

Unconventional Geothermal Resources

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Texas Alliance for Energy Producers (TAEP)

Texas Renewable Energy Industries Association (TREIA)

Texas State Energy and Conservation Office (SECO)

Geothermal Energy





Keeping ice
cold with
hot water

Geothermal Energy

- ❖ 8,000 MW world wide-Hydrothermal
- ❖ Baseload, >95% load factors
- ❖ Long term contracts
- ❖ 1.9 cents PTC for 5 years
- ❖ REC
- ❖ Carbon Credits
- ❖ 500 MW set aside in Texas RPS



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



How Much is it Worth?

1 MW Power at \$0.01/kWhr = \$ 87,660/ yr

@\$0.06 = \$525,960/yr

PTC @\$0.019 = \$ 166,554/yr

REC @\$0.005 = \$ 43,830/yr

Total = \$ 736,344/yr

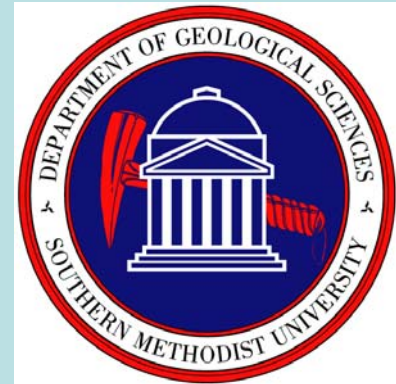
@\$0.12 = \$ 1,051,920/yr

Power Plant Cost/MW \$ 2,000,000



The Past Year

- ❖ **August 20, 2006; Chena Power Plant Inaugurated**
- ❖ **September 01, 2006; TXU announces plans for 14,000 MW of new coal and nuclear power**
- ❖ **January 18, 2007; Ormat Buys Texas geothermal leases**
- ❖ **January, 2007; *Future of Geothermal Report*, MIT released**
- ❖ **January 2007; Ormat and RMOTC sign Cooperative R&D agreement for 1st coproduced power project**
- ❖ **Continuing; EGS activity in Europe and Australia**



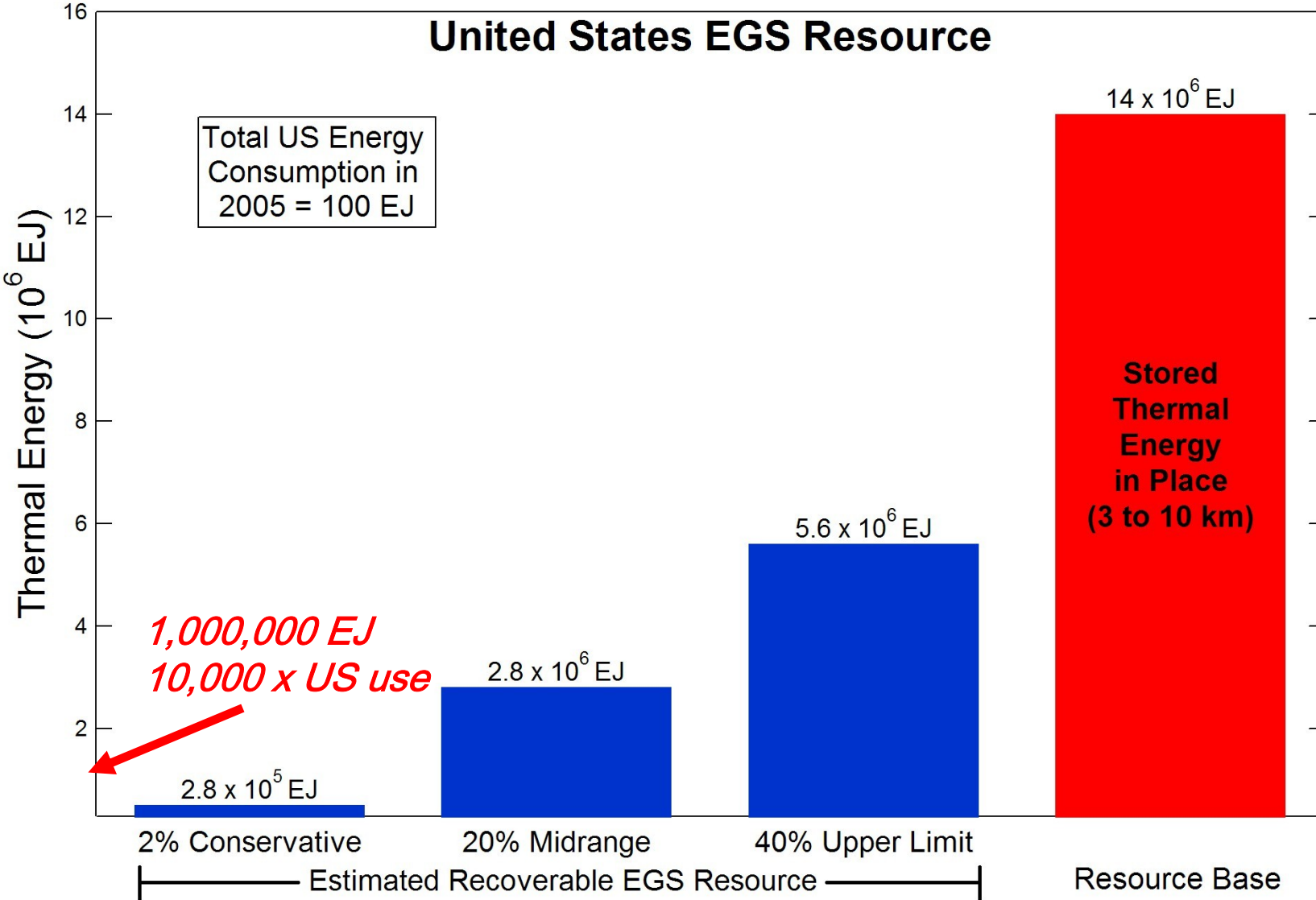
The Future of Geothermal Energy

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

 Massachusetts
Institute of
Technology



United States EGS Resource

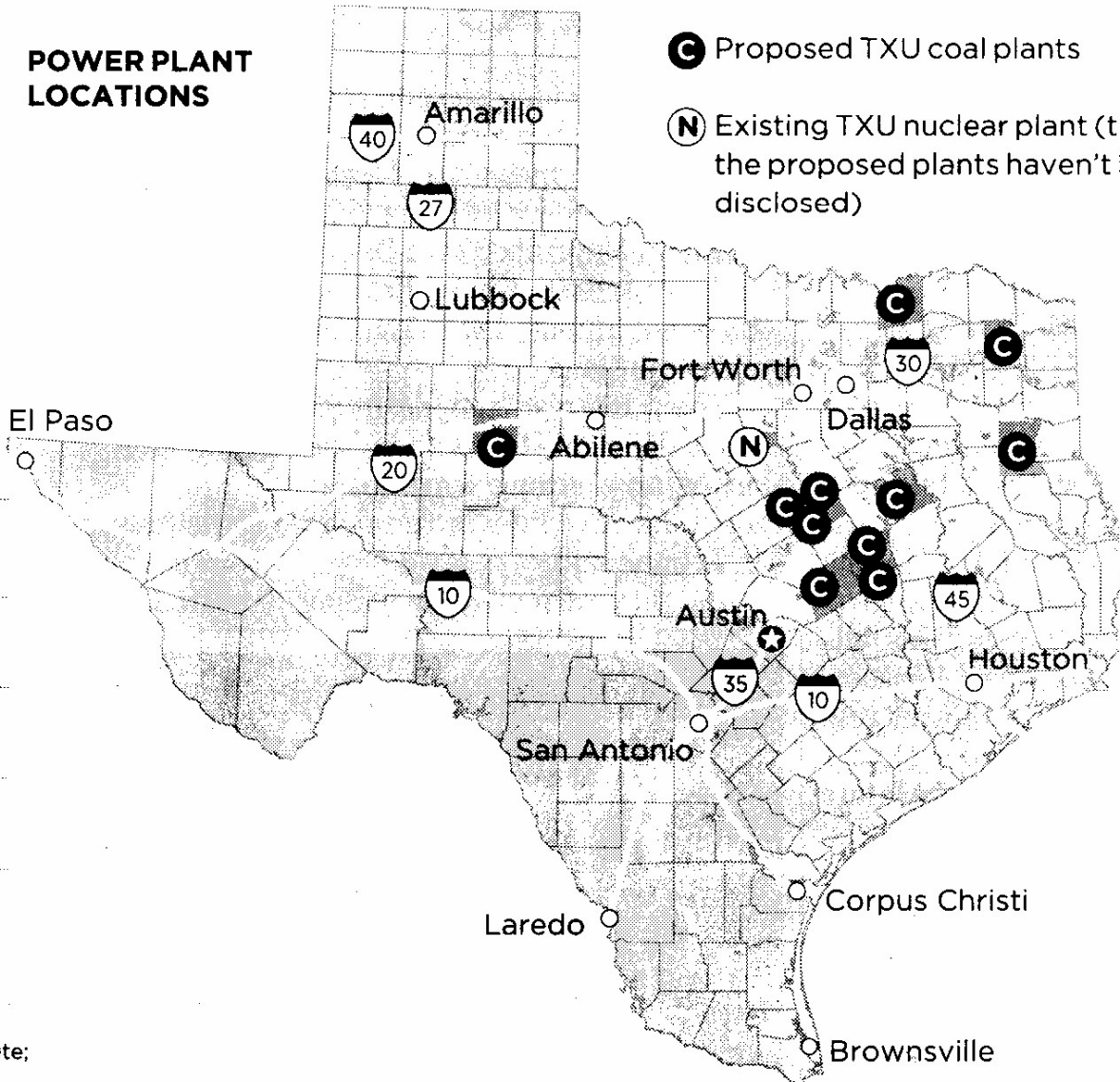


Estimated total geothermal resource base and recoverable resource given in EJ or 10^{+18} Joules.



POWER PLANT LOCATIONS

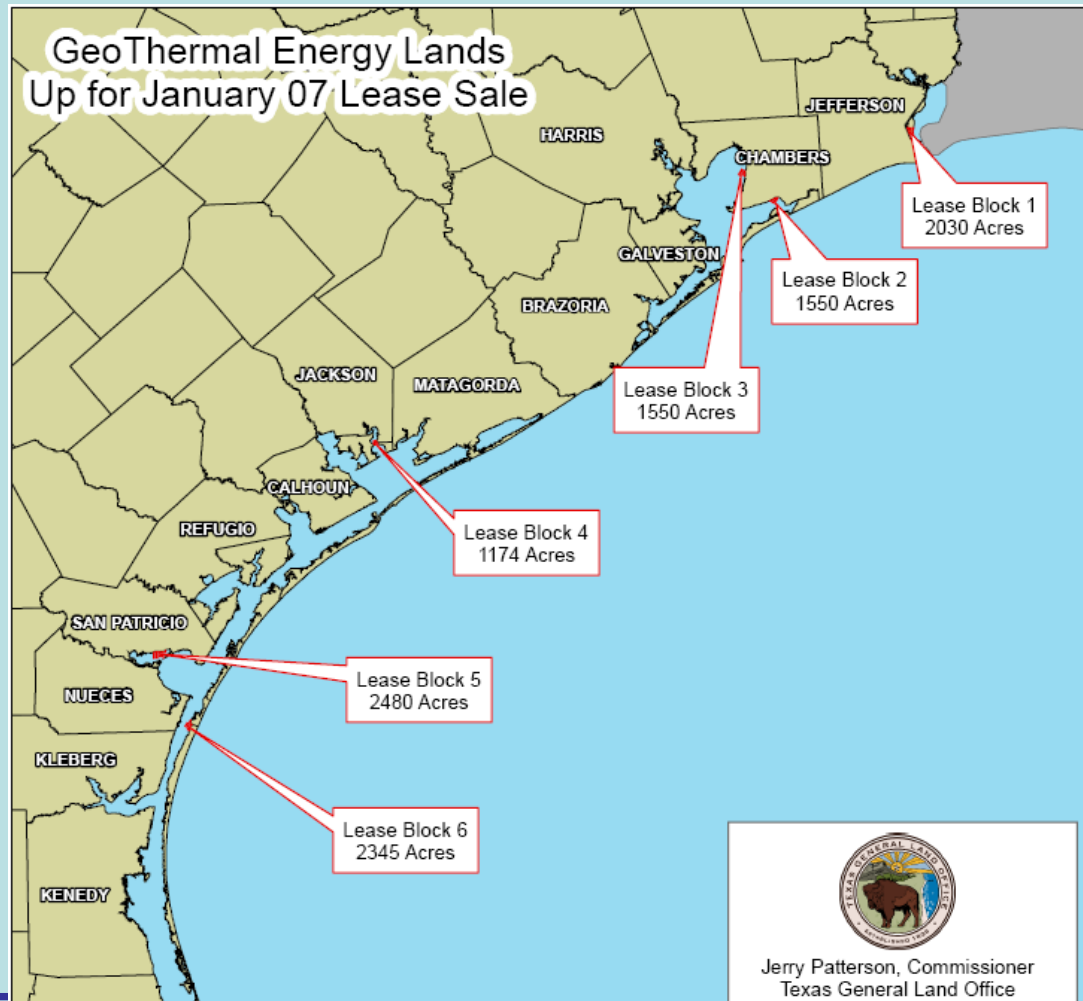
- C** Proposed TXU coal plants
- N** Existing TXU nuclear plant (the site of the proposed plants haven't been disclosed)



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Competitive Lease of Texas Lands January 18, 2007





Tea Pot Dome, Wyoming

Scenarios for Development in Sedimentary Basins

Coproduced fluids Geopressure fluids Sedimentary EGS

These are briefly described, resource base discussed, and examples of development given for each category

The resource base for these 3 types of geothermal development is briefly summarized: HUGE!



Geothermal Energy

Advantages for O&G industry

Secondary recovery, pays costs of pumping in water floods
Technology grounded in practices of hydrocarbon industry
Infrastructure exists already: roads, power lines (run pumps?), etc.
Financial strength of O&G companies
Can use *existing* reservoir or *modify* it after production ends

Advantages to Local Economy/Environment

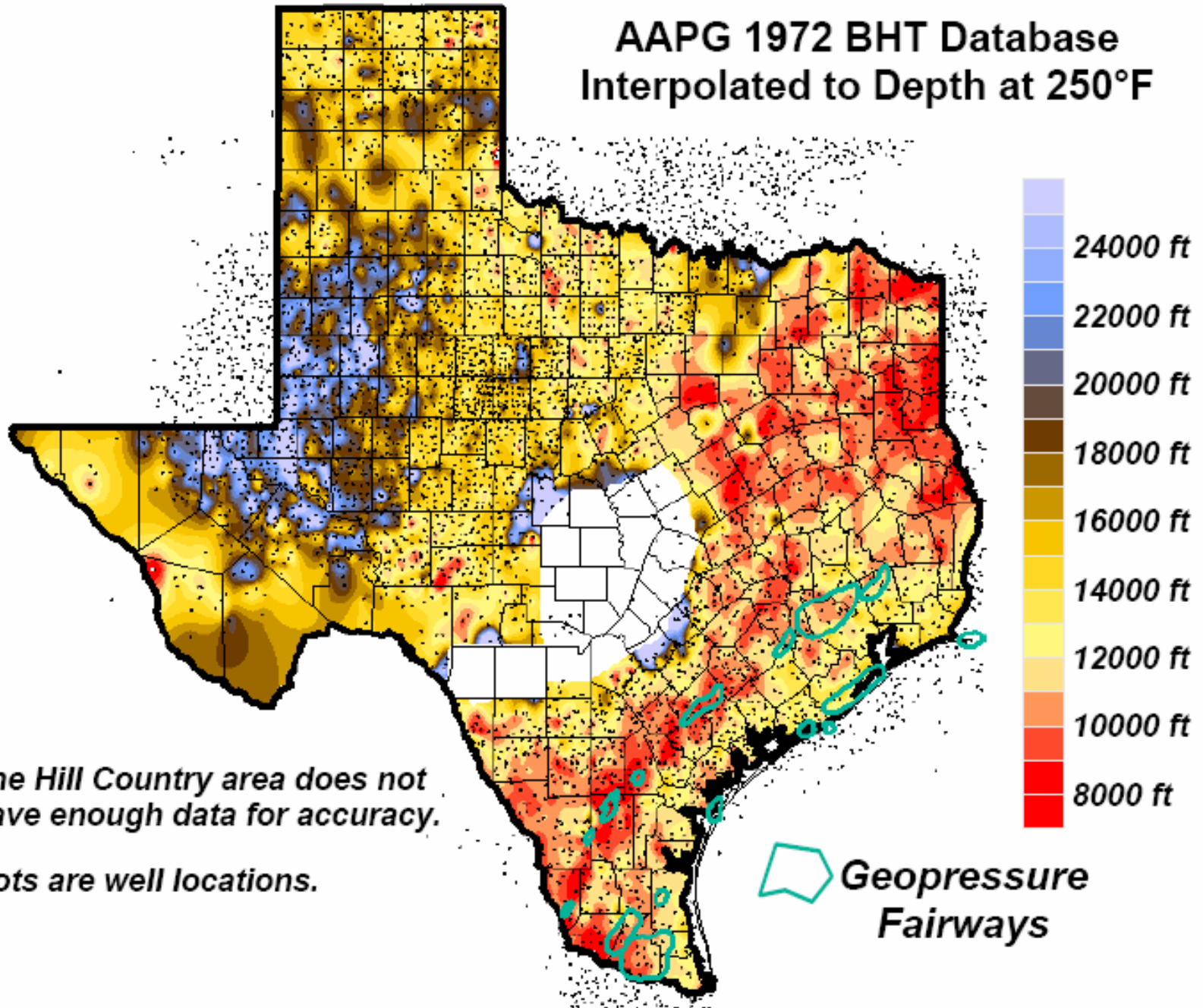
Extends life of technologies and the companies that use and develop it
Increases tax revenue and jobs for local economies that would be otherwise lost as oil and gas extraction becomes uneconomical
Allows distributed power development
Costs for O&G EGS area development are lower than for start-from-scratch
EGS (possible payouts in 3-5 years), contracts are 10+years
Can be scaled, possible to start small and enlarge system as resource/experience/technology evolves

Advantages for the Nation

Economic extraction of a higher % of in situ oil and gas, decreasing imports



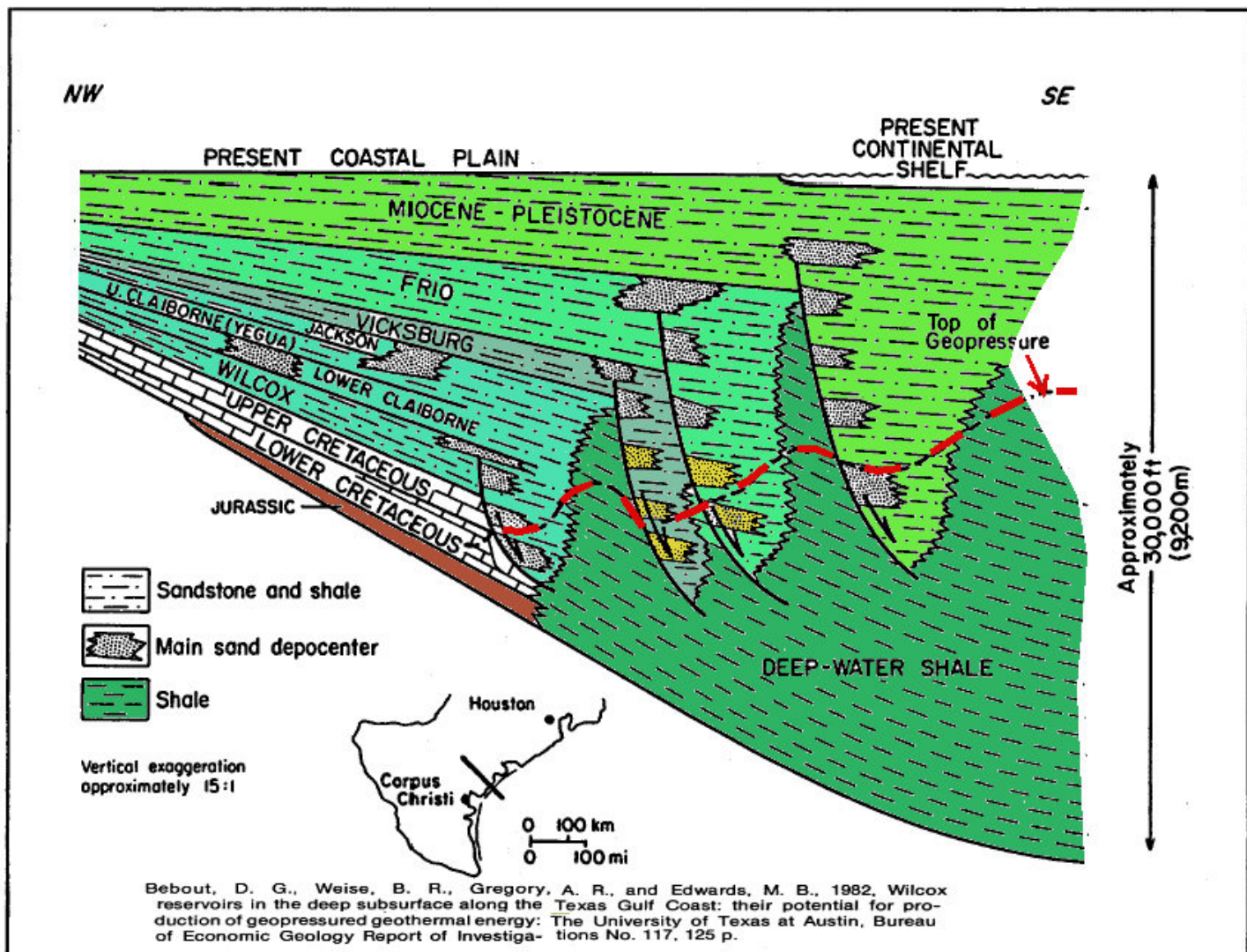
AAPG 1972 BHT Database Interpolated to Depth at 250°F



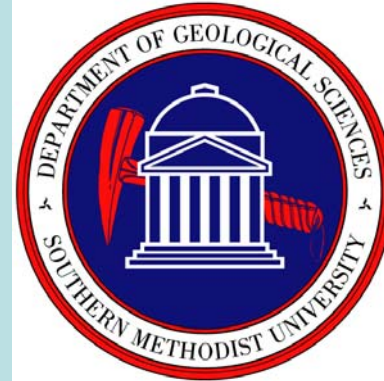
*The Hill Country area does not
have enough data for accuracy.*

Dots are well locations.

**Geopressure
Fairways**



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).



Geopressure



- Pleasant Bayou, Brazoria, Texas 1989-1990





- 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, as well as, cycled 1.4 MMstb of brine and 39.2 MMscf of natural gas through the facility [40].

- Net Power 980kW

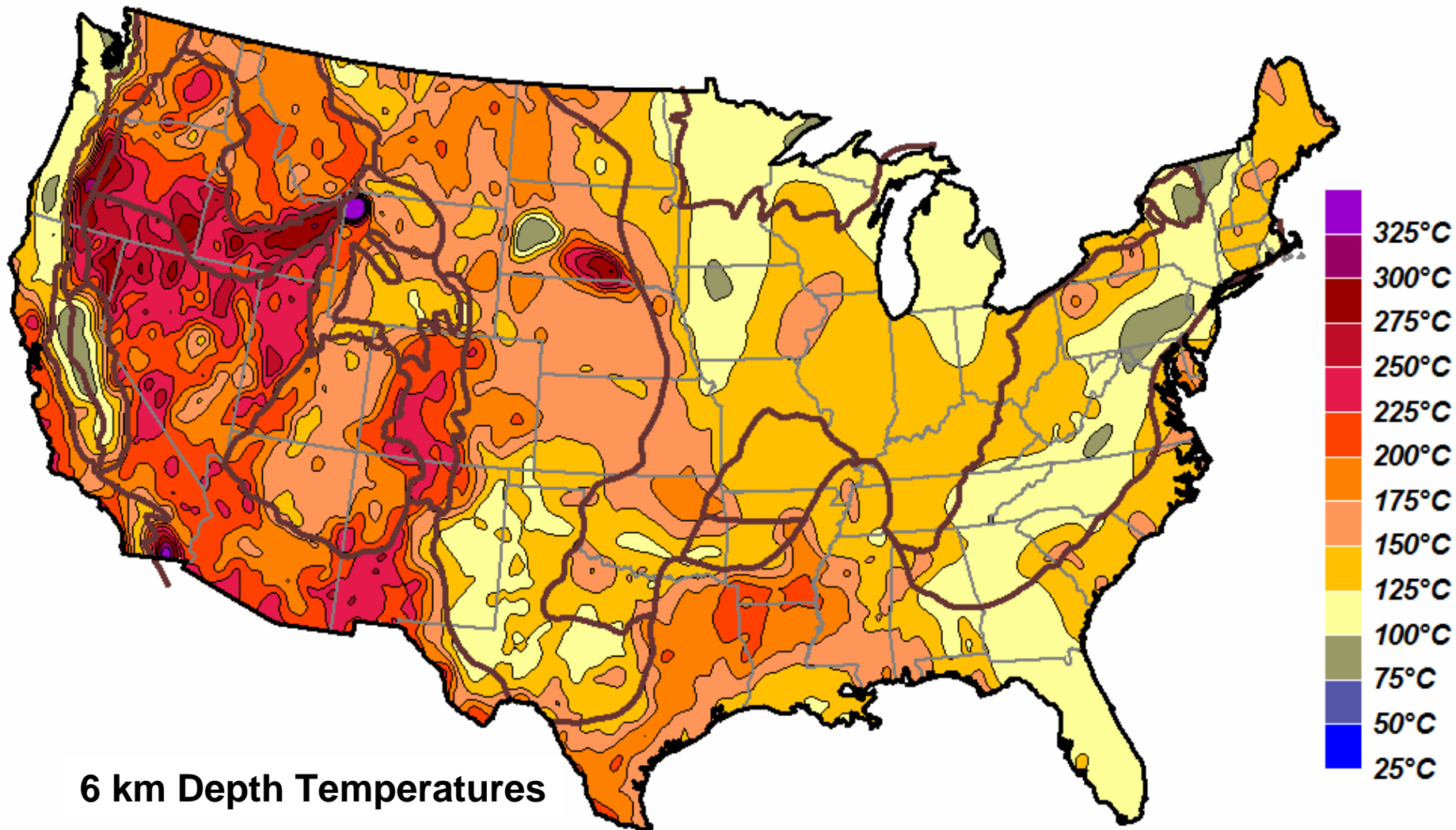
The EGS system

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.

An area that is very favorable is in east Texas and northern Louisiana where the low permeability tight formations of the Jurassic with temperatures over 350 °F are being exploited as tight gas systems.

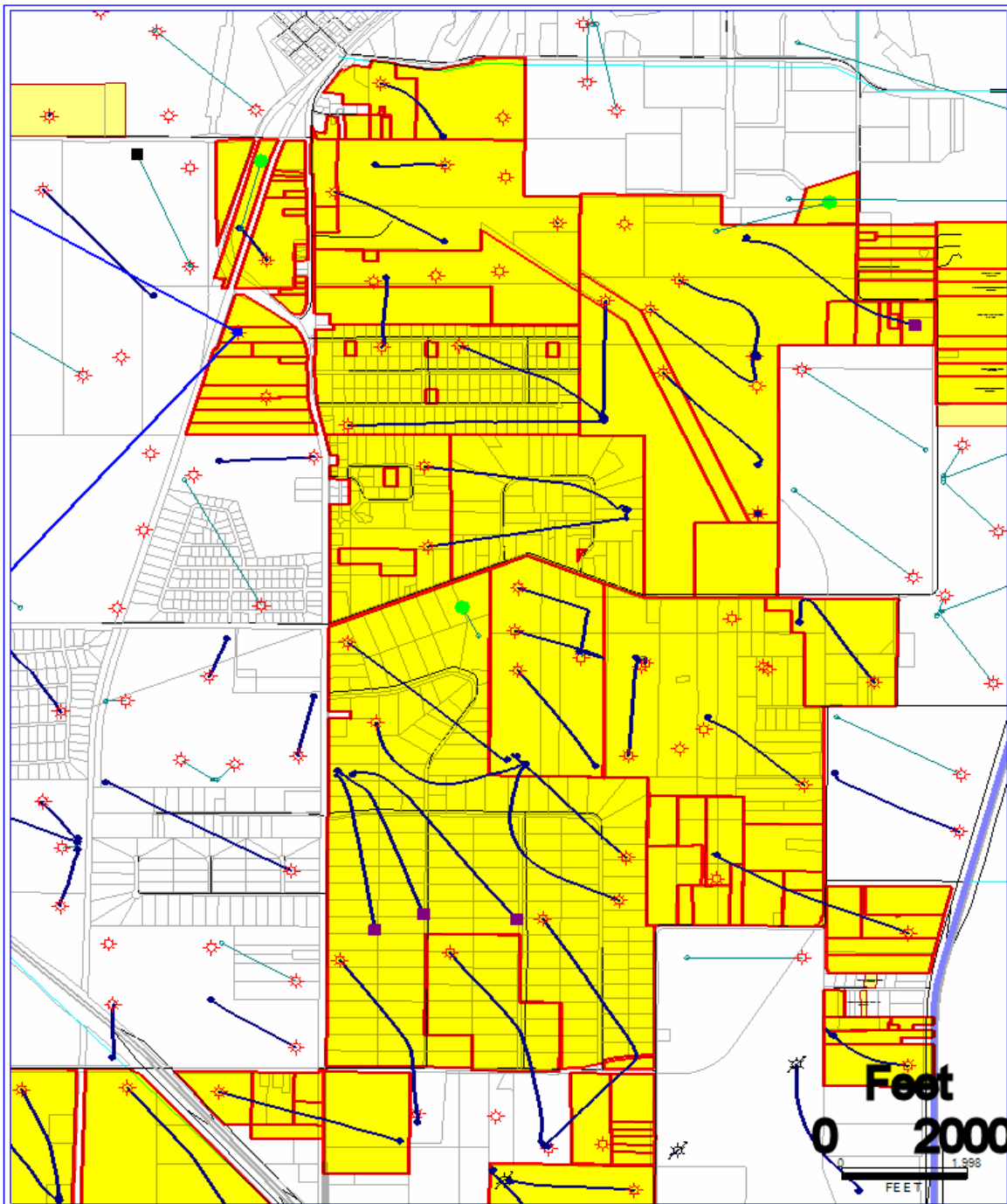
Other examples include the Cooper Basin, Australia, Gross Schoenbeck Germany





6 km Depth Temperatures





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The EGS resource base for Texas alone (at temperature above 150 °F and depths less than 22,000 ft) is 7.2×10^{14} MW-20yrs. If a recovery factor of 0.0001% is used there is still 7.2×10^8 MW for 20 years available (the present installed electrical power capacity in Texas of 0.1×10^6 MW).

The US Geological Survey has estimated the resource in the geopressured setting in Texas and Louisiana to be 1.74×10^{14} MW-20 yrs plus the dissolved gas (10^9 mcf). The geothermal number is essentially in addition to the EGS component of the resource. In the case of the geopressure there is also the potential for producing huge amounts of gas that would be otherwise uneconomical to produce.

