Dr. Michelle Michot Foss, CEE/BEG/JSG/UT

The Story…
• “It’s a factory business…”
• “Have I got a shale deal to sell you…”
• “We can make money at $4…”

…and the Back Story
• Private lands event
• Unknown unknowns in technology
• Shifting upstream business models
• Is natural gas price volatility “dead”?
Rocks for Jocks

Major US shale basins:

- Niobrara
- Green River
- Bakken
- Permian
- Marcellus
- Haynesville
- Antrim
- Utica
- Caney and Woodford
- Fayetteville
- Marcellus
- Chattanooga
- Floyd and Conasauga/Neal
- Huron
- Bluff
- Mowry
- Gammon
- Excello/Mulky
- New Albany 86–160 tcf
- Antrim 35–76 tcf
- Utica
- Haynesville/Bossier 25–252 tcf
- Caney and Woodford
- Mowry
- Gammon
- Excello/Mulky
- New Albany 86–160 tcf
- Antrim 35–76 tcf
- Utica

Schlumberger
All Shale is Not the Same

Estimated ultimate recoveries per well (Barnett):

<table>
<thead>
<tr>
<th>Isopach</th>
<th>BCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Sweet Spot&quot;</td>
<td>3.0+</td>
</tr>
<tr>
<td>Second</td>
<td>2.5-3.0</td>
</tr>
<tr>
<td>Third</td>
<td>1.75 – 2.5</td>
</tr>
<tr>
<td>Fourth</td>
<td>1.25 – 1.5</td>
</tr>
<tr>
<td>Fifth</td>
<td>0.5 – 1.25</td>
</tr>
<tr>
<td>Sixth</td>
<td>&lt;0.5</td>
</tr>
</tbody>
</table>
The Frontier – FLAME 2009


Shale Gas Pores

Areas of higher carbon content

SEM of ion-cut surface

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The New “Nanodarcy Nirvana”  
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
Not All Producers are the Same

- 10% Return
- U.S. 2010 Cash Operating Costs $/MCFE
- U.S. All Source FD Costs 07-10 $/MCFE
- Henry Hub Spot Price, $/MCFE

Gainers, Losers

- Differences, 2009-2010
- U.S. Cash Operating Costs $/MCFE
- U.S. All Source FD Costs, $/MCFE
"Glubbausage"

Searching for the bottom...

- Henry Hub Monthly Average Spot Price ($/MMBtu)
- Avg Feb 89-Nov 99
- Avg Dec 99-Jan 09
- Avg Feb 09-Apr 11

CEE based on U.S. EIA
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Price Change & Volatility Matter

- Y-Y Change Henry Hub Monthly Average Spot Price (%)
- Y-Y Change U.S. Dry Natural Gas Production (%)
- Y-Y Change U.S. Natural Gas Total Consumption (%)

232%

37%

Compiled by CEE using EIA

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“Why Can’t We Be Friends”

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U.S. Net Generation by Energy Source

1996 Total Net Generation = 3.4 Billion Megawatthours
2010 Total Net Generation = 3.9 Billion Megawatthours
Net Difference = 506 Million Megawatthours

Change in shares of net generation, 1996-2010 (net generation, 2010), all %:
10 (23) 1 (20) 2 (4) 0 (0) 0 (0) -8 (44) -1 (1) -3 (7)

ERCOT Peak Day by Fuel Type

Generation from private networks not included

Electric Reliability Council of Texas (ERCOT)
Dr. Michelle Michot Foss, CEE/BEG/JSG/UT

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  4,445 (Nov)

Compiled by CEE using ERCOT data ©CEE-UT, 19

Environment Discontents

• Hydraulic fracturing
  – Water use, disposal, contamination (chemicals and methane)
  – Seismicity

• Air emissions
  – Drilling operations
  – Fugitive methane

• Fugitive emissions from value chain

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**CEE-UT US/North America LNG Import Capacity Assessment**
Based on agency pre-filings, filings, approvals and industry information. As of May 2011. **NOTE:** Includes both onshore and offshore.

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