THE US SHALE BOOM

Institute for Energy Economics, Japan
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2014 DOE PRICE FORECAST SURVEY
WHAT WENT WRONG (FOR SOME)?

- **THE UNEXPECTED**
  - Marcellus/Utica kept US prices very low
  - Differentials very high in Marcellus/Utica

- **WHAT SHOULD HAVE BEEN EXPECTED**
  - Oil prices $50 or so; natural gas prices under $5/MMBTU
  - Gas riskier than oil (no gaspec in North America)
  - High debts, high risk
    - Small companies
  - More production potential than production (Samson)

- **IRRATIONAL EXUBERANCE**
  - Assume prices do what you want
  - Spend money carelessly
“SHALE IS GOOD”

- “THE UNCONVENTIONAL RESOURCE PRIZE IS TOO LARGE FOR PRIVATE EQUITY CAPITAL TO IGNORE” (SAMSON DEAL 2012)
- “...land acquisition became the key to capturing the greatest values from the unconventional plays” Aubrey McClendon 2011 Forbes
- Cheapeake stock price
SUCCESS FROM:

- HIGH WELL PRODUCTIVITY
  - GOOD LOCATIONS
    - LUCK
    - GOOD GEOLOGISTS
    - GOOD MANAGEMENT
  - GOOD ENGINEERING
    - REPEATED TESTS
    - EXPERIENCED PEOPLE
- FISCAL CAUTION
  - NOT BUYING AT PEAK
  - NOT ASSUMING HIGH PRICES
DEBT AND REVENUE ($MIL)
CHENIERE PLANNED IMPORTS WHEN LNG PRICES WERE HIGH.
MOST RECENT US GAS PRICE FORECASTS

![Graph showing US gas price forecasts from 1990 to 2040. The graph compares actual prices with forecasts from various organizations: DOE 2014, IHSGI, EVA, ICF, and DOE 2015. The forecast trends show an upward trajectory from 2015 onwards.](image-url)
2006 US GAS FORECASTS
GAS PRICE FORECASTS 2001
DIVERGING NATURAL GAS PRICES

$/MCF

JAPAN
GERMAN
US


DUAL VIEWS ON BREAKEVEN COSTS

- NO ONE MAKING MONEY
  - NO FREE CASH FLOW
  - RECYCLING INVESTMENT CAPITAL
  - COSTS ABOVE PRICES

- HIGH PROFITS
  - USUALLY COMPANY VIEWS
  - MIGHT EXCLUDE G&A
  - PRIMARILY HIGH-GRADING
SHALE GAS BREAKEVEN COSTS (PRE-2014)
WHY THE MISUNDERSTANDING OF BREAKEVEN COSTS?

- **BAD ESTIMATES**
  - INCLUDING INTEREST PAYMENTS
  - ASSUMING HIGH LEASE PAYMENTS
  - HISTORICAL AVERAGE VS CURRENT COSTS

- **STATIC INSTEAD OF DYNAMIC**
  - NUMEROUS WAYS TO LOWER COSTS
    - RAPIDLY CHANGING TECHNOLOGY
    - CYCLICAL COST BEHAVIOR
    - HIGH-GRADING
# SOURCES OF COST SAVINGS
(CONSOL IN UTICA, WELL COST IN $MIL)

<table>
<thead>
<tr>
<th>Source</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARLY COSTS</td>
<td>26.2</td>
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<tr>
<td>Drilling Efficiency</td>
<td>8.2</td>
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<tr>
<td>Service Cost</td>
<td>2.2</td>
</tr>
<tr>
<td>Casing Design</td>
<td>0.4</td>
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<tr>
<td>Multi-Well Pad</td>
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<tr>
<td>Completion Design</td>
<td>1.2</td>
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<tr>
<td>Proppant Optimization</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>FINAL</strong></td>
<td><strong>12.3</strong></td>
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</table>
DRILLED AND UNCOMPLETED OIL WELLS

OIL DUCS

- BAKKEN
- EAGLE FORD
- NIOBRA
- PERMIAN
DECLINE RATES

- ONE CERTAINTY: VERY HIGH
- PESSIMISTS CONCLUDE EARLY PEAK, SHARP DECLINE
- OPTIMISTS SEE POTENTIAL TO OVERCOME
- INDIVIDUAL WELLS HIGHLY VARIABLE
- LONG-TERM DECLINE UNCERTAIN
PROJECTIONS OFTEN EXCEED EXPERIENCE
BIG VARIANCE AMONG WELLS
### EVOLUTION OF MARCELLUS

<table>
<thead>
<tr>
<th>Year</th>
<th>DECLINE RATE</th>
<th>EUR IN BCFe</th>
<th>IP</th>
<th>HORIZ LENGTH</th>
<th>EUR/FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>43.87%</td>
<td>2</td>
<td>1.4</td>
<td>2280</td>
<td>0.88</td>
</tr>
<tr>
<td>2009</td>
<td>43.21%</td>
<td>3.3</td>
<td>2.4</td>
<td>2890</td>
<td>1.14</td>
</tr>
<tr>
<td>2010</td>
<td>48.52%</td>
<td>4.9</td>
<td>4.0</td>
<td>3800</td>
<td>1.29</td>
</tr>
<tr>
<td>2011</td>
<td>49.02%</td>
<td>4.5</td>
<td>4.0</td>
<td>4100</td>
<td>1.10</td>
</tr>
<tr>
<td>2012</td>
<td>48.38%</td>
<td>4.2</td>
<td>4.3</td>
<td>4500</td>
<td>0.93</td>
</tr>
<tr>
<td>2013</td>
<td>46.22%</td>
<td>5.4</td>
<td>5.8</td>
<td>4751</td>
<td>1.14</td>
</tr>
</tbody>
</table>

**SOURCE:** SWINDELL 2016.
EAGLE FORD SHOWS HIGHER 2ND YEAR DECLINE RATES

<table>
<thead>
<tr>
<th>Year</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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</thead>
<tbody>
<tr>
<td>2009</td>
<td>-70%</td>
<td>-30%</td>
<td>-20%</td>
<td>-20%</td>
</tr>
<tr>
<td>2010</td>
<td>-68%</td>
<td>-39%</td>
<td>-28%</td>
<td>-42%</td>
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<tr>
<td>2011</td>
<td>-65%</td>
<td>-47%</td>
<td>-27%</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>-64%</td>
<td>-48%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>-69%</td>
<td></td>
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SOURCE: EIA BASED ON DRILLINGINFO DATA.
BUT INITIAL PRODUCTION RATES ARE HIGHER

Average oil production per well during the first 48 months of operation
barrels per day

1ST YEAR PROD:
2010: 300 MB
2013: 800 MB
NOW WHERE TO: VIEW FROM CABOT 2016

- **MARCELLUS**
  - 52% DROP IN DRILLING COSTS FROM 2012
  - UPGRADED RIGS, MORE EFFICIENCY, BETTER TERMS WITH SERVICE COS.
  - LATERALS INCREASED FROM 5200 FT TO 7000 FT IN 2 YEARS
  - PRE-TAX IRR 132% AT C. $2.25/MMBTU
CHANGE IN GAS PRODUCTION (YEAR ON YEAR, BCFD)
CAN SHALE OIL DO THE SAME?

- DRILLING DECLINE LED TO PRODUCTION DROP
- SHALE OIL FLOWS LOWER THAN SHALE GAS
- SHALE OIL STILL LESS MATURE THAN SHALE GAS
  - ENGINEERING STILL EVOLVING
- QUESTION: CAN PERMIAN DO FOR OIL WHAT MARCELLUS DID FOR GAS?
# EFFECT OF HIGH-GRADING

<table>
<thead>
<tr>
<th></th>
<th>Well Cost</th>
<th>IP</th>
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</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>$mil</td>
<td>mcf/d</td>
</tr>
<tr>
<td>Barnett</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Marcellus</td>
<td>5.7</td>
<td>20</td>
</tr>
<tr>
<td>Petroleum</td>
<td>$mil</td>
<td>b/d</td>
</tr>
<tr>
<td>Bakken</td>
<td>5.9</td>
<td>425</td>
</tr>
<tr>
<td>Permian</td>
<td>7.2</td>
<td>1000</td>
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BREAKEVEN PRICE: WHEN DOES PRODUCTION RECOVER?

Exhibit 11: Most fields achieve 11% IRRs in the $80-$90/bbl Brent range; this would fall by about $6/bbl for a 10% reduction in capital costs. Brent oil price in $/bbl for 11% IRR.

Source: Goldman Sachs Global Investment Research.

CALCULATIONS C. 2014.
BAKKEN RIGS AND PRICE

DRILLING DECLINED AT $50 (WELLHEAD).
DIFFERENCE

- BAKKEN 30-DAY IP 2011: 125 B/D
- BAKKEN 30-DAY IP 2015: 425 B/D
- PERMIAN 30-DAY IP 2015: 1000 B/D (SOME REPORTS)
- PERMIAN INFRASTRUCTURE CHEAPER
- PERMIAN TRANSPORT COSTS CHEAPER
  - BUT BAKKEN COMING DOWN
PERMIAN NOT YET IN DECLINE
DRILLING RECOVERING

ANOTHER 25 RIGS AND PERMIAN SHOULD OFFSET DECLINES ELSEWHERE
CONCLUSIONS

- SHALE RESOURCE IS LARGE
  - SUPPLY CURVE VERY FLAT
- POLITICS WILL DETERMINE GLOBAL SPREAD
  - INFRASTRUCTURE SECONDARY
- AVOID SIMPLE ANALYSIS
  - “SHALE IS GOOD”
  - “PRICES DON’T GO DOWN”
- BE OPEN-MINDED
- MEASURE TWICE, CUT ONCE