Expansion of Geothermal: Re-Using Produced Oilfield Water
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
PART 1: MACRO MARKET TRENDS & ANALYSIS

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
# Daily Supply - World Oil Markets (2011)

<table>
<thead>
<tr>
<th>Country - Producer</th>
<th>Total Oil Production</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi Arabia</td>
<td>11.2</td>
<td>12.86%</td>
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<tr>
<td>Russia</td>
<td>10.2</td>
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<td>United States</td>
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<td>Brazil</td>
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<td>Kuwait</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>87.1</strong></td>
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*Source: U.S. Energy Information Administration*
### Daily Demand - World Oil Markets (2011)

<table>
<thead>
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<th>Country - Consumer</th>
<th>Total Oil Consumption</th>
<th>% of Total</th>
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<td>India</td>
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<td>Canada</td>
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<tr>
<td>South Korea</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>88.2</strong></td>
<td></td>
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</tbody>
</table>

**Source:** U.S. Energy Information Administration
Primary Energy Use by Source, 2011

Quadrillion Btu and Percent

Total U.S. = 97.5 Quadrillion Btu

- Natural Gas: 24.9 Quadrillion Btu (25%)
- Petroleum: 35.3 Quadrillion Btu (36%)
- Coal: 19.9 Quadrillion Btu (20%)
- Nuclear Electric Power: 8.3 Quadrillion Btu (8%)
- Renewable Energy: 9.1 Quadrillion Btu (9%)

**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 Ratio (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)
<table>
<thead>
<tr>
<th>State</th>
<th>Crude Oil (bbl/year)</th>
<th>Total Gas (Mmcf)</th>
<th>Produced Water (bbl/year)</th>
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<td>Federal Total</td>
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<td>1,750,452,000</td>
<td>24,374,000</td>
<td>20,995,174,000</td>
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</table>
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

Hydraulic Fracturing

Hydraulic fracturing, or “fracking,” involves the injection of more than a million gallons of water, sand and chemicals at high pressure down and across into horizontally drilled wells as far as 10,000 feet below the surface. The pressurized mixture causes the rock layer, in this case the Marcellus Shale, to crack. These fissures are held open by the sand particles so that natural gas from the shale can flow up the well.

Well turns horizontal

The shale is fractured by the pressure inside the well.

Sand keeps fissures open

Natural gas flows from fissures into well

Mixture of water, sand and chemical agents

Graphic by Al Granberg
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.
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 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
  - 650 KW from gas engine
  - Equaled total production of **1.19 MW power**
- See summary on next slide.
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
DEPTH TO REACH 250 DEGREES FAHRENHEIT

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

Dots are well locations.
PART III – GROWTH INDUSTRY & FINANCIAL ANALYSIS

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)*
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)
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%)
SUMMARY: MAXIMIZE ENERGY OUTPUT FROM WATER

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.
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 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 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)
GOVERNMENT SEC DEFINITION OF “RESERVES”


• 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 (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**

**Industry Rule-of-Thumb:** Oil & Gas properties valued at 48 months of net cash flows (similar to FCF = CFO (N.I. + depreciation) – CAPEX)
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)
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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);
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• J.D. (Law) - University of Tulsa School of Law;
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• 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.