SLIDES: The Here and Now of U.S. Nat Gas

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High Altitude

- 1970s & 1990s “redux” with regard to perceptions about reliability, deliverability
  - Similar policy/regulatory disconnects
  - Risk that demand will be encouraged while supply and deliverability are constrained
- Even without GHG policy, gas “push” is inevitable
  - http://www.sierraclub.org/coal/
  - Strategic opposition to electric power transmission hinders both coal and renewables
- Drilling is essential
  - Environment, oil and gas tax policies
Natural Gas Resource Assessments

Technically recoverable assessments of the U.S. natural gas endowment 1970 to 2009 increased four to six times: 2,084 Tcf in 2009

Source: Modified from Bill Fisher et. al., BEG-UT; GTI

Major US shale basins:

- Niobrara
- Green River
- Baxter
- Mancos
- McClure
- Monterey
- Cane Creek
- Hovenweep
- Lewis and Mancos 97 tcf
- Pierre
- Palo Duro
- Barnett and Woodford
- Pearsall
- Barnett 25–262 tcf
- Haynesville/Bossier
- Fayetteville
- Fayetteville
- Conasauga/Neal
- Marcellus
- Utica
- Antrim 35–76 tcf
- New Albany 86–160 tcf
- Bakken
- Excella/Mulky
- Burgoyne

Schlumberger
Shale Gas is A Hedge for Offshore

Technically recoverable resources; gold areas are moratoria; total 240.1 BBOE

Barnett Shale Experience

- Water use for “frac’ing” and other Barnett Shale development is less than 1% of total water use in affected counties (BEG)
  - Water use will grow, but rate of use will be lower with technology improvement and recycling/re-use
  - Operators are actively testing recycling and reductions to manage water demand and produced water
- NETL Produced Water MIS
- NETL Frac Technologies
The New “Nanodarcy” Universe of Technology

• Detection and advanced stimulation
  – Slow decline curves
  – Reduce drilling (fewer rigs, lower costs, smaller footprint)
  – Manage water disposal and other production issues

• Enhanced recovery
  – Extend field life

A Tough Business, Anyway

- 10% Return
- US 09 Cash Operating Costs ($/BCFE)
- US All Source F&D Costs 07-09 ($/BCFE)
- Nov ’10 HH

Compiled by CEE based on company financial reports
Price Trends

- "Drill for oil, find gas? Drill for gas, hope it’s wet?"
- Overall, both drilling and marketed gas production are more responsive to oil price, but…….

Wellhead Price Eras

- Customers pay and producers sell on gas price basis

CEE based on CME price data
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CEE based on U.S. EIA
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Price Level and Volatility Matter

Average price ($2005)

<table>
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<tr>
<th></th>
<th>Wellhead</th>
<th>City Gate</th>
<th>Res</th>
<th>Comm</th>
<th>Ind</th>
<th>Elec. Power</th>
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<tr>
<td>Before 99:12</td>
<td>2.82</td>
<td>4.39</td>
<td>8.96</td>
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<td>00:01-09:11</td>
<td>5.30</td>
<td>6.73</td>
<td>11.99</td>
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<td>Change</td>
<td>88%</td>
<td>53%</td>
<td>34%</td>
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* 76:01-99:12; b 83:10-99:12; c 81:01-99:12; d 01:01-09:12; e 02:01-09:12
**Price volatility ($2005)**

<table>
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<td>7.2%</td>
<td>6.0%</td>
<td>6.3%</td>
<td>2.5%</td>
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<td>00:01-09:11</td>
<td>12.2%</td>
<td>10.5%</td>
<td>7.7%</td>
<td>5.3%</td>
<td>11.4%</td>
<td>10.6%</td>
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<tr>
<td>Change</td>
<td>71%</td>
<td>74%</td>
<td>22%</td>
<td>110%</td>
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* Std dev of change in price

**US Net Generation by Energy Source**

1996 Total Net Generation = 3.4 Billion Megawatthours
2009 Total Net Generation = 3.9 Billion Megawatthours
Net Difference = 509 Million Megawatthours

Compiled by CEE; U.S. EIA

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ERCOT Peak Day by Fuel Type

Does Renewable Energy Create Volatility?

April 26, 2009

MCPE ($/MWh)

Negative price intervals (15 min)

- 2006: 76
- 2007: 338
- 2008: 4,894
- 2009: 3,069
- 2010: 2,413 (5/31)

Compiled by CEE using ERCOT data
Price Observations

- Volatility is a sensitive issue for large users and regulated utilities; lack of data prevents analysis on changes over time
- Residential (and some commercial) customers are sheltered by regulators
- Wellhead price takers both suffer from and may contribute to volatility
- Electric power demand swings on marginal gas generators + impact of renewables may contribute to volatility

**LNG “Optionality”**

Compiled by CEE based on industry data
Beyond Unconventional

The Endless Resource?

"100 ft of pay, 50% porosity, 90% gas saturation"

Critical Role of Natural Gas in the U.S. Energy Mix

- Benefits of utilization – options for natural gas uses
  - For lower carbon electric power?
  - Industrial revitalization?
- Supply and price volatility
  - Frontiers, production management, frac and water issues
- Electric power dynamics – effective, optimal dispatch?