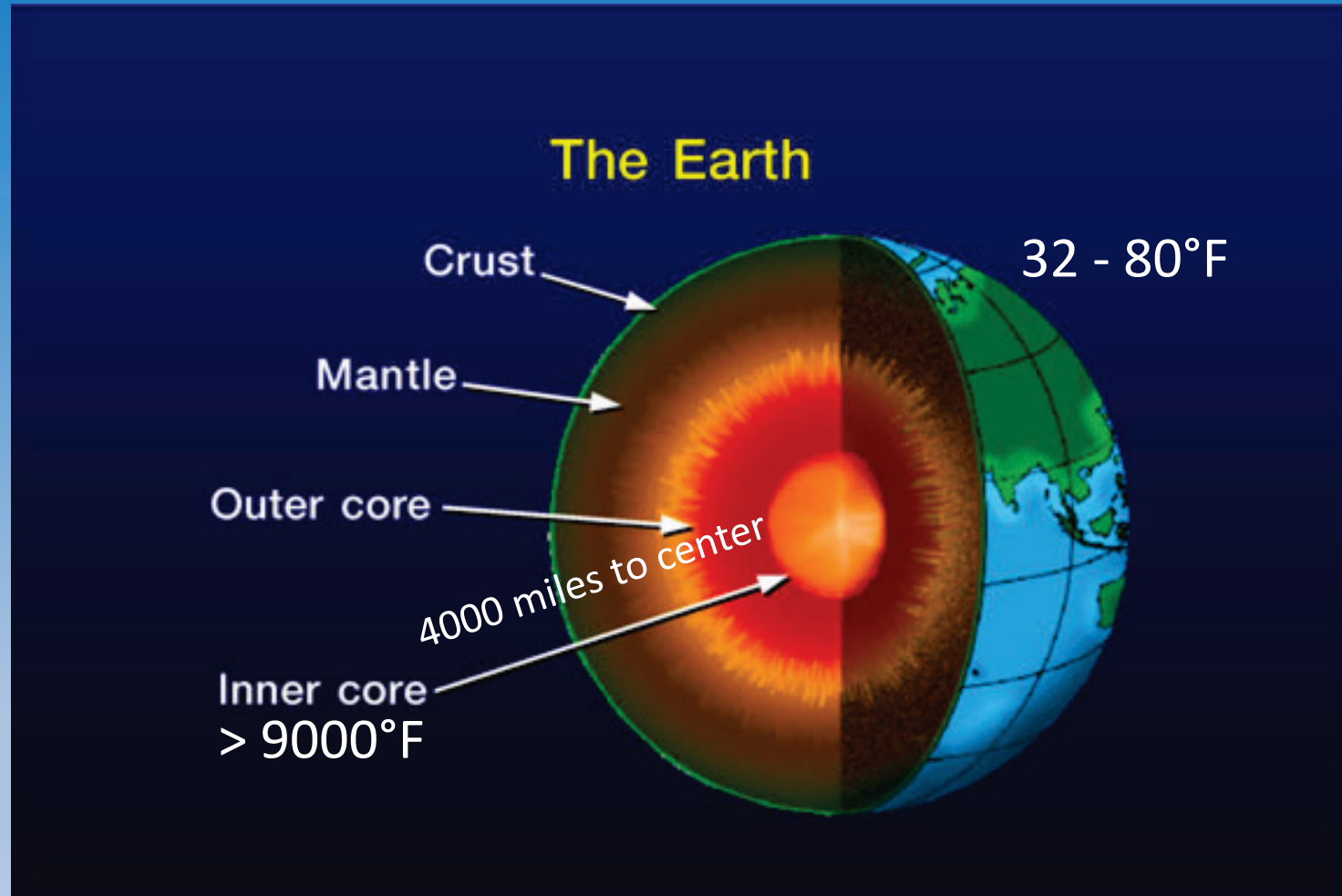
<http://www.smu.edu/geothermal>

Research and Outreach Focus



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# Texas Energy Opportunities... Geothermal









# Texas Energy Opportunities...

## Geothermal Heat Pumps



**NET ZERO Buildings**

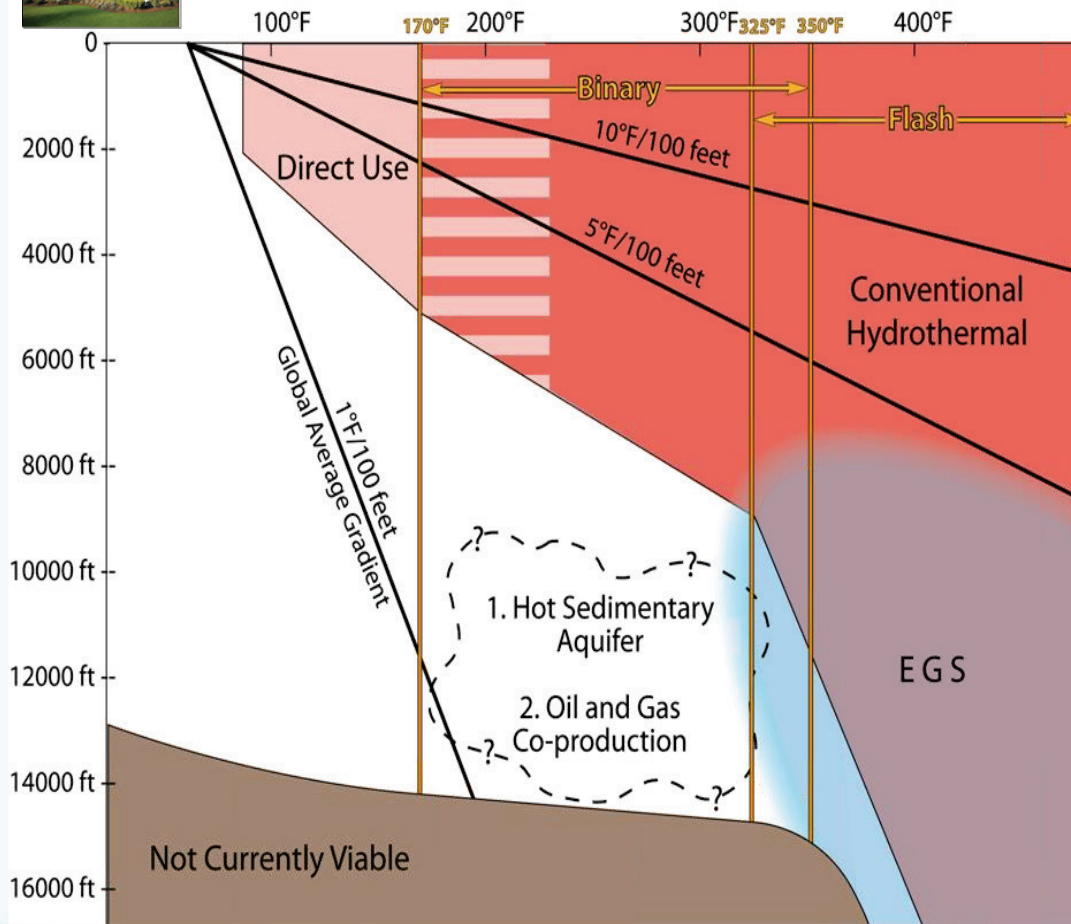


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# Possible Texas Geothermal Electrical Categories



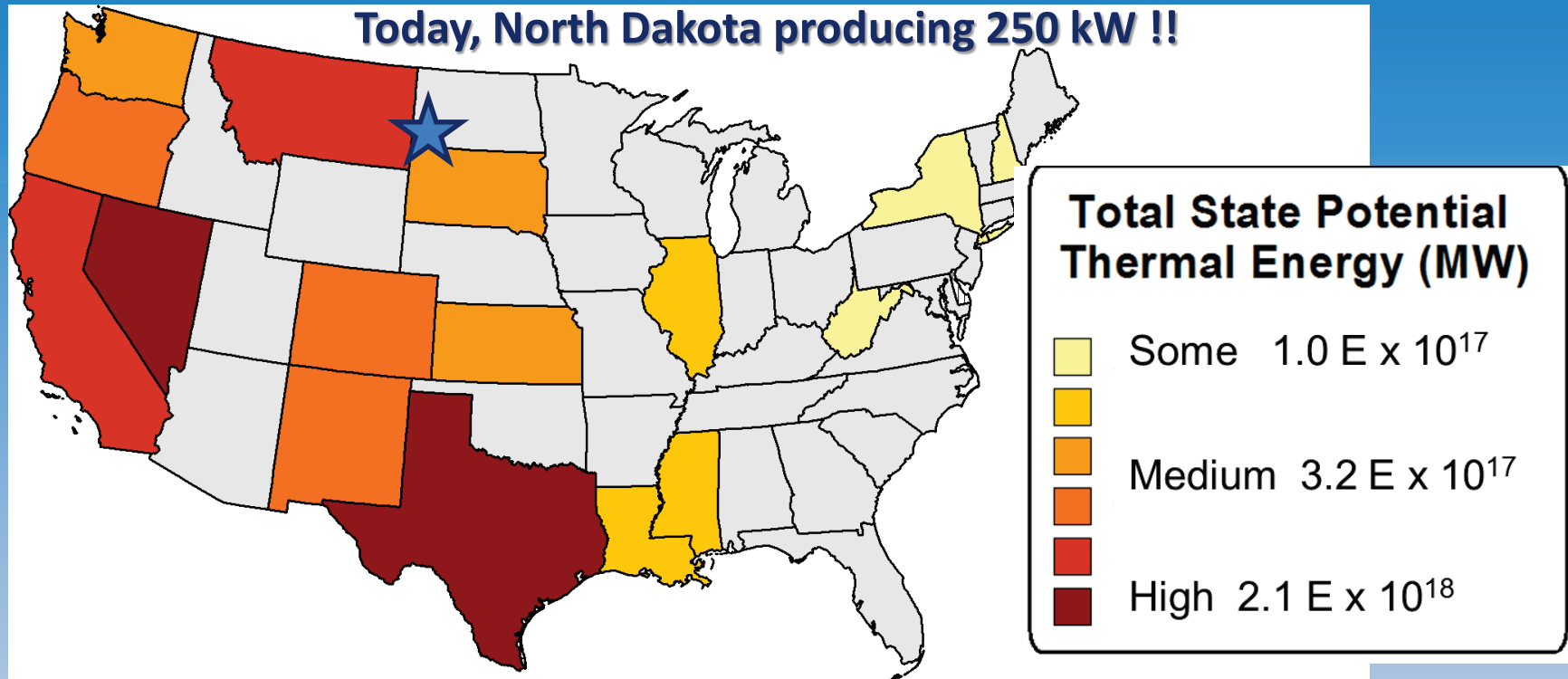
Schematic Depth-Temperature Plot for Geothermal Resources



- **Binary Fluids** ( 195 - 300°F)
  - \* Coproduction with oil wells
  - \* Direct production of fluids
    - < 5 MW for field
    - >25 kW /well
- **Enhanced Geothermal Systems (EGS)**
  - > 300°F
  - \* Sedimentary Basin
  - 50 MW+
- **Geopressed Formations**
  - > 300°F
  - \* entrained gas

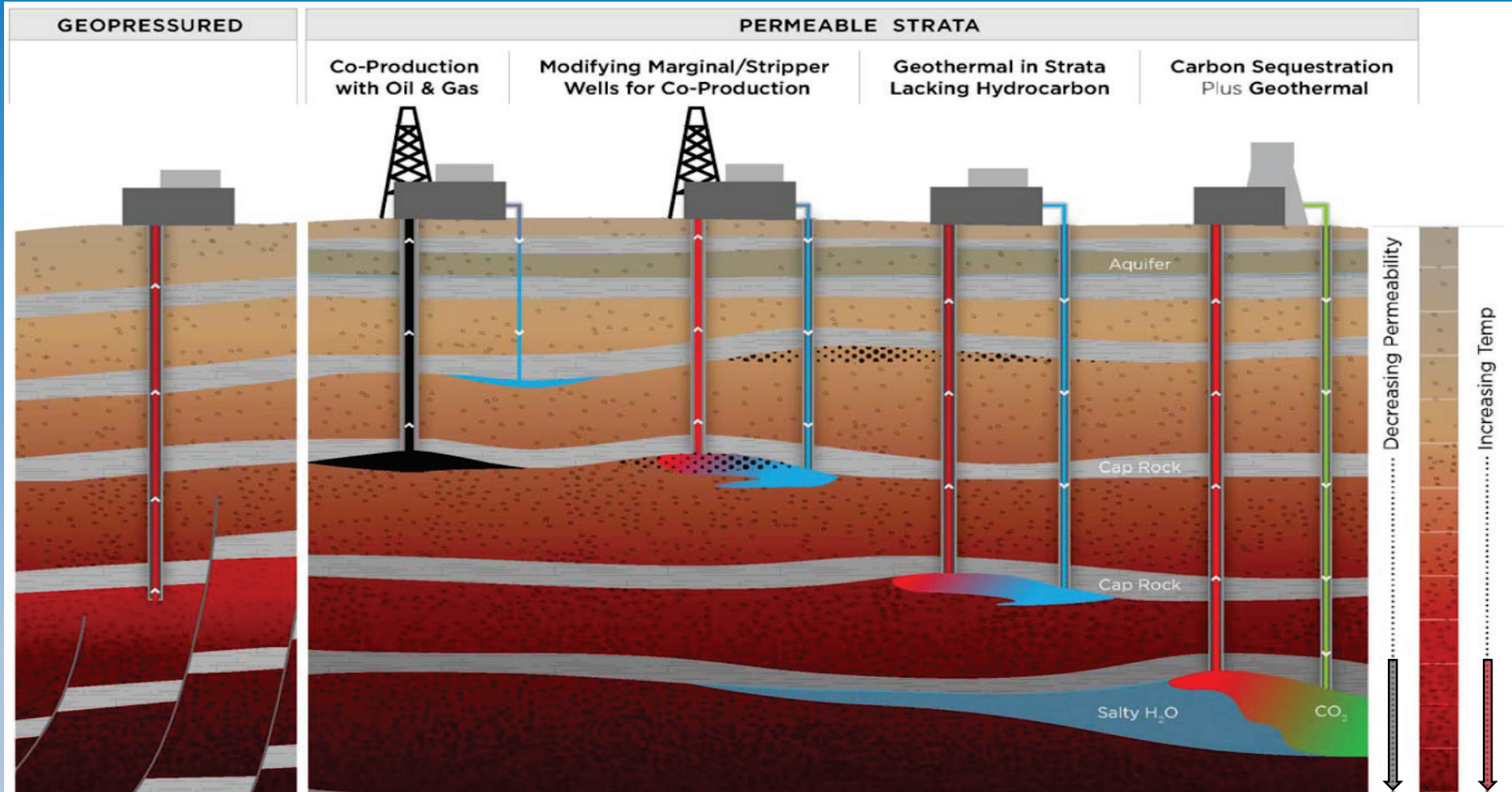


# U.S. Potential Power Production



**Based on Temperatures in Sedimentary and Basement Rocks**  
**Power from: Coproduced, EGS, and Geopressure Geothermal Energy**

# Texas = O/G + Geothermal Power Options



# How about a Water Flood?!



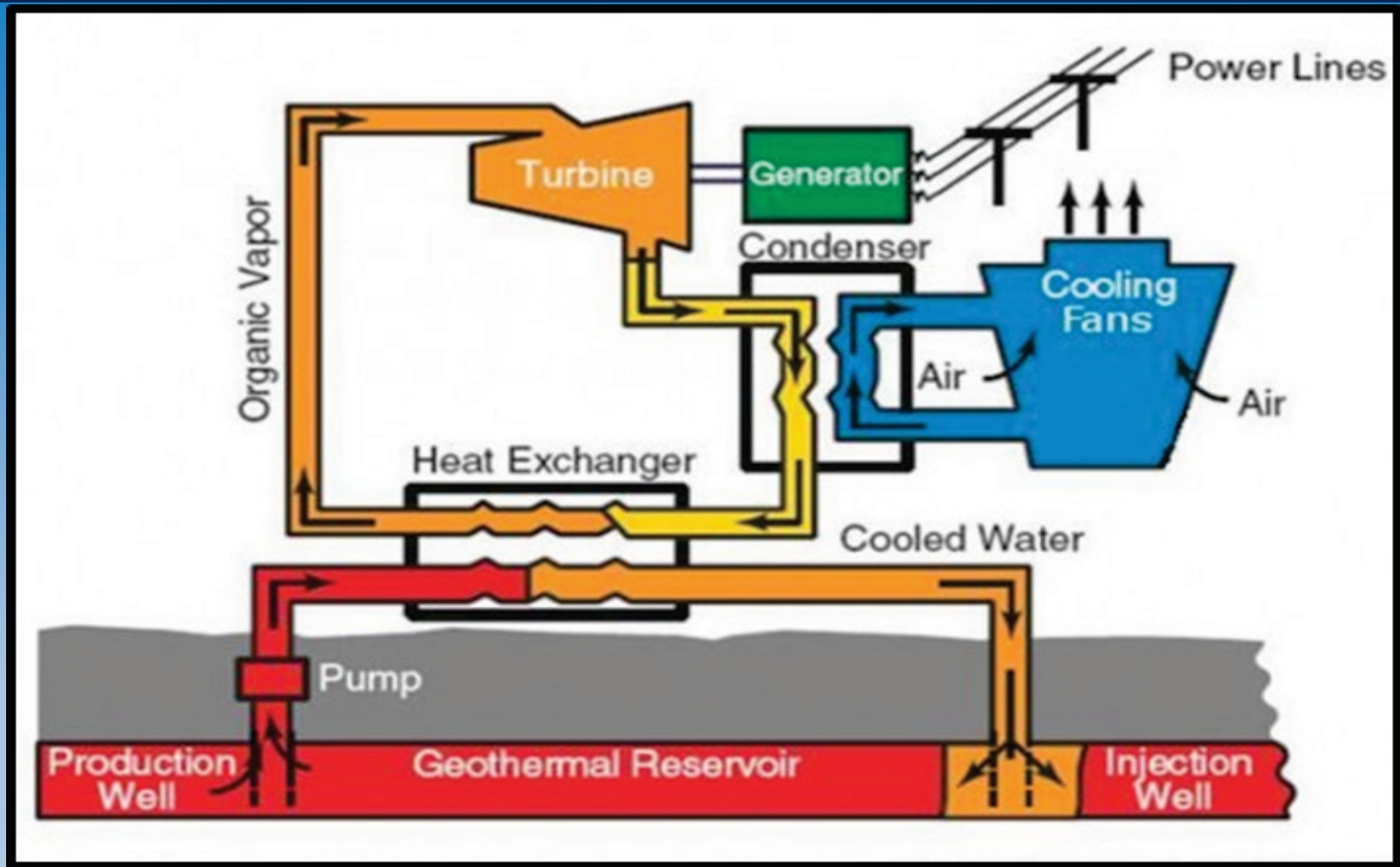
Will Gosnold, Tim Reinhardt, Karl Gawell

[Video on ND Project](#)

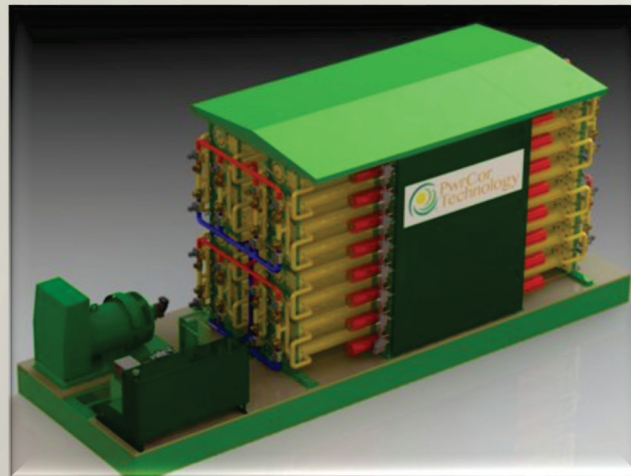


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# Texas = Binary Power Production

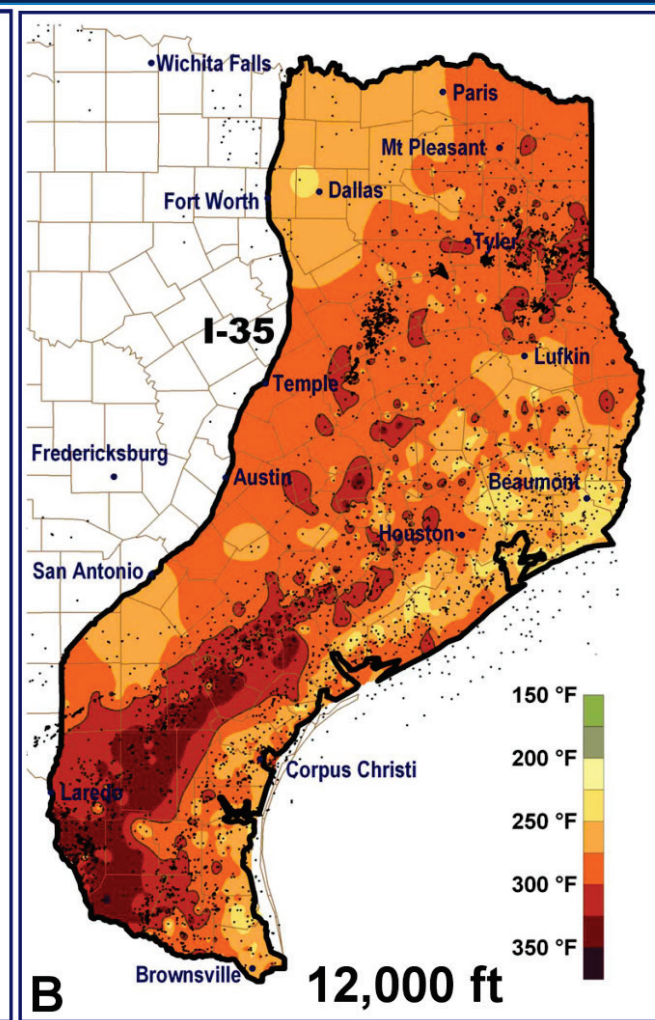
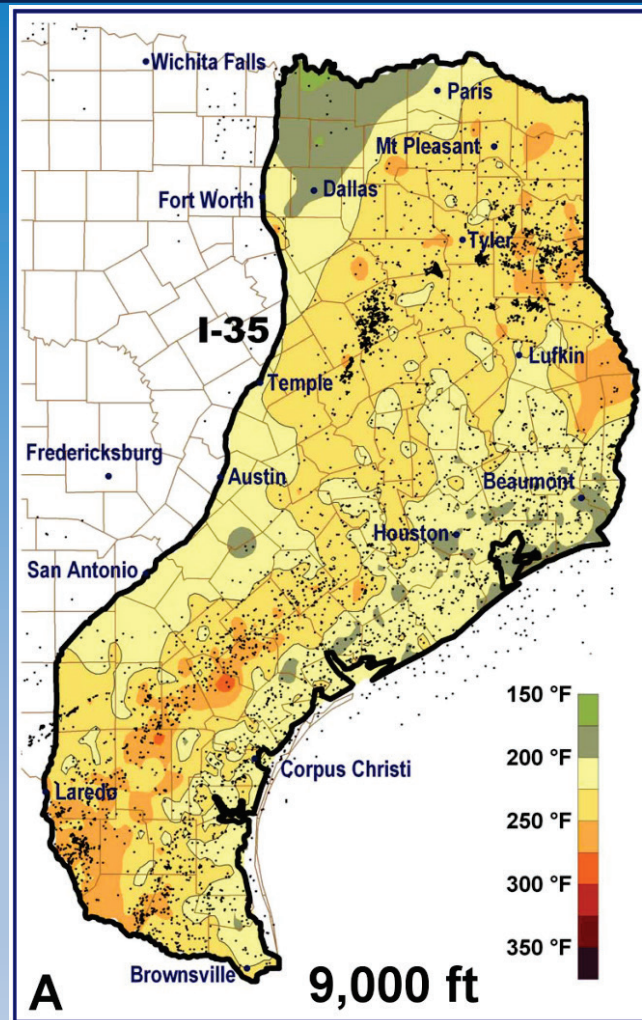
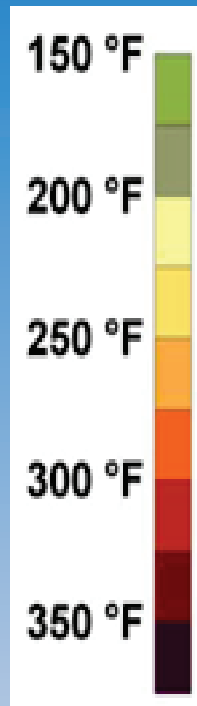


# Binary Technologies



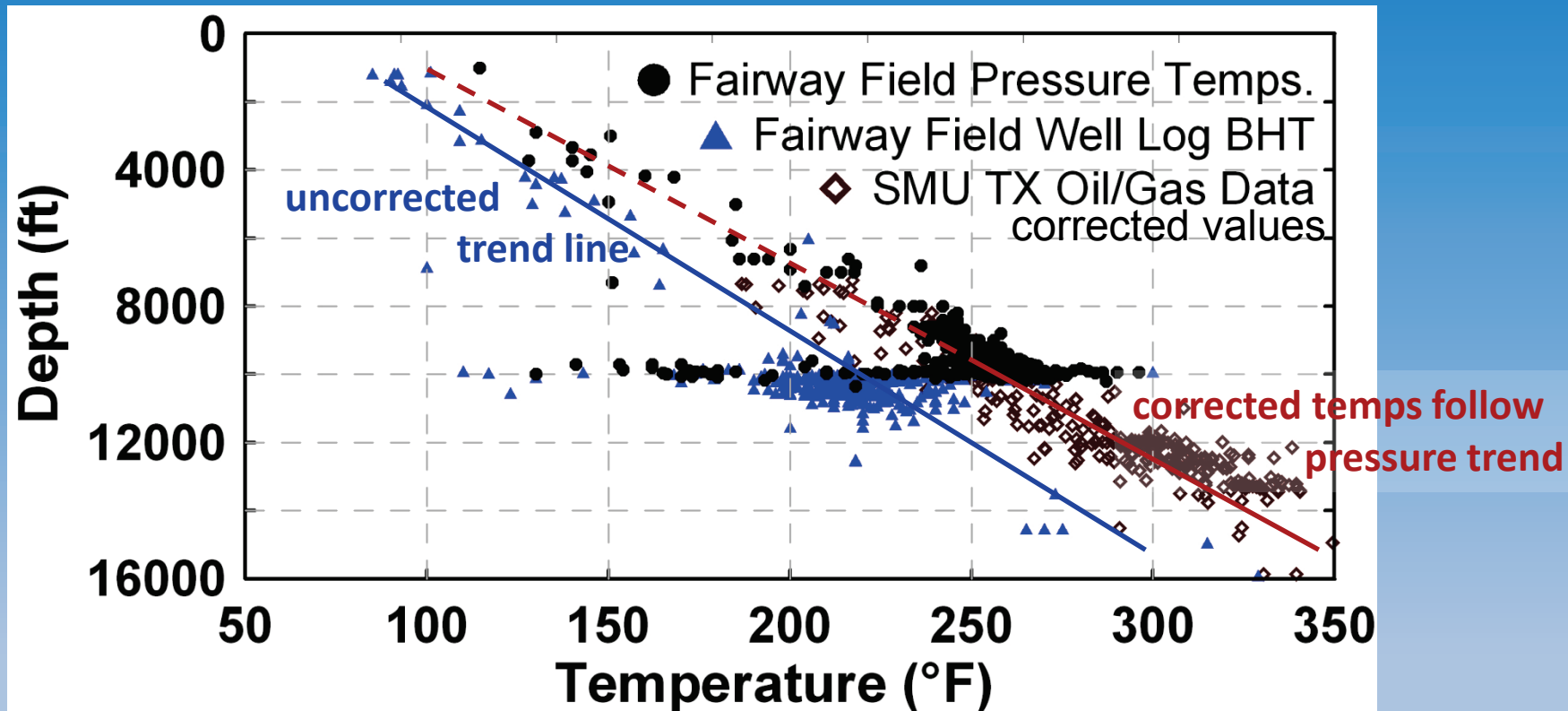
# Estimating temperatures from oil/gas BHT

## Corrected Temperatures



# East Texas Fairway Field

## BHT data vs Pressure Log temps

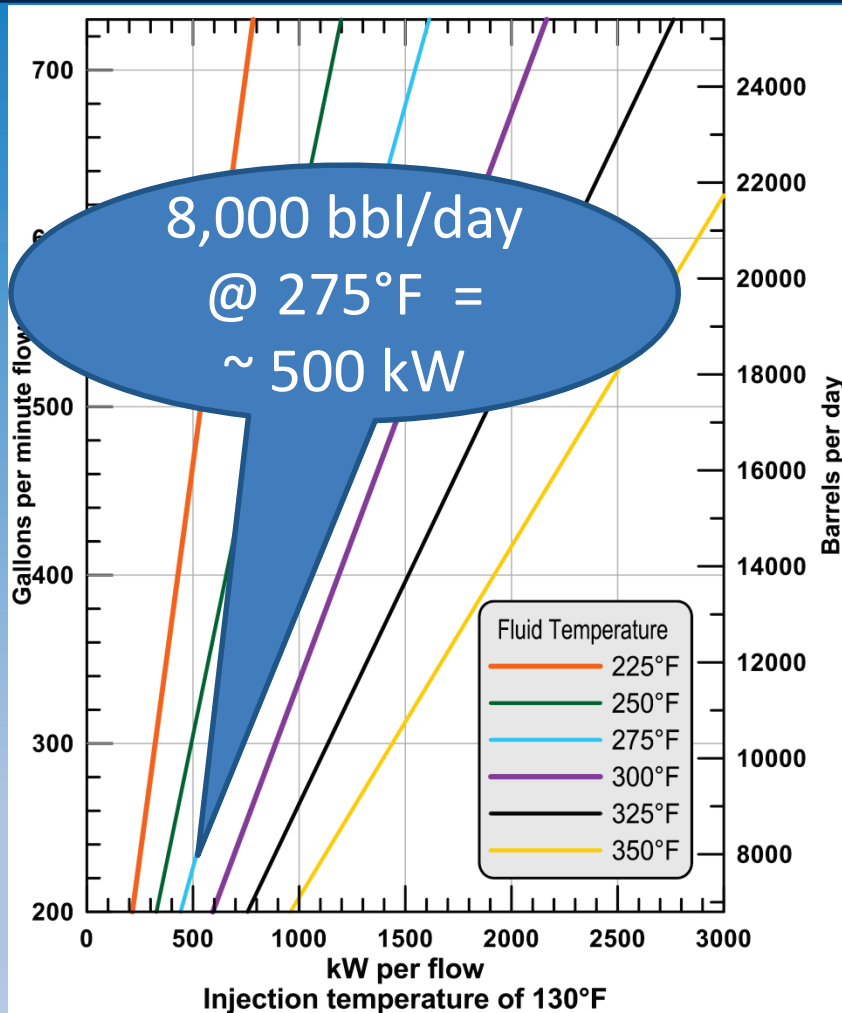


*FYI - SMU receives static pressure-temperature logs and gives the company a tax deduction*



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# Fluids are Important Variables - Cold and Hot

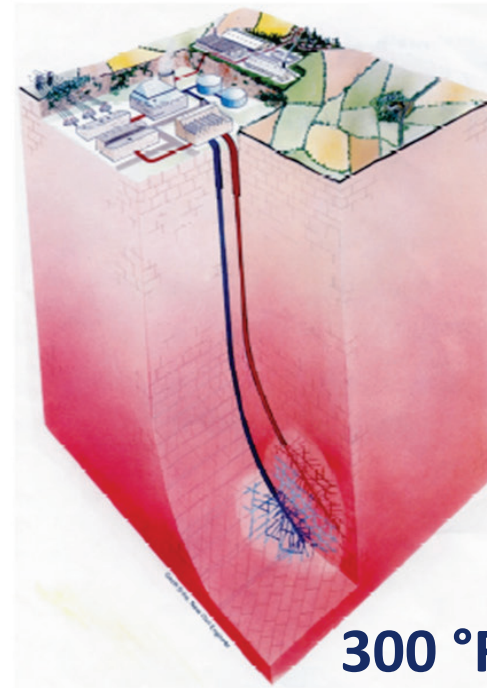
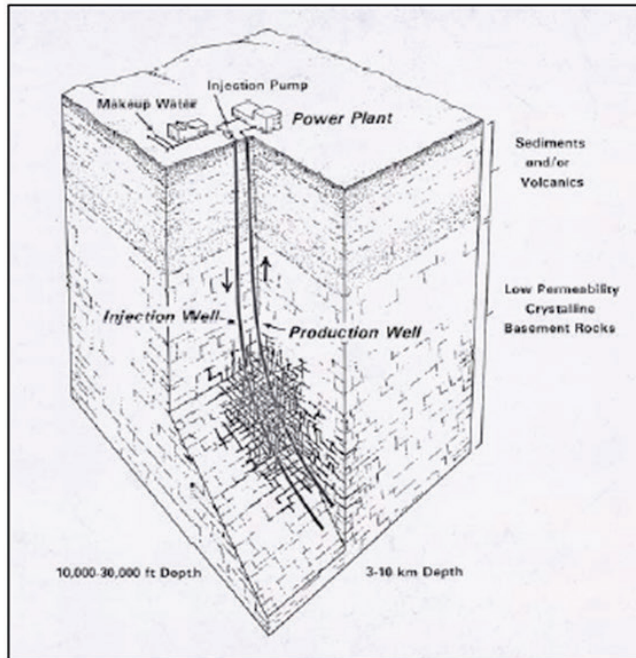


- Based on  $\Delta T$  of 120° F
- Baseline for estimation
- Curve will be different based on
  - Technology
  - $\Delta T$

**1 W = 1000 mW**  
**1000 W = 1 kW**  
**1000 kW = 1 MW**



# EGS – Enhanced Geothermal Systems



300 °F or hotter

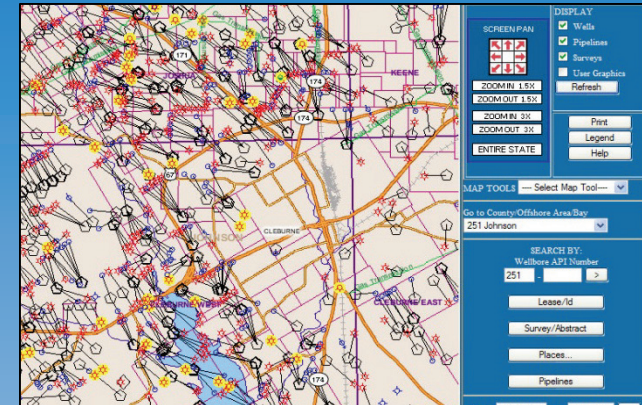
**EGS defined broadly as engineered reservoirs that have been stimulated to emulate the production properties of high grade commercial hydrothermal resources.**



# EGS – Enhanced/Engineered Geothermal System

*\*EGS is where we need to get to for utility scale projects*

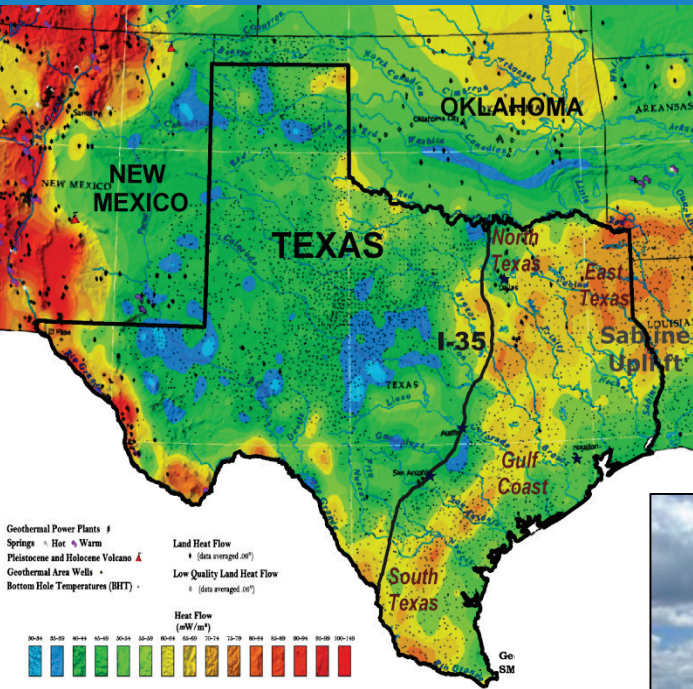
East Texas/ LA  
Haynesville Shale  
Sabine Uplift  
EGS



North Texas  
Ellenburger Limestone  
Fort Worth, TX  
EGS, Coproduced



Gulf Coast & South TX  
Frio and Wilcox  
EGS, Geopressure



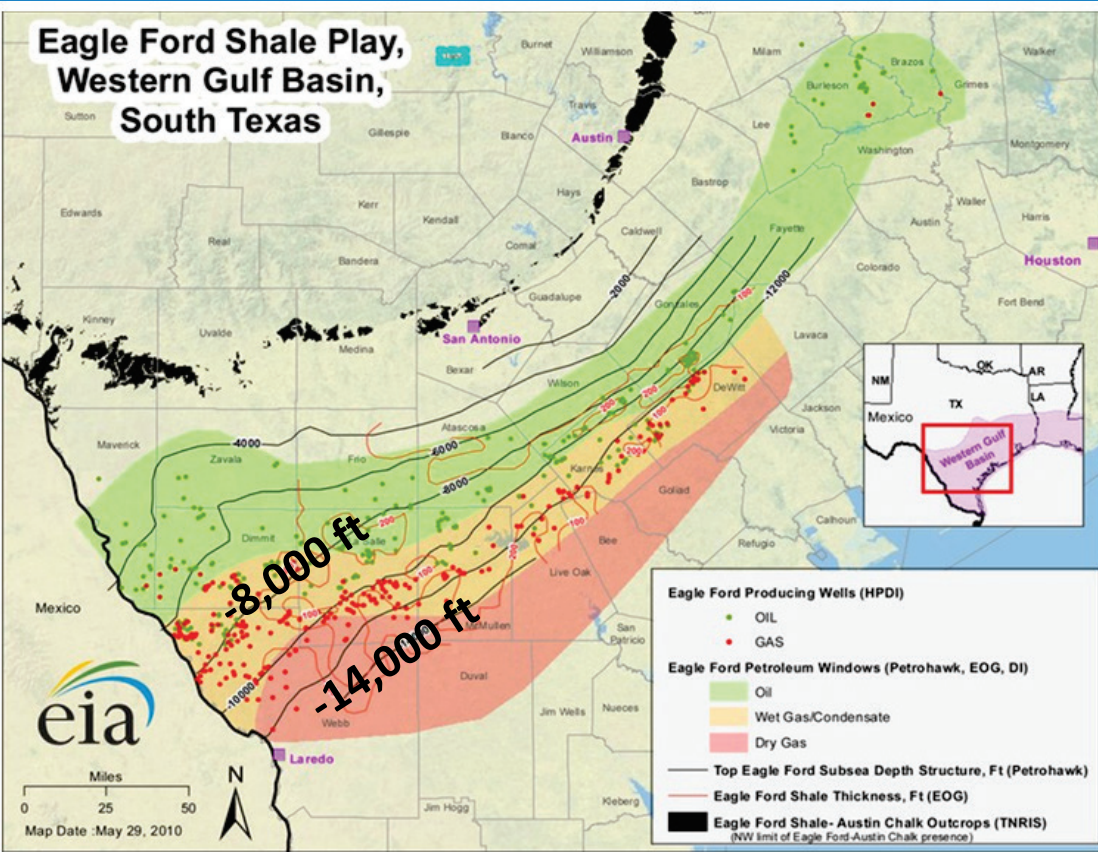
2004, Blackwell and Richards, GMNA



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# Unconventional plays include geothermal

## Eagle Ford Shale Play, Western Gulf Basin, South Texas



## Drilling depths

8,000 to 14,000 ft

>14,000 overpressured

250 - 500°F

## Top locations to consider

Gulf Coast Geopressure

Eagle Ford Shale

Haynesville Shale

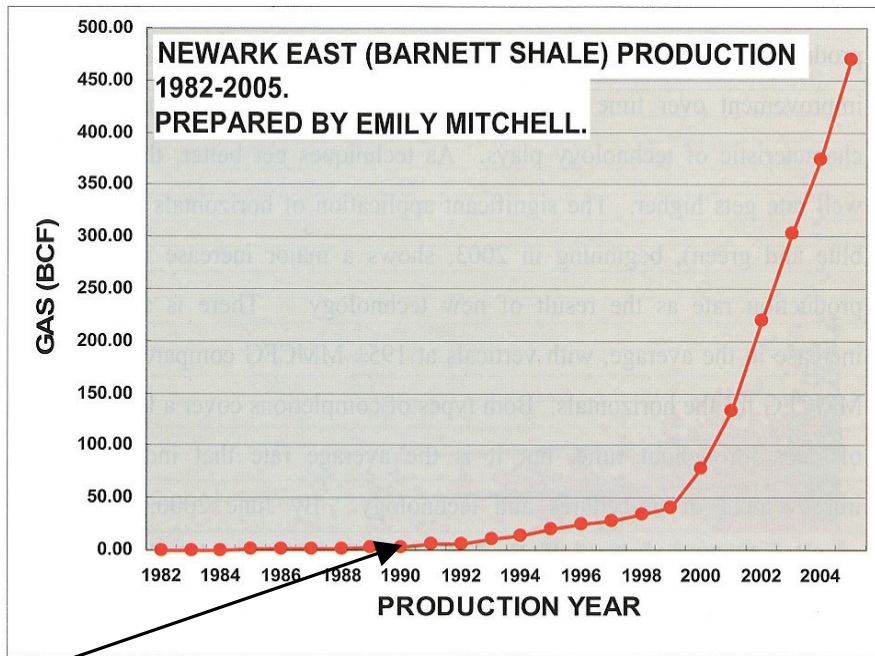
Deep water/CO<sub>2</sub> floods

Tight sands

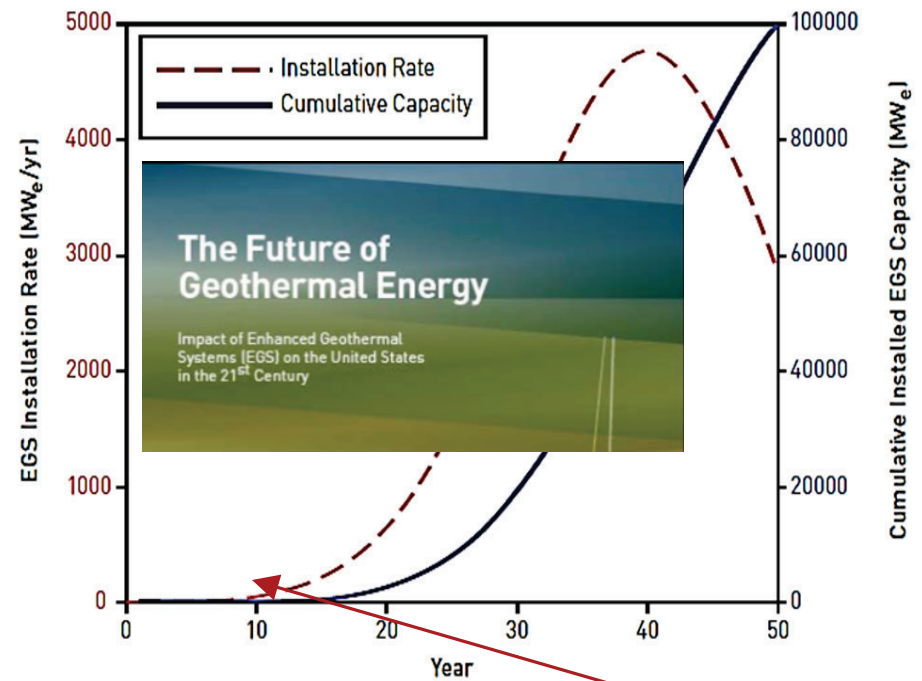
Where fluids and heat exist



# Extending the life of oil/gas fields



*Based on the shale plays*



**Geothermal development in O/G fields is right on target!**

Currently experimental in US, Australia, Germany, & UK



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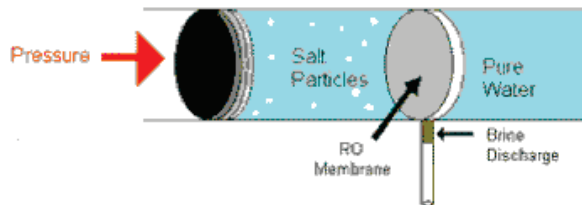
# Overlapping Technologies Possible



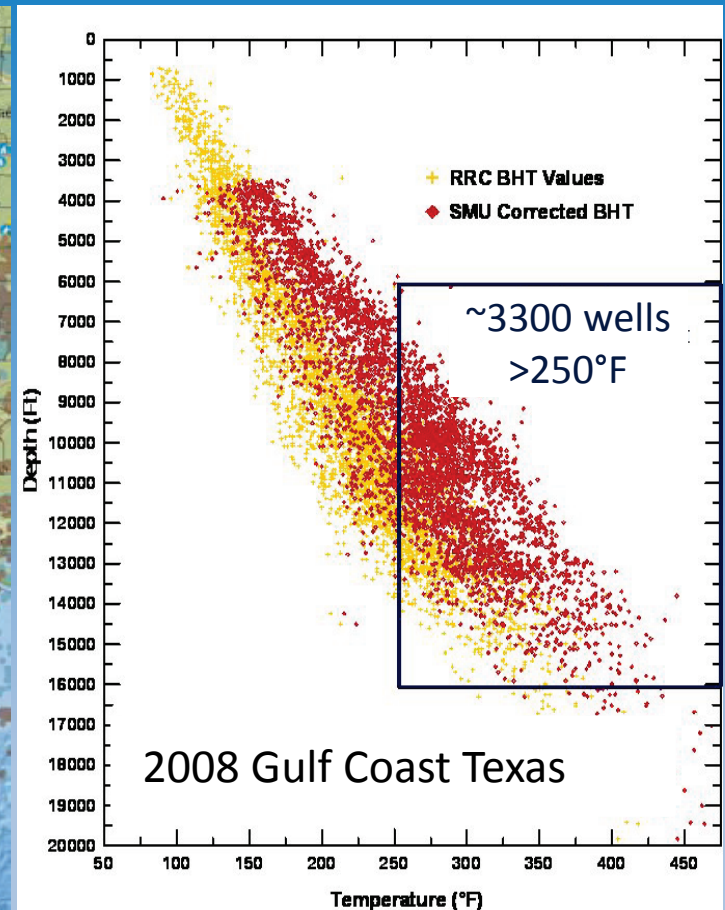
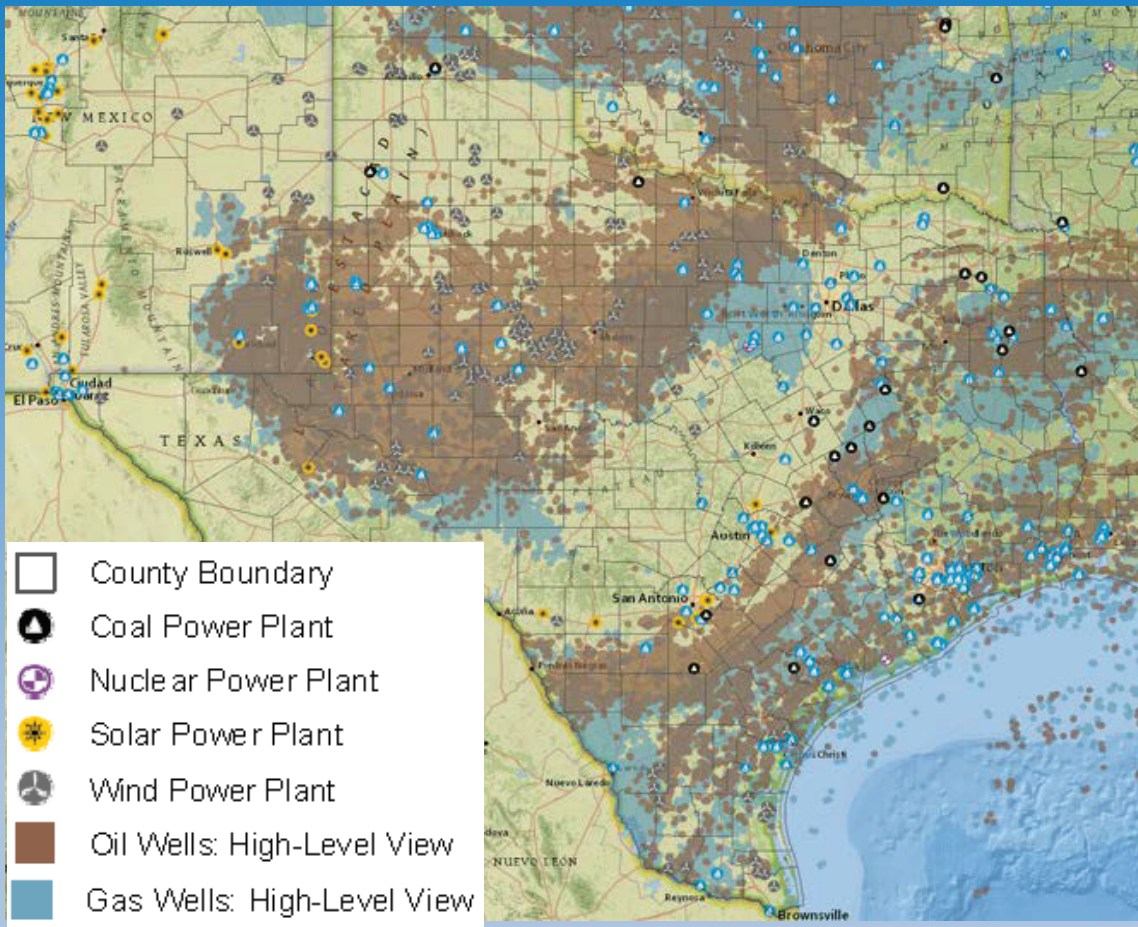
Solar, Wind, Biomass  
Salt Troughs & Membranes  
Combined Heat & Power  
Battery Storage  
Desalinization  
Flare Gas  
Coal Plant Conversion



Function of RO Membrane



# Future of Geothermal ... Coal sites?

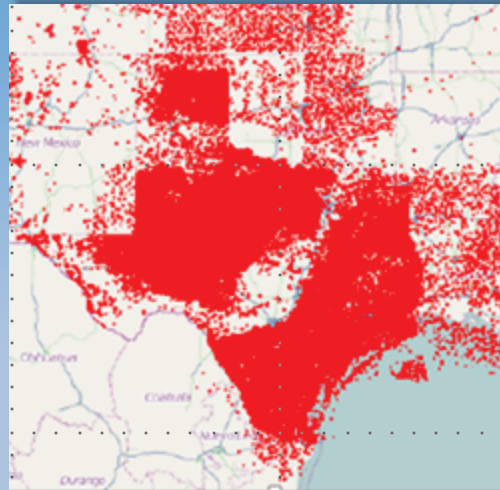


Map of power plant locations and oil and gas well sites in Texas (EIA, 2016).

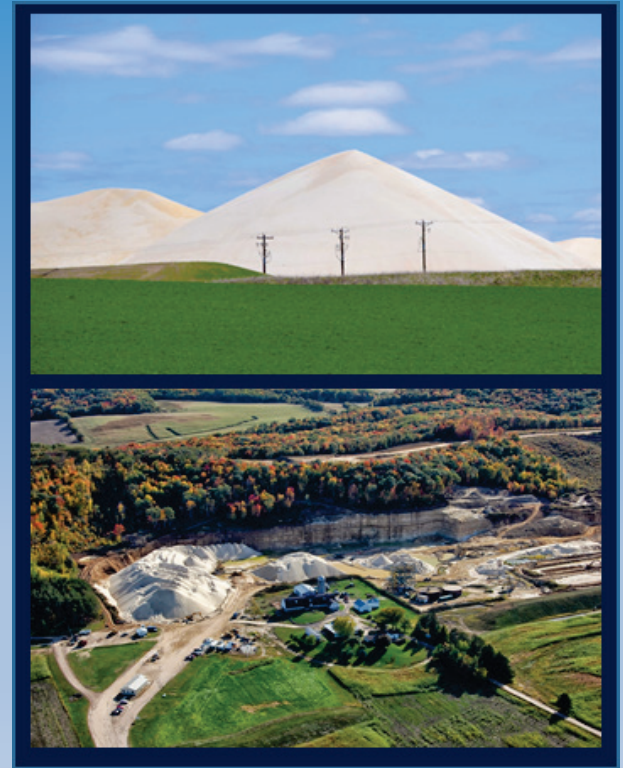
# Geothermal Energy Baseload to Distributed Texans can change the industry



1960 First Geothermal power plant @ 11 MW  
Today > 3500 MW of geothermal power in US  
Future + 1300 MW under development in US  
Texas > wind + solar combined

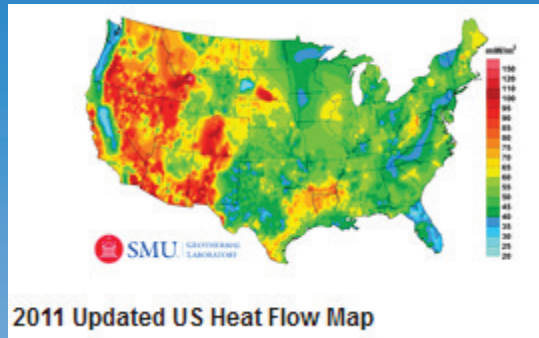


\* Photos by Ted Auch downloaded from FRACTRACKER Alliance



# SMU Geothermal Lab Resources

## Lab Research



- Heat Flow and Heat Loss
- Oil & Gas Reservoir
- Geothermal Energy
- Play Fairway Analysis
- Temperature Logging
- Thermal Conductivity

**POWER PLAYS™**

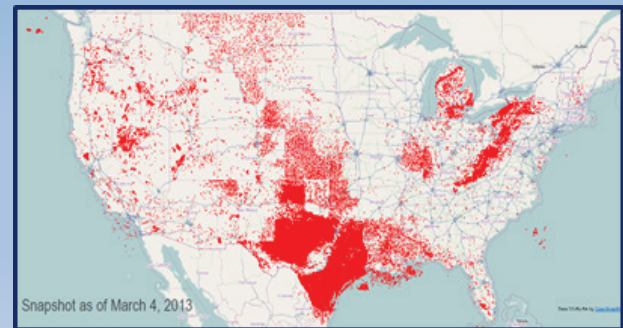
GEOHERMAL ENERGY IN OIL AND GAS FIELDS

Conference & Workshop April 25-26, 2016 SMU Campus, Dallas, TX

Past Presentations

A summary article of each conference describing the highlights for 2006, 2007, 2008, 2009, 2013 and 2015.

**National Geothermal Data System SMU Node**  
well site information <http://geothermal.smu.edu>



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# Why Consider Geothermal Energy?

1. Geothermal is **Reliable** Power
2. Geothermal heat pumps **Reduce** Power Plant Loads
3. Geothermal energy promotes **National Security**
4. Geothermal energy is **Environmentally Friendly**
5. Geothermal equipment is **Small in Footprint** size
6. Geothermal supports **Local** Economic Development and **Job Creation**
7. Geothermal is **Versatile** (heat pumps to power plants)
8. Geothermal can **Overlap** with other resources
9. Geothermal Energy is **Widely Available**
10. Geothermal products increase **U.S. Exports Market**



# Misconceptions of Geothermal Industry

## 1. I can Do it Alone

1. Team building = need expertise in all areas including large financing

## 2. High Fluid Flow rates for coproduction already exist

2. Single wells less flow than expected

## 3. Hot water is main focus of finding site

3. Surface cooling (water/air) often larger flow than hot water flow rates

## 4. Geothermal energy resource is enough for profit

4. Combine resources = surface waste heat + solar + peak load storage

## 5. Oil Companies communicate between different areas of operation

5. production  $\neq$  injection; upstream  $\neq$  downstream; field operators  $\neq$  well owners



# Misconceptions of Geothermal Industry

## 6. Easy to convert existing oil/gas wells to geothermal

6a. Casing narrow, o/g regulations, multiple owners, new perforation zones

6b. Look for wells drilled, yet not completed = complete for geothermal

## 7. Government regulations for geothermal exist already

7. Most cities, counties, states need laws for geothermal permits

## 8. Electrical energy is the way to go

8. Direct use of heat for buildings or manufacturing maybe more efficient

## 9. Demonstrations are no longer necessary

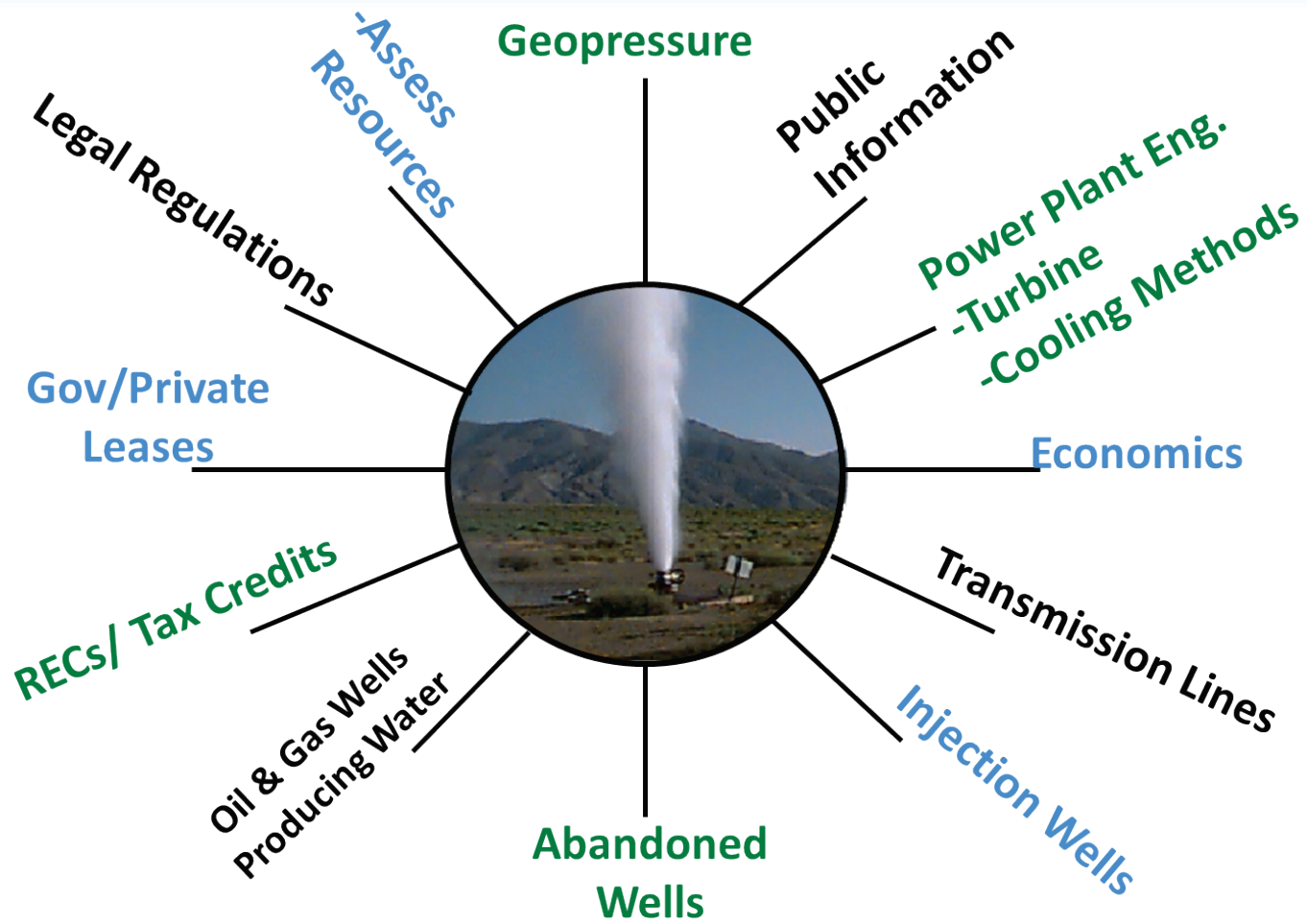
9. Demonstrations find solutions and educate workforce/researchers

## 10. Easy to sell electricity

10. Purchase Power Agreement before starting and get community support

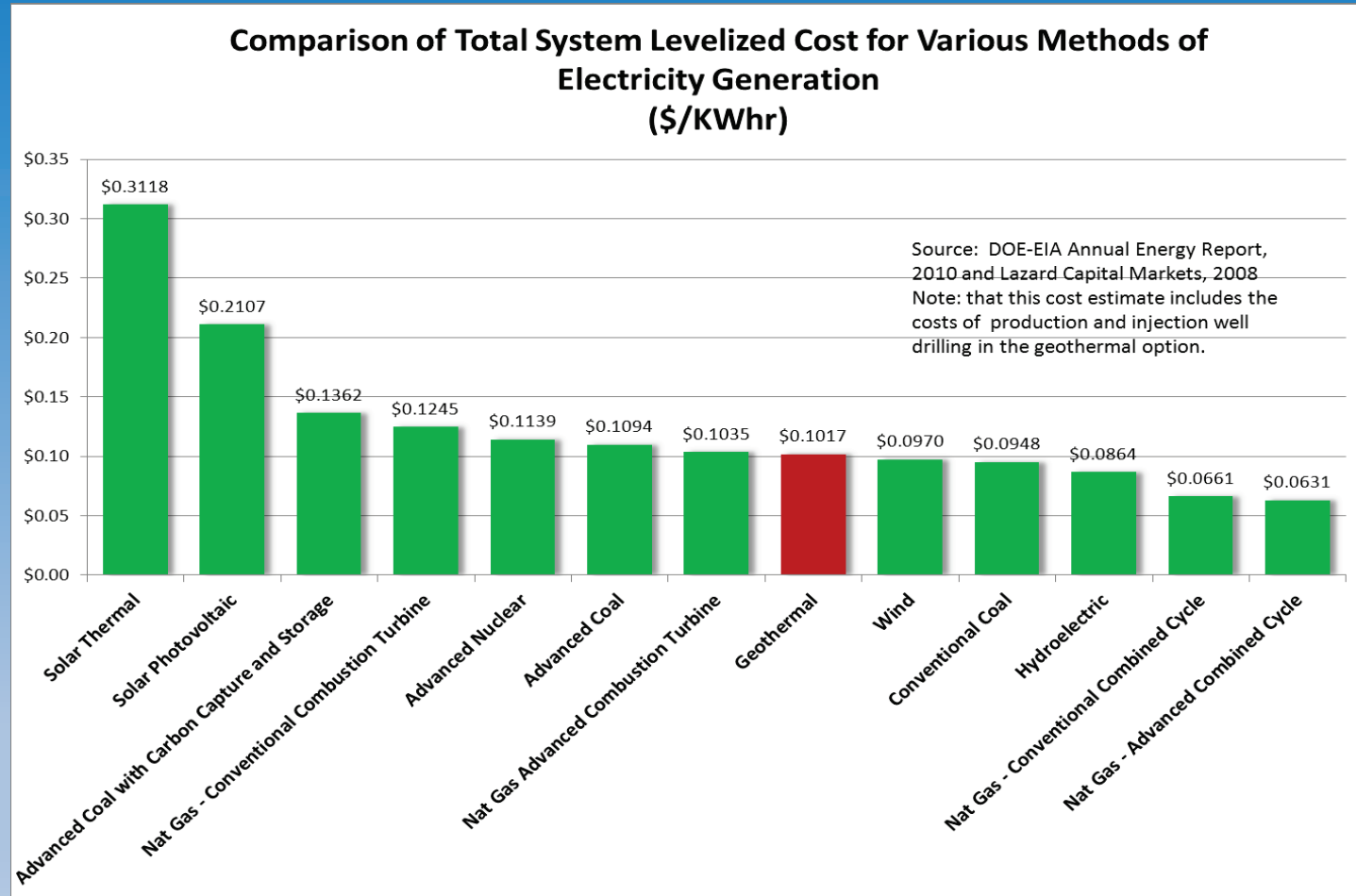


# Power Project Development Sectors



# Cost – Benefits for Systems

## EIA report using 2008 data



# Related links and resources

Presentations from the past five SMU Geothermal Conferences related to developing geothermal in oil and gas fields:  
<http://smu.edu/geothermal/Oil&Gas/Oil&GasPresentations.htm>.

Augustine, Chad and Dave Falkenstern, 2012, An Estimate of the Near-Term Electricity Generation Potential of Co-Produced Water From Active Oil and Gas Wells, GRC Transactions, <http://www.geothermal.org>.

Tester, J. W., Anderson, B., Batchelor, A., Blackwell, D., DiPippo, R., Drake, E., Garnish, J., Livesay, B., Moore, M.C., Nichols, K., Petty, S., Toksoz, N., Veatch, R., Augustine, C., Baria, R., Murphy, E., Negraru, P., Richards, M. 2006. The future of geothermal energy: Impact of enhanced geothermal systems (EGS) on the United States in the 21st century. Massachusetts Institute of Technology, DOE Contract DE-AC07-05ID14517 Final Report, 374 p.

Geothermal potential. Petroleum Review, 6 September 2011, George Lockett looks at the prospect of utilizing North Sea platforms to extract geothermal energy from the oil and gas fields on which the platforms are placed.

Property Rights and Legal Issues:  
[http://smu.edu/geothermal/Oil&Gas/2011/Wright\\_GeothermalPropertyRights\\_2011.pdf](http://smu.edu/geothermal/Oil&Gas/2011/Wright_GeothermalPropertyRights_2011.pdf)

NREL's System Advisor Model (SAM) is a performance and financial model designed to facilitate decision making for people involved in the renewable energy industry. <https://sam.nrel.gov/>

The same technology for geothermal heat extraction is used for waste heat. <http://www.heatispower.org/>

Blackwell, D.D., M. Richards, and P. Stepp, Texas Geothermal Assessment for the I-35 Corridor East, Final Report for the Texas State Energy Conservation, Contract CM709, SMU Geothermal Laboratory, 88 p., 2010.

