Steven D. Erdahl

SMU Conference March 13-14, 2013

Expansion of Geothermal: Re-Using Produced Oilfield Water

GreenTech Petroleum, LLC
Oilfield Water Solutions

PRESENTATION OUTLINE

Question: How can the energy output/cash flows from water be maximized?

Presentation: Three profiles of energy industry

- Macro Market Trends & Analysis
  - Energy Industry Global & U.S. Economic Factors
- Water Market Evolution Beyond Geothermal
  - Impact of Hydraulic Fracturing
- Growth Industry – Financial Analysis
  - Heavy Demand for Frac Water

Economic Benefits of Oil & Gas Industry – U.S. Statistics

- **Total Jobs**
  - Oil and natural gas industry supports 9.2 million American jobs
  - = 5.2% of the total employment
- **Labor Income**
  - Oil & gas labor income is estimated to be $558 billion
  - = 6.3% of the national labor income total.
- **Percentage of GDP**
  - Oil & gas total value added contribution to the national economy was over $1 trillion
  - = 7.5% of U.S. GDP in 2007.

Source: Colorado Oil & Gas Association

ENERGY INDUSTRY STATISTICS – WORLD DAILY SUPPLY

Daily Supply - World Oil Markets (2011)

	Country - Producer	**Total Oil Production**	
		MMbpd	**% of Total**
1	Saudi Arabia	11.2	12.86%
2	Russia	10.2	11.71%
3	United States	10.1	11.60%
4	China	4.3	4.94%
5	Iran	4.2	4.82%
6	Canada	3.6	4.13%
7	United Arab Emirates	3.1	3.56%
8	Mexico	3	3.44%
9	Brazil	2.7	3.10%
10	Kuwait	2.6	2.99%
	Total	87.1	

Source: U.S. Energy Information Administration

GreenTech Geothermal, LLC
Clean Energy Producer

ENERGY INDUSTRY STATISTICS – WORLD DAILY DEMAND

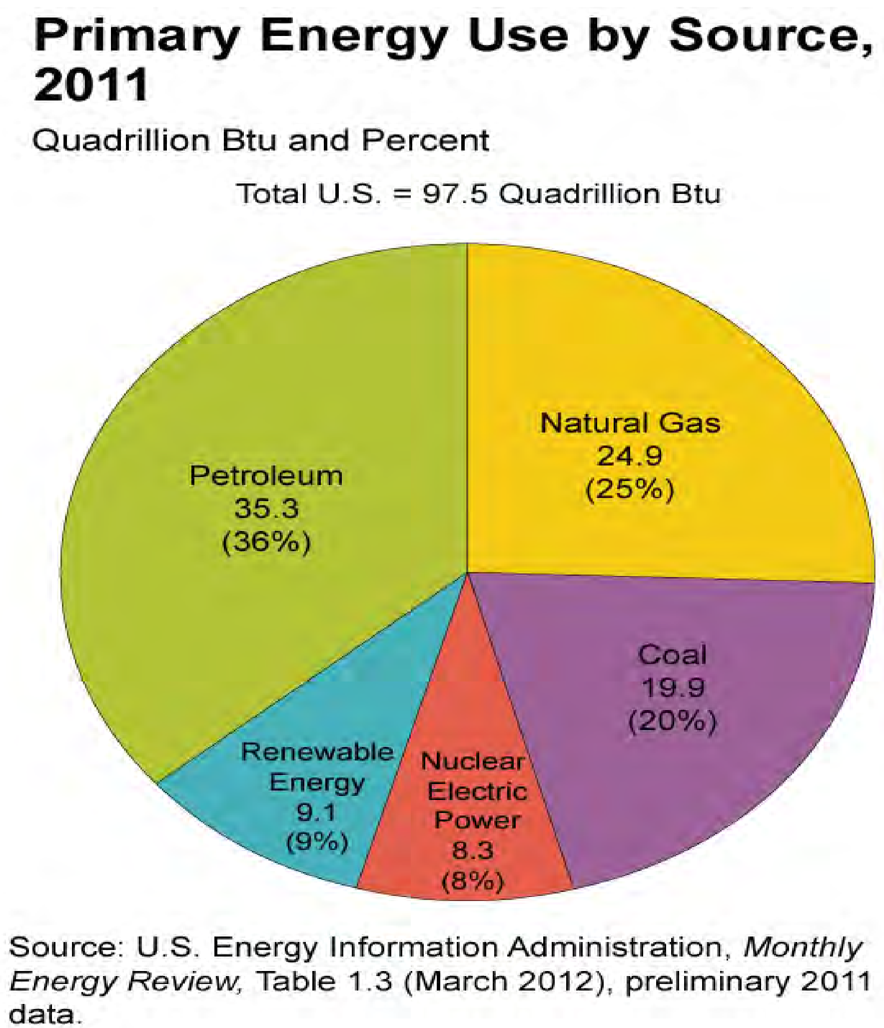
Daily Demand - World Oil Markets (2011)

		Total Oil Consumption	
	Country - Consumer	**MMbpd**	**% of Total**
1	United States	18.9	21.43%
2	China	9.8	11.11%
3	Japan	4.5	5.10%
4	India	3.4	3.85%
5	Russia	3.1	3.51%
6	Brazil	2.6	2.95%
7	Saudi Arabia	2.6	2.95%
8	Germany	2.4	2.72%
9	Canada	2.3	2.61%
10	South Korea	2.2	2.49%
	Total	88.2	

Source: U.S. Energy Information Administration

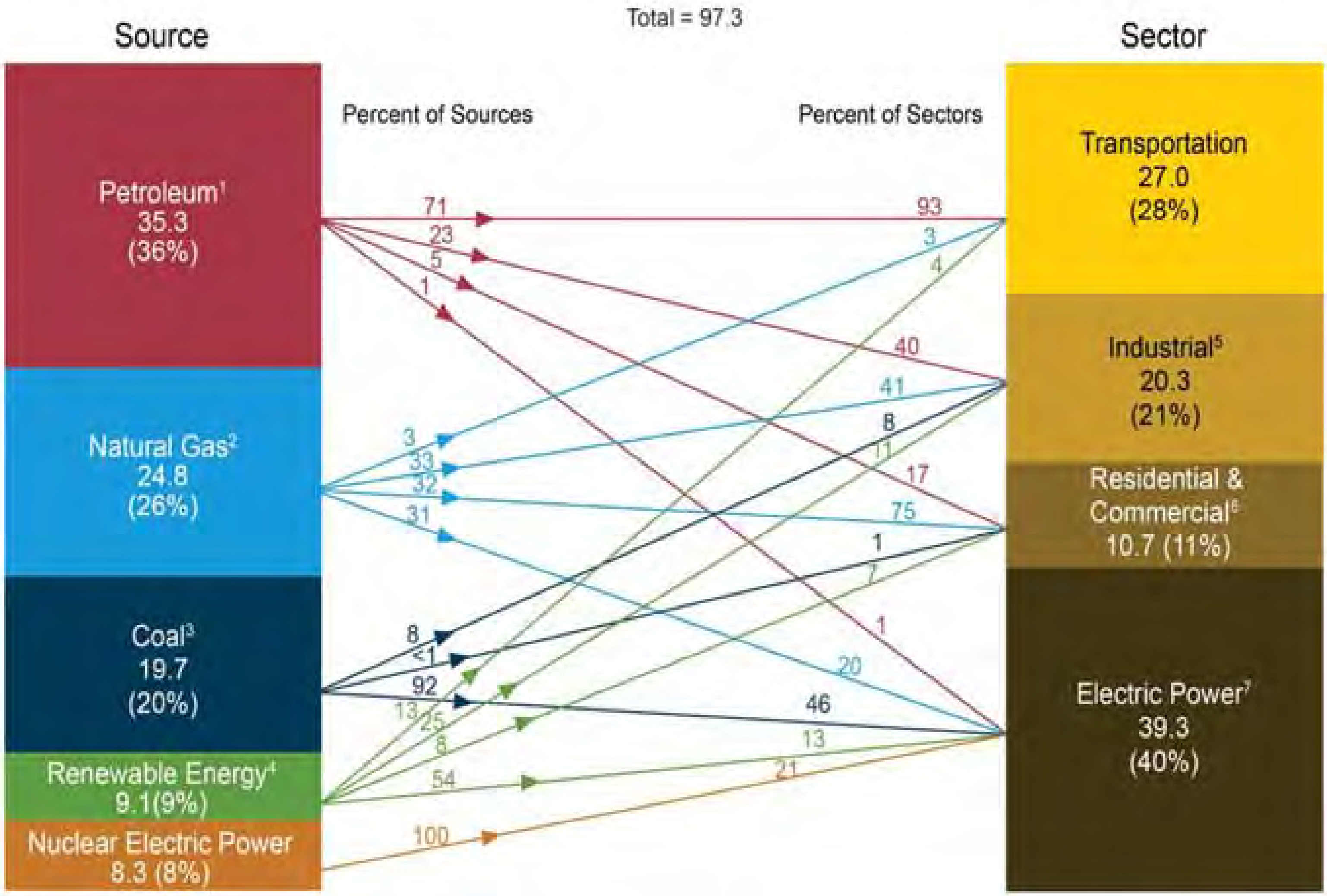
GreenTech Geothermal, LLC
Clean Energy Producer

2011 U.S. PRIMARY ENERGY USE BY SOURCE



GreenTech Geothermal, LLC
Clean Energy Producer

2011 U.S. ENERGY CONSUMPTION BY SOURCE & SECTOR



GreenTech Geothermal, LLC
Clean Energy Producer

What is Produced Oilfield Water?

- Water trapped in underground formations brought to surface during oil & gas production
- Also called “brine” and “formation water”
- Not a single commodity: physical and chemical properties vary depending on geographic location of the field, geological host formation and type of hydrocarbon being produced

What is Frac Flowback Water?

- Water-based solution that flows back to the surface during and after the completion of hydraulic fracturing
- Volume of recovery estimated 20% & 40% of the water initially injected into the well

HUGE MARKET OF PRODUCED OILFIELD WATER

In 2007, Total Volume in U.S. of Produced Oilfield Water was 21 Billion Barrels

- Equates to 57.4 million barrels per day
- Generated from one million actively producing oil & gas wells in U.S.
- Texas largest state market: 7.3B barrels from 216,000 oil & gas wells (35% of total U.S. water volume)

Other Market Factors

- Water-to-Oil Ratio (WOR) = 7.6 bl./bl. (U.S. average)
- Water-to-Gas Ration (WGR) = 260 bl./Mmcf (U.S. average)
- Over life of wells, ratios increase (because water production increases and oil production decreases)
- More than 98% of produced water is re-injected underground

Source: Study conducted by U.S. Department of Energy Laboratory managed by UChicago Argonne (dated September 2009)

STATE-BY-STATE PRODUCED OILFIELD WATER (2007)

State	Crude Oil (bbl/year)	Total Gas (Mmcf)	Produced Water (bbl/year)
Alabama	5,028,000	285,000	119,004,000
Alaska	263,595,000	3,498,000	801,336,000
Arizona	43,000	1,000	68,000
Arkansas	6,103,000	272,000	166,011,000
California	244,000,000	312,000	2,552,194,000
Colorado	2,375,000	1,288,000	383,846,000
Florida	2,078,000	2,000	50,296,000
Illinois	3,202,000	No data	136,872,000
Indiana	1,727,000	4,000	40,200,000
Kansas	36,612,000	371,000	1,244,329,000
Kentucky	3,572,000	95,000	24,607,000
Louisiana	52,495,000	1,382,000	1,149,643,000
Michigan	5,180,000	168,000	114,580,000
Mississippi	20,027,000	97,000	330,730,000
Missouri	80,000	No data	1,613,000
Montana	34,749,000	95,000	182,266,000
Nebraska	2,335,000	1,000	49,312,000
Nevada	408,000	0	6,785,000
New Mexico	59,138,000	1,526,000	665,685,000
New York	378,000	55,000	649,000
North Dakota	44,543,000	71,000	134,991,000
Ohio	5,422,000	86,000	6,940,000
Oklahoma	60,760,000	1,643,000	2,195,180,000
Pennsylvania	1,537,000	172,000	3,912,000
South Dakota	1,665,000	12,000	4,186,000
Tennessee	350,000	1,000	2,263,000
Texas	342,087,000	6,878,000	7,376,913,000
Utah	19,520,000	385,000	148,579,000
Virginia	19,000	112,000	1,562,000
West Virginia	679,000	225,000	8,337,000
Wyoming	54,052,000	2,253,000	2,355,671,000
State Total	**1,273,759,000**	**21,290,000**	**20,258,560,000**
Federal Offshore	467,180,000	2,787,000	587,353,000
Tribal Lands	9,513,000	297,000	149,261,000
Federal Total	**476,693,000**	**3,084,000**	**736,614,000**
U.S. Total	**1,750,452,000**	**24,374,000**	**20,995,174,000**

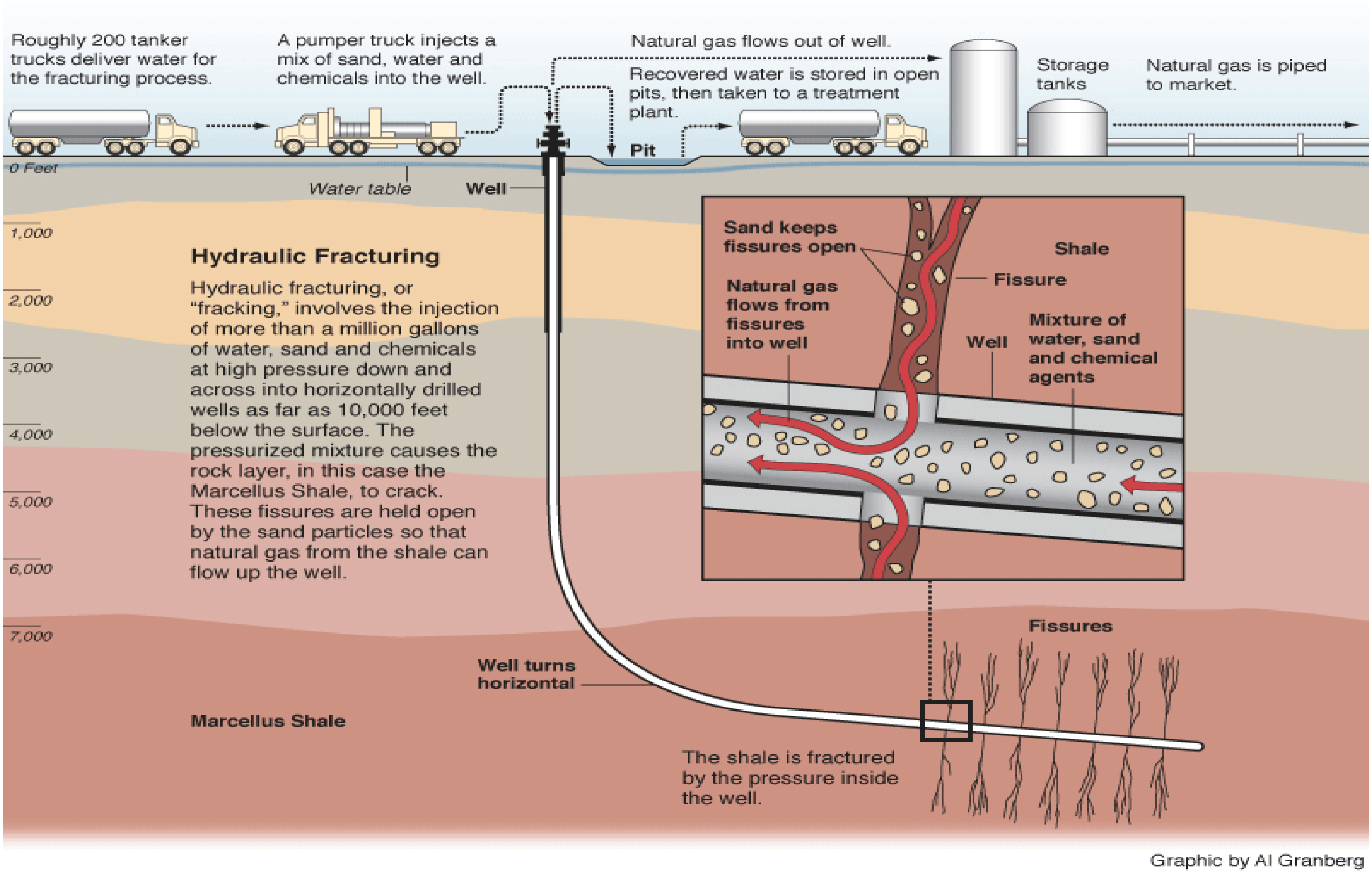
GreenTech Geothermal, LLC
Clean Energy Producer

HYDRAULIC FRACTURING REQUIRES MILLIONS GALLONS WATER

Hydraulic fracturing is a proven technological advancement, allowing natural gas and oil producers to safely recover natural gas and oil from deep shale formations

- Stimulation to unlock the oil & gas that is in the rock itself
- Been used safely for more than 60 years (since 1947) in more than a million wells.
- Involves using water pressure to create fissures, or fractures, in deep underground shale formations to allow natural gas and oil to flow.
- Newly created fissures are "propped" open by sand, allowing the gas and oil to flow into the wellbore and be collected at the surface.
- Over 90% of wells drilled today are fracked
- 99% of frac fluid mixture is water and sand, along with small amount of special-purpose additive (acid to dissolve minerals and initiate cracks in rock)
- Single-well frac-jobs require millions of gallons of water (4M to 8M), injected over multi-day period
- Trend: more frac stages (up to 40) and shorter stage lengths (250 feet)

HYDRAULIC FRACTURING SUMMARY DIAGRAM



TREATMENT & SALE OF FRAC WATER

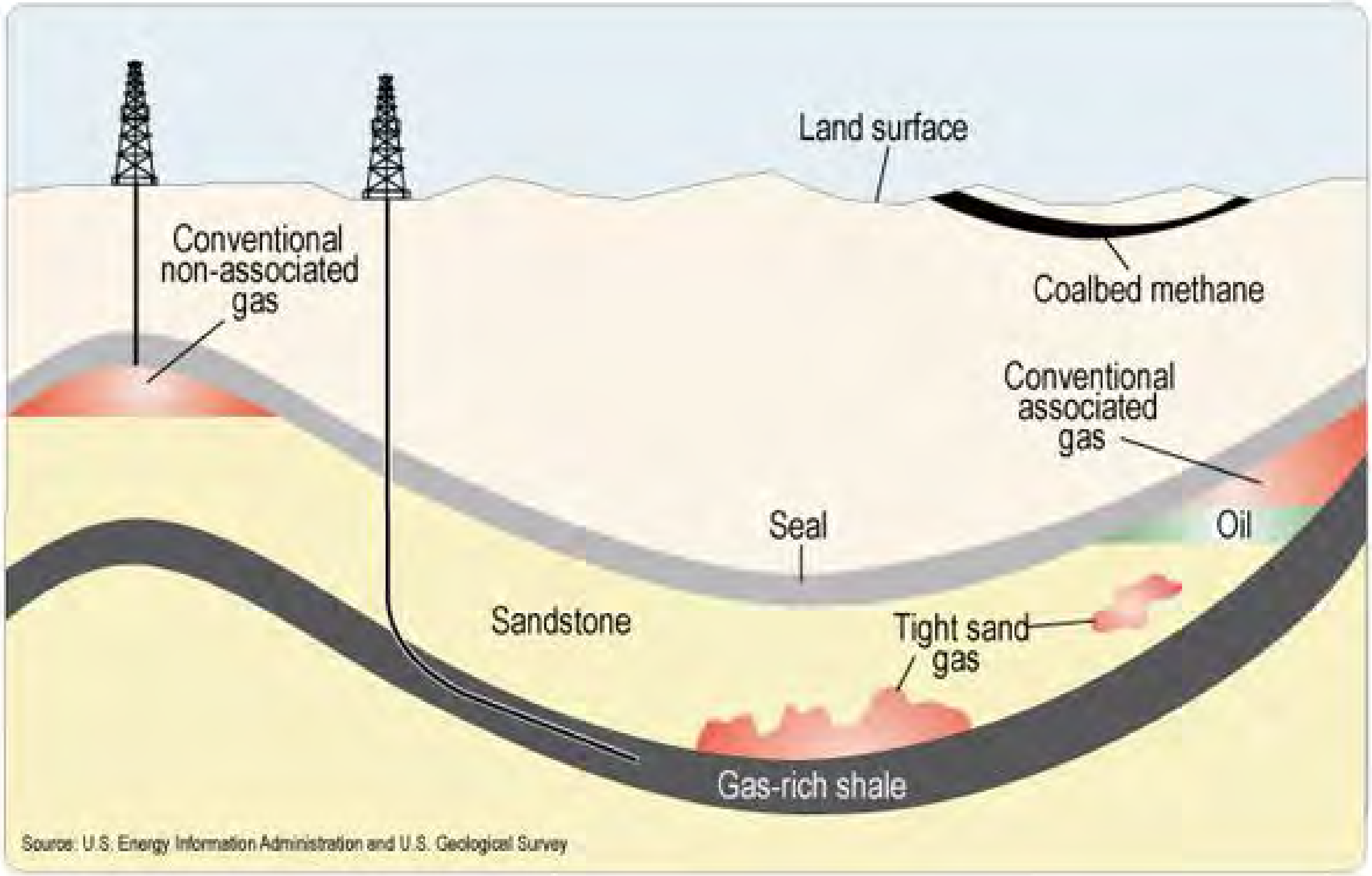
Sale of Treated Produced Oilfield Water to Companies Conducting Hydraulic Fracturing Operations

- Today's oil & gas markets include heavy demand for water used in hydraulic fracturing operations, an industry-changing phenomenon which is materially increasing our country's domestic supply of oil & gas reserves
- Consequently, Produced Oilfield Water is very valuable
- Processing and selling the water into the fracking marketplace, where oil and gas companies are paying heavy premiums for much-needed water. The market price per barrel of water, depending upon specific locations, ranges from $1.00-$2.00
- Given the huge market of Produced Oilfield Water – upwards of 1,000-5,000 barrels a day per well – material revenues can be generated from the sale of the water.

MAP OF U.S. SHALE PLAYS – WHERE FRACKING IS REQUIRED

Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

FRACKING IN SHALE FORMATIONS



ADVANTAGES OF RE-USING PRODUCED OILFIELD WATER

The Problem?

E&P companies currently face management problems in not only getting rid of their produced oilfield water but also meeting their heavy demand for suitable water for fracking operations.

The Solution?

Oil and gas companies, by off-loading their produced oilfield water to a water treatment company, gain four self-explanatory benefits:

- Reduces the E&P Company's out-of-pocket cash cost of getting rid of their brine (upwards of $3.50/Barrel)
- Avoids management problems (and time delays) in seeking permits for and costly drilling of saltwater disposal wells
- Provides a new source of water suitable for frac fluids
- Political benefits of reusing produced oilfield water

GEOTHERMAL ADVANTAGES AS RENEWABLE ENERGY SOURCE

As an alternative energy source, geothermal energy has many advantages and benefits

- **Virtually emission free**
  - Binary cycle plants are completely closed systems and produce virtually no pollution
- **Baseload Power**
  - Produces continuously deliverable base load power with a capacity factor greater than 95%. Unlike wind and solar, which are intermittent with a capacity factor of only around 20-35%, a geothermal plant can run continuously, generating base-load power, making it direct competition for coal
- **Small Environmental Footprint**
  - Because most of the development is underground, geothermal plants have small physical and environmental footprints
- **Very low maintenance**
  - With low-temperature binary plants, there are no pressurized steam loops to worry about, so they have a low manpower requirement

GEOTHERMAL LIMITS OF MARKET LOCATIONS

Geothermal energy production is largely a function of two factors: water temperatures and production volumes

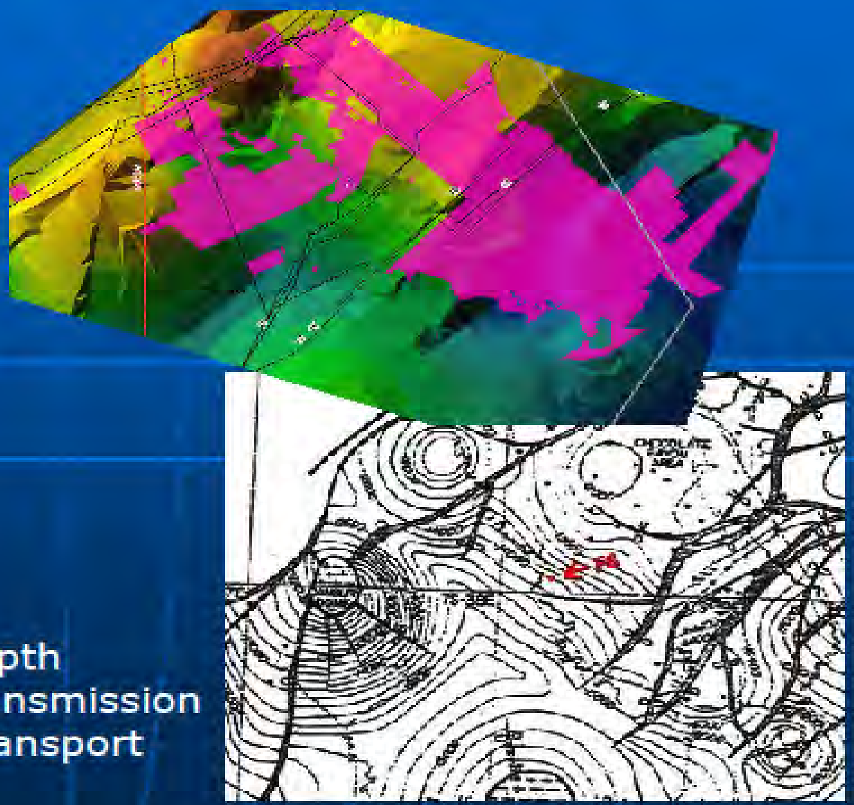
- SMU Geothermal Lab is national leader in identifying , mapping and assessing geothermal resources
- General rule: water temperatures exceeding 250 degrees Fahrenheit and production volumes of 7,500-10,000 barrels per day per well
- Texas Gulf Coast is prime area for co-production of geothermal and oil & gas
- DOE’s 17-year, $200M study in gulf coast in late 1980’s, including Pleasant Bayou #2 well in Brazoria county, successfully producing:
    - 542 KW from binary cycle plus
    - 650 KW from gas engine
    - Equaled total production of **1.19 MW power**
    - See summary on next slide

PLEASANT BAYOU #2 WELL – DOE'S PILOT OPERATION

Brazoria Prospect

Pleasant Bayou #2

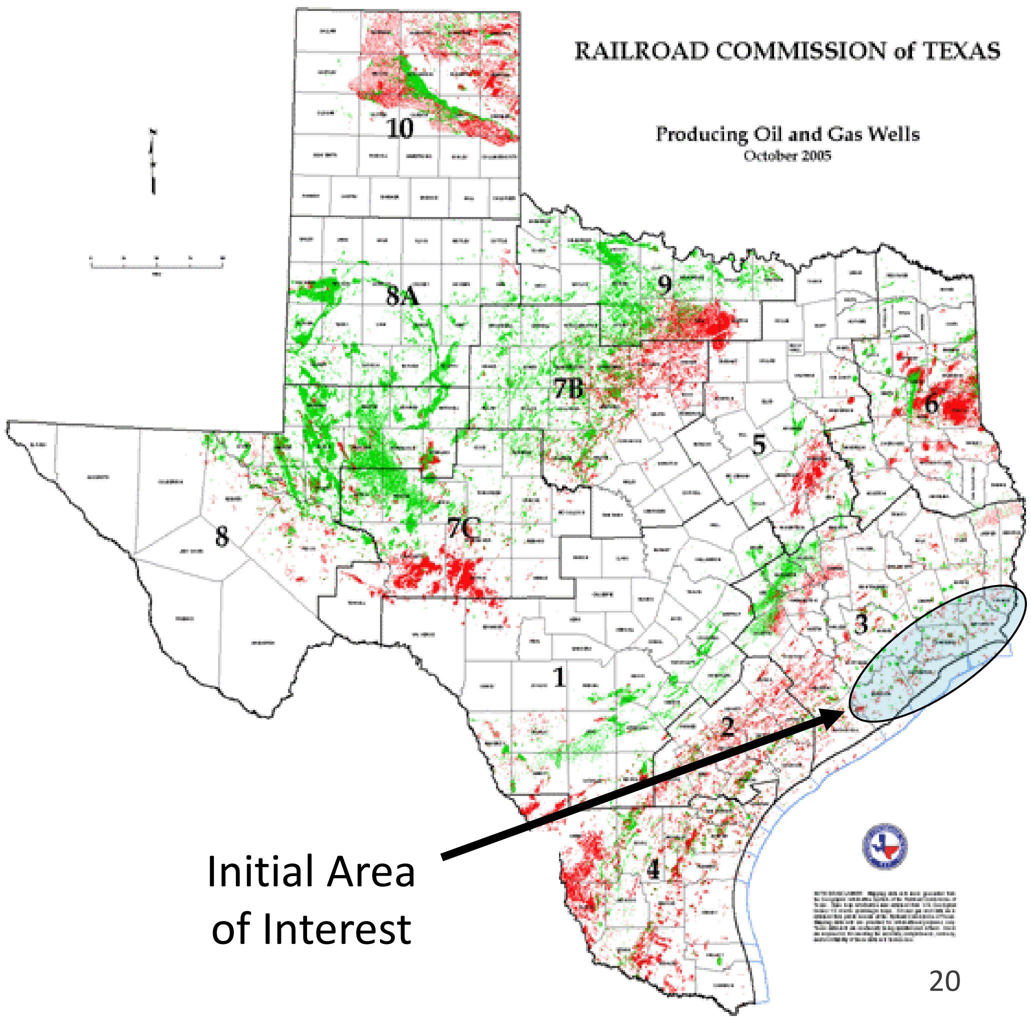
- Produced 1988-1992
- 16,465 ft
- 9800 psi
- 302° F (BH)
- 272° F (WH)
- Salinity: 127,000 ppm TDS
- Gas/Brine Ratio: 24 scf/stb
- Max Flow Rate: 25,000 BPD
- Methane: 85 (mol%)
- CO2: 10 (mol%)
- Other Gases: 5 (mol%)
- Porosity: 19%
- Permeability: 200 mD
- Plugged at various depths
- Numerous wells in area at depth
- Close proximity to electric transmission
- Close proximity to pipeline transport



SCREENING CRITERIA FOR TARGET PROPERTIES

Producing targets screening criteria:

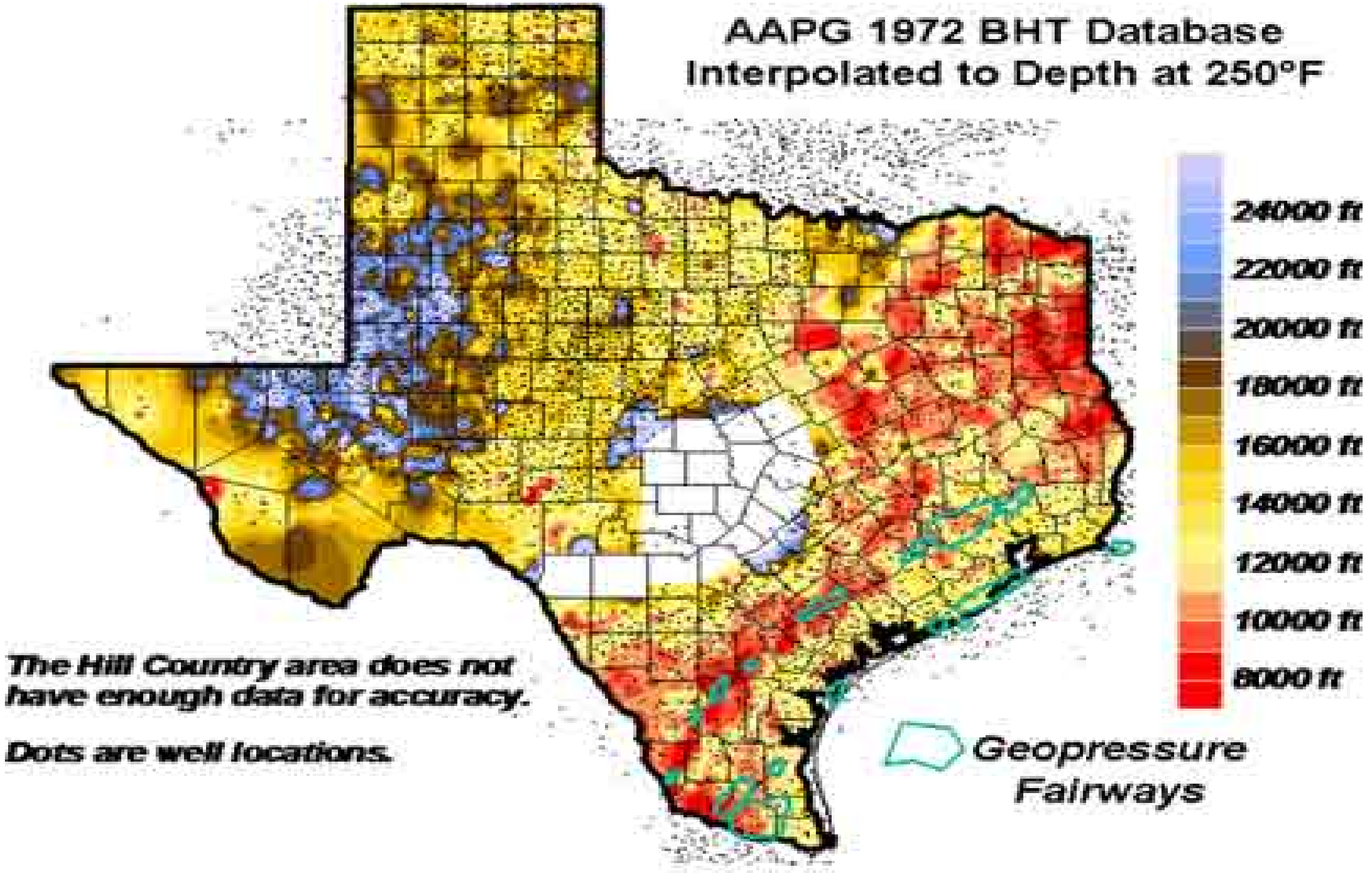
- Production below 11,000 feet
- Recently drilled wells
- Motivated seller
- Known hot water aquifers
- Good quality reservoirs
- Close to electricity grid
- Close to oil & gas infrastructure
- Ability to increase scale
- Land access
- High equity & operatorship



GreenTech Geothermal, LLC
Clean Energy Producer

GEOTHERMAL RESOURCES IN TEXAS GULF COAST
SOURCE: STATE ENERGY CONSERVATION OFFICE (SECO)

DEPTH TO REACH 250 DEGREES FAHRENHEIT



GreenTech Geothermal, LLC
Clean Energy Producer

Water is becoming ever more valuable in the oil & gas industry, marked by explosive demand from horizontal drilling and hydraulic fracturing to increase oil & gas production

- Fracking in shale fields, a process requiring millions of gallons of water per well, per frack-job, is revolutionizing the landscape of the American domestic energy sector.
- Used in over one million wells in the United States for more than 60 years, fracking has been successfully used to retrieve more than 7 billion barrels of oil and over 600 trillion cubic feet of natural gas.
- In 2010 alone, the consumer surplus from shale gas production was worth over $100 billion, in addition to creating a remarkable energy boom and hundreds of thousands of jobs in the U.S.

MONTHLY REVENUES – FRAC WATER SALES

Summary Financial Model: Monthly Gross Revenues from Treatment & Sale of Frack Water
(Does NOT Deduct Costs or Expenses)

Financial Inputs:

Daily production of Water (Barrels)		**10,000**
Injection Percentage		**40.0%**
Water Sale Percentage		60.0%
Production Days in Month		**25**
Barrels Treated per month		250,000
Oil-Cut Percentage (% per Barrel of Water)		**1.0%**
Price of Oil (per barrel)		**$85**
Revenue per barrel of Brine Off-Taken		**$0.25**
Sale Price per barrel of Treated Frack Water		**$1.50**

Monthly Gross Revenues:

Inbound Brine Revenue	(Total Barrels X off-take price)	$75,000
Oil-Cut Sales	(Barrels treated X oil-cut % X oil price)	$212,500
Treated Frac Water Sales	(Barrels treated X sales % X frac price)	$225,000
Total Monthly Gross Revenues		**$512,500**

(NOTE: Blue inputs are sensitive)

GreenTech Geothermal, LLC
Clean Energy Producer

MONTHLY REVENUES – GEOTHERMAL ENERGY

Summary Financial Model: Monthly Gross Revenues from Geothermal Energy
(Does NOT Deduct Costs or Expenses)

Financial Inputs:

Daily production of Water (Barrels)		**25,000**
Production Days in Month		**28**
Production Hours in Month		672
Power Generated (in MWh)	(Based on Pleasant Bayou #2)	**1.25**
Power Sale Price (per MWh)		**$50**

Monthly Gross Revenues:

Geothermal Energy Sales	(Production Hours x MWh x price)	$42,000
Total Monthly Gross Revenues		**$42,000**

(NOTE: Blue inputs are sensitive)

GreenTech Geothermal, LLC
Clean Energy Producer

COST STRUCTURES – FRAC WATER & GEOTHERMAL

Main Categories of Costs

- **Frac Water Operation**
  - Saltwater Disposal Well Permitting, Drilling, Tanks & Land ($3.5M)
  - Trucking/Transportation of Water (depends on proximity and location)
  - Water treatment costs (per barrel)
  - Injection costs per barrel (for non-treatable brine)
- **Geothermal Energy Operation**
  - Project Cost per Installed MW ($3M)
  - Royalty costs (2%-5%)

Financial Metrics

- **Sales of Dry Natural Gas & Oil Production** – Natural gas & oil production sales from existing reserves & production from acquired fields and wells.
- **Geothermal Gas** – Each barrel of water produced contains roughly 20-40 scf of natural gas, from which electricity will be generated.
- **Geothermal Energy** – Base-load Electricity generated from hot water produced in wells (upwards of 2 MWs per well).
- **Sales of Frac Water** – Single-well hydraulic fracturing jobs in Eagle Ford field require about 10 million gallons of water, creating heavy demand, amounting to market prices of $1.00-$2.00 per barrel of frac water. Each well can produce material barrels of water per day.
- **Off-Take Inbound Brine Revenues** – E&P Operators pay to get rid of their unwanted brine
- **Oil-Cut Revenues** – Separation & sale of oil-cut from Brine
- **Federal Production Tax Credits** - $22 per MWh of power generated.
- **Exemption from 7.5% Texas Severance Tax** – For gas incidentally produced in association with geothermal.
- **Reduction of Operating Costs** - Reduce its operating costs by utilizing existing oil and gas wells and infrastructure. Rather than drilling new wells, re-enter existing wells via less expensive workover rigs (rather than more expensive full drilling rigs).
- **Higher IRRs** - Higher revenues and lower costs support higher IRRs.

PART IV APPENDIX – SELECTED ENERGY INDUSTRY METRICS

The following slides focus on selected metrics analyzed in oil & gas industry

- Definition of “Minerals”
- Definition of “Geothermal Energy”
- Industry definition of “Reserves”
- Government/SEC definition of “Reserves”
- Petroleum Engineering Reserve Reports
- SEC Valuation Formula of Reserves
- Oil & Gas Industry Valuation Model
- U.S. GAAP Accounting of F&D Costs

TEXAS LEGAL DEFINITION OF "MINERALS"

Texas Geothermal Resources Act of 1975 Section 141.002

Sec. 141.002. DECLARATION OF POLICY. It is declared to be the policy of the State of Texas that:

(4) since geopressured geothermal resources in Texas are an energy resource system, and since an integrated development of components of the resources, including recovery of the energy of the geopressured water without waste, is required for best conservation of these natural resources of the state, all of the resource system components, as defined in this chapter, shall be treated and produced as mineral resources;

[This indicates that geothermal rights are considered part of the mineral estate.]

TEXAS LEGAL DEFINITION OF "GEOTHERMAL ENERGY"

Texas Geothermal Resources Act of 1975 Section 141.003

(4) "Geothermal energy and associated resources" means:

(A) products of geothermal processes, embracing indigenous steam, hot water and hot brines, and geopressured water;

(B) steam and other gasses, hot water and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations;

(C) heat or other associated energy found in geothermal formations; and

(D) any by-product derived from them.

(5) "By-product" means any other element found in a geothermal formation which is brought to the surface, whether or not it is used in geothermal heat or pressure inducing energy generation (emphasis added).

[This indicates that methane entrained in geothermal fluids is considered part of the geothermal resource which includes by-products, (Sherk, 1982).]

INDUSTRY DEFINITION OF "RESERVES"

Since cash-flow source is subject to depletion, analysis must include review of applicable Reserves

- Example: Typical Gulf Coast Gas depletion curves: 50% year 1; 30% year 2; 30% year 3. Oil depletion generally not as rapid.
- **Proven** (P1 – Is asset under GAAP if 90% certainty under present technical and economic conditions)
    - **PDPs** (Proven Developed Producing)
    - **PDNPs** (Proven Developed Non-Producing)
    - **PUDs** (Proven Undeveloped)
- **Probable** (P2 – 50%-89% probability – cannot be counted as asset under GAAP)
- **Possible** (P3 – 10%-49% probability – cannot be counted as asset under GAAP)

GreenTech Geothermal, LLC
Clean Energy Producer

GOVERNMENT SEC DEFINITION OF "RESERVES"

To prevent over-booking of Proven Reserves, SEC regulates disclosures. New rules effective January 1, 2010.

- **Pricing**:
  - Old Rules: Year-end price
  - New Rules: First day of month for each of last 12 months, simple mathematic average
- **Definition of Proved**:
  - Old Rules: Direct contact with a reservoir via flowing well test
  - New Rules: May use new technology if such technology has been demonstrated empirically to result in reliable conclusions
- **Full-Cost Ceiling Test:**
  - Old Rules: Compare ceiling to carrying value using year-end price, or subsequent price if needed to avoid impairment
  - New Rules: Compare ceiling to carrying value using 12-month historic average price. No revision for subsequent improvement in pricing (Still can use subsequently proved up reserves, however)
- **Disclosure of probable and possible reserves**
  - Old Rules: Prohibited
  - New Rules: Permitted, but not required
- **5-year presumption of PUDs:**
  - New Rules: Must explain why material PUDs older than 5 years remain classified as proved reserves. NOTE: Plan must be to drill within 5 years unless "specific circumstances" justify a longer time.
  - Erdahl Commentary: This rule may create uncertainty? What happens after 5 years? Are they converted to Probables? Will this reporting rule cause companies to change their underlying operational strategies? Accounting and SEC rules should simply report the operations, not be a driver of such operations?

PETROLEUM ENGINEERING RESERVE REPORTS

Petroleum Engineering Reserve Reports (often referred to as "Summary of Reserves & Revenue") provide :

- Production quantities and volumes from wells
    - Considers depletion curves
    - Considers technical & engineering analyses of properties
    - Considers Reserve-Production Ratios (Proved Reserve Additions ÷ BOE Produced)
- Reserves; and
- Estimates of pre-tax net cash flows, considering revenues less production taxes, OPEX and CAPEX.

Planning Note: Such Reports do not, however, typically provide a valuation analysis.

SEC VALUATION FORMULA OF RESERVES

SEC PV-10 Value of Reserves

• Present value of pre-tax estimated future revenues generated from Proved Reserves, net of estimated lease operating expenses, using prices without escalation, discounted at 10%.

• Is a non-GAAP measure.

Gross vs. Net Acres/Wells:

• Net refers to fractional working interest

Common Industry measures:

• 3-year F&D Costs (e.g., $3.47/mcfe)

• TTM Opex & GA Costs (e.g., $2.21/mcfe)

OIL & GAS INDUSTRY VALUATION MODEL

Two Main Valuation Approaches

- **Income Method**
  - Discounted cash flows
  - Engineering Reserve Report is a form of the Income Method
- **Market Method** – Key Pricing Guideline Company Metrics
  - Enterprise Value (market cap + debt – cash) ÷ BOE
    - Metric estimate = $15-$18x
    - Example: If 9M BOE Reserves – FMV of $135M
  - EV ÷ EBITDAX
    - Metric estimate = 2.5x-3.0x
    - Example: If $90M of EBITDAX – FMV of $225M
  - EV ÷ Daily Production (Boe/d)
    - Metric estimate = $45,000x-$60,000x
    - Example: If 2,100 barrels of daily production – FMV of $94.5M
- **EV – Debt = FMV of Equity**

<u>Industry Rule-of-Thumb</u>: Oil & Gas properties valued at 48 months of net cash flows (similar to FCF = CFO (N.I. + depreciation) – CAPEX)

GreenTech Geothermal, LLC
Clean Energy Producer

U.S. GAAP ACCOUNTING OF F&D COSTS

Under GAAP, oil companies can choose from two methods to account for Finding & Development Costs (F&D)

- **Successful Efforts**
  - Permits write-off of F&D expenses against profits until Reserves become Proven. Dry Hole costs are expensed. Once Reserves are Proven, associated F&D Costs can be capitalized.
- **Full Cost**
  - Capitalize all exploration spending, whether dry hole or successful
  - Is less conservative method (because can defer some costs)

GreenTech Geothermal, LLC
Clean Energy Producer

CONTACT INFORMATION

For Further Information, Contact:

Steven D. Erdahl
Founder & CEO
GreenTech Petroleum, LLC
Denver, Colorado
Phone **303/324-7152**
Email **steven.erdahl@gtrenewables.com**
Website **www.greentechpetroleum.com**

GreenTech Geothermal, LLC
Clean Energy Producer

ERDAHL BIO

Steven D. Erdahl

CPA, J.D., LL.M. (Tax), M.B.A., CVA
Board Certified Tax Law
Texas Board of Legal Specialization

Diverse Experience – Accounting, Tax, Law & Finance: Steven Erdahl is GreenTech's Founder and CEO, responsible for implementing and giving direction and leadership toward achieving the Company's strategic goals and objectives. He is an attorney (Texas), CPA (Texas), CVA (National Association of Certified Valuation Analysts) and entrepreneur with over 20 years of experience in accounting, tax, law and finance. He is also Board Certified in Tax Law by the Texas Board of Legal Specialization. Mr. Erdahl's experience includes public accounting and private law practice, as well as legal and corporate finance executive positions in Dallas with Oryx Energy Company (now Anadarko Petroleum). He has a heavy international background, including mergers and acquisitions, and all types of domestic and cross-border transactions. Mr. Erdahl has spent many years in the oil & gas industry and has successfully testified as a finance expert witness in major commercial litigation (involving hundreds of millions of dollars) in venues including state courts, U.S. Federal District Court and U.S. Tax Court.

Education: Steve holds several degrees:

- **M.B.A. (Finance) -** Cox Business School at Southern Methodist University (Beta Gamma Sigma);
- **LL.M. (Taxation) -** New York University School of Law;
- **J.D. (Law**) - University of Tulsa School of Law;
- **B.S. (Accounting) -** Montana State University; &
- In 2012, completed **National Geothermal Academy** program, held at University of Nevada-Reno and co-sponsored by DOE, focused on energy industry engineering and geology, from which he earned six (6) semester credits of graduate-level engineering.