
Timothy J. Considine

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The Costs & Benefits of Best Management Practices

INSIGHTS & EXAMPLES FROM THE MARCELLUS SHALE

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Outline of Presentation

- Discuss some features of shale energy production
- The incentives for drilling responsibly
- The environmental record in the Marcellus
- Estimating the environmental impacts
- Valuation of environmental impacts
- Defining best management practices
- Evaluating best management practices
  - May not be just a cost-benefit ratio
  - Product liability concerns & risks may be more important
  - What level of risk is acceptable & how much compensation is necessary for people to accept these risks?
Shale Drilling Employs Advanced Technology

- Seismic Imaging
- Directional Drilling
- Hydraulic fracturing
- Continuous adaptation of techniques to local geology

These innovations
  - Reduce time to drill,
  - Lower costs, and
  - Raise output

A very dynamic industry
The Production Treadmill

- Why so many wells?
- The steep production decline curve
- Example to right
  - Year 1: 511.9 mmcf
  - Year 2: 257 mmcf
  - Year 10: 88 mmcf
  - Year 30: 32 mmcf
- To keep increasing output, need to keep drilling!
History of Barnett Drilling & Production

- Intensive drilling
  - Increase from 556 wells in 2002
  - To 3,594 wells in 2009
- Production increased
  - 221 bcf in 2002 (0.61 bcf / day)
  - 1,764 bcf in 2009 (4.83 bcf / day)
- Occurred in urban area over past 10 years
The Shale Plays Multiply

- After the great economic success of the Barnett shale many more shale plays began to pop up across the country.
- Today there are about 20 large scale shale plays in the United States.
Marcellus Drilling in 2009

Drilled Marcellus Wells
2009
Total: 1122

[Map showing the location of Marcellus Drilling in 2009]
Marcellus Spending in millions of current dollars

<table>
<thead>
<tr>
<th></th>
<th>Pennsylvania</th>
<th>West Virginia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>Total Spending</td>
<td>3,224.6</td>
<td>4,535.3</td>
</tr>
<tr>
<td>Lease &amp; Bonus</td>
<td>1,837.7</td>
<td>1,728.8</td>
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<tr>
<td>Exploration</td>
<td>121.9</td>
<td>243.8</td>
</tr>
<tr>
<td>Drilling &amp; Completion</td>
<td>857.8</td>
<td>1,700.4</td>
</tr>
<tr>
<td>Pipeline &amp; Processing</td>
<td>329.4</td>
<td>695.8</td>
</tr>
<tr>
<td>Royalties</td>
<td>22.2</td>
<td>54.7</td>
</tr>
<tr>
<td>Other</td>
<td>55.5</td>
<td>111.8</td>
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<tr>
<td>Severance Taxes</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Source: Estimates & based upon industry surveys.*
## Economic Impacts

<table>
<thead>
<tr>
<th>Year</th>
<th>Value Added</th>
<th>Local Taxes</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>2,556</td>
<td>265</td>
<td>30,137</td>
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<tr>
<td>2009</td>
<td>3,877</td>
<td>389</td>
<td>44,098</td>
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</table>

**Planned**

<table>
<thead>
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<th>Year</th>
<th>Value Added</th>
<th>Local Taxes</th>
<th>Jobs</th>
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<tbody>
<tr>
<td>2010</td>
<td>8,039</td>
<td>785</td>
<td>88,588</td>
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<tr>
<td>2011</td>
<td>10,129</td>
<td>987</td>
<td>111,413</td>
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</table>

**Forecast**

<table>
<thead>
<tr>
<th>Year</th>
<th>Value Added</th>
<th>Local Taxes</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>14,415</td>
<td>1,417</td>
<td>160,205</td>
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<tr>
<td>2020</td>
<td>18,853</td>
<td>1,872</td>
<td>211,909</td>
</tr>
</tbody>
</table>
Environmental Impacts

• Unavoidable impacts
  ○ Clearing of land for well pads and pipelines
  ○ Local congestion, noise, dust in rural communities
  ○ Emissions during drilling

• Environmental hazards
  ○ Stray gas – failures in casing & contamination of water
  ○ Containment pond breaches
  ○ Condensate handling
  ○ Well blow-outs, spills

• Environmental risk – perceptions
  ○ There have been isolated, serious problems
  ○ From a societal perspective, what is there proper context?
Environmental Violations

- All Violations: 15.2%
  - Administrative: 42.0%
  - Erosion: 9.2%
  - Water: 16.4%
  - Major Spills: 7.1%
  - Other Spills: 3.4%
  - Blowouts and Venting: 2.6%
  - Cement and Casing: 0.4%
  - Gas Migration: 0.7%
Economic Benefits & Environmental Costs

- **Benefits**
  - Gains in real output, jobs, and tax revenues
  - Environmental – avoided emissions from coal

- **Costs**
  - Air emissions from shale energy production
  - Water pollution
  - Forest disruption
  - Noise, traffic externalities, etc.

- Are the costs really more than $14.3 billion in cumulative value added from 2008 to 2010?

- What level of benefits are necessary to accept environmental risks?
Best Management Practices: Goals & Methods

- Protecting water supplies
  - American Petroleum Institute standards for cement
  - Use of intermediate casing strings
  - Using tarpaulins at well sites
  - Testing before & after drilling
  - Pipelines to move fresh & produced water

- Ensuring safety – blowout preventers & crisis crews

- Reducing traffic – pipelines & air drilling

- Minimizing erosion & sedimentation – Closed system drilling & use of steel pits
Evaluating Best Management Practices

- Need for a baseline – breakout of “Allowance for Expenditure” forms in the industry
- What is currently being spent and for what?
- What are the incremental costs of BMPs?
- What are the benefits?
  - Reducing probability of accident or incident
  - Avoiding fines, law suits, and damages
- Benefit-cost framework assumes risk neutrality
  - Aversion to risky outcomes appears paramount
  - What is the local population’s willingness to accept risks?
Concluding Thoughts

- Rapid technological change
- Intensive shale energy production underway
- Economic benefits are significant
- Environmental impacts – few & localized
- There are techniques to minimize these impacts
- Evaluation on a cost-benefit basis should be done
- Risk is critical
  - What is societal risk aversion?
  - What are acceptable risks & what level of compensation is necessary to accept these risks?