The Costs & Benefits of Best Management Practices

INSIGHTS & EXAMPLES FROM THE MARCELLUS SHALE

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Outline of Presentation

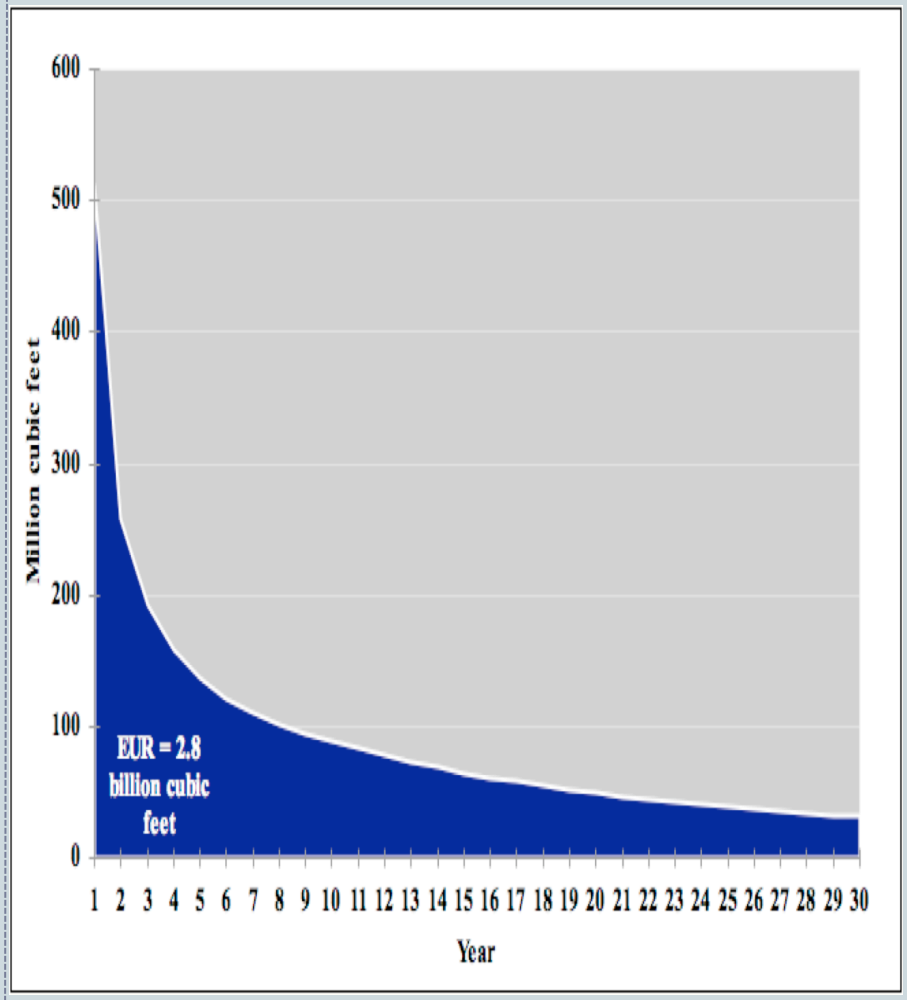
- Discuss some features of shale energy production
- The incentives for drilling responsibly
- The environmental record in the Marcellus
- Estimating the environmental impacts
- Valuation of environmental impacts
- Defining best management practices
- Evaluating best management practices
  - May not 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

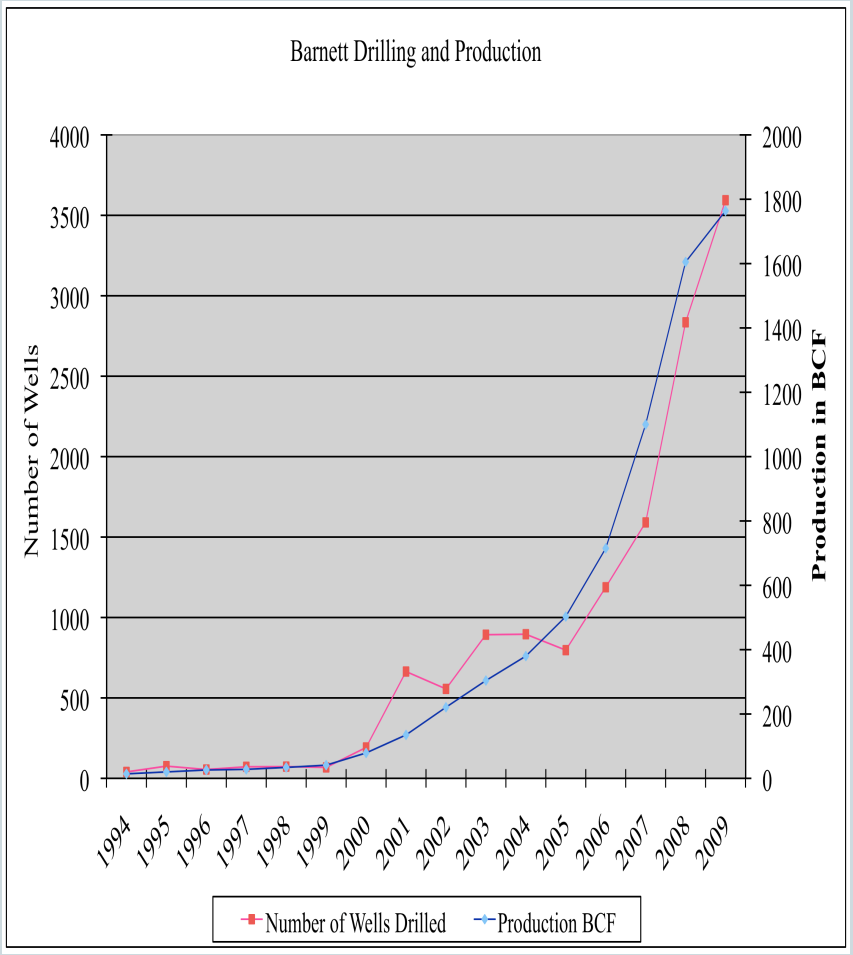
The Production Treadmill

- 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!



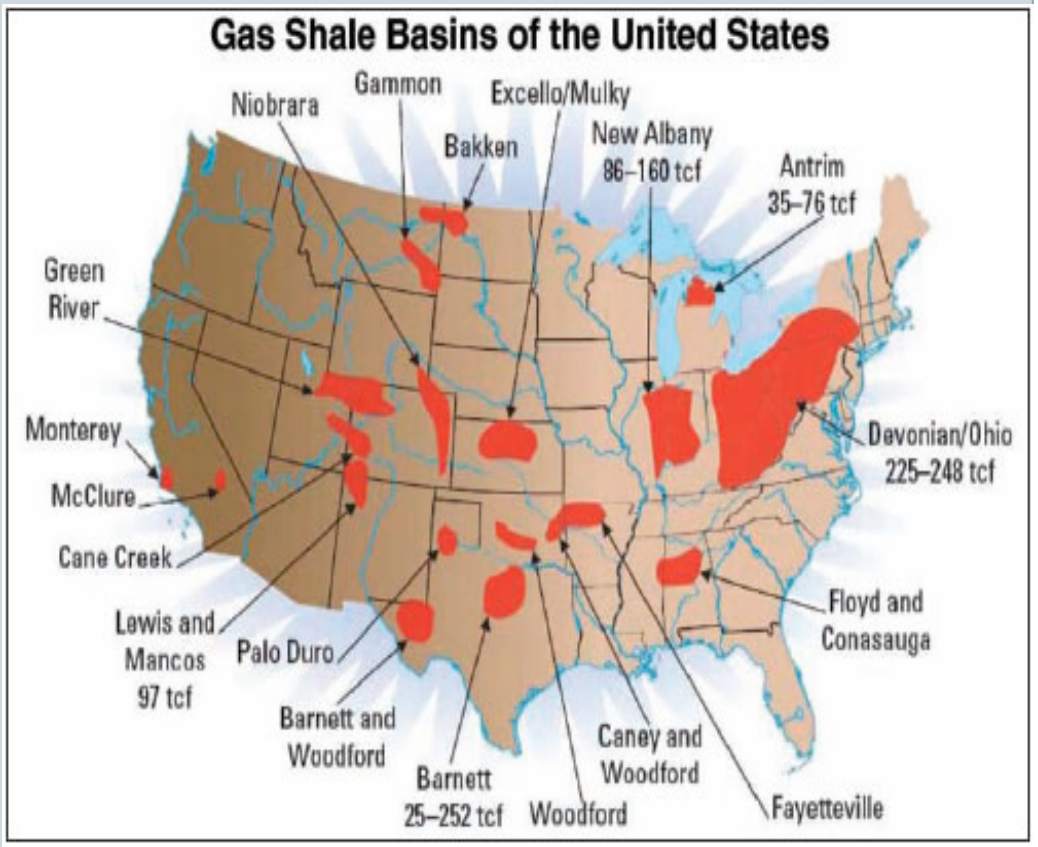
History of Barnett Drilling & Production

- 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

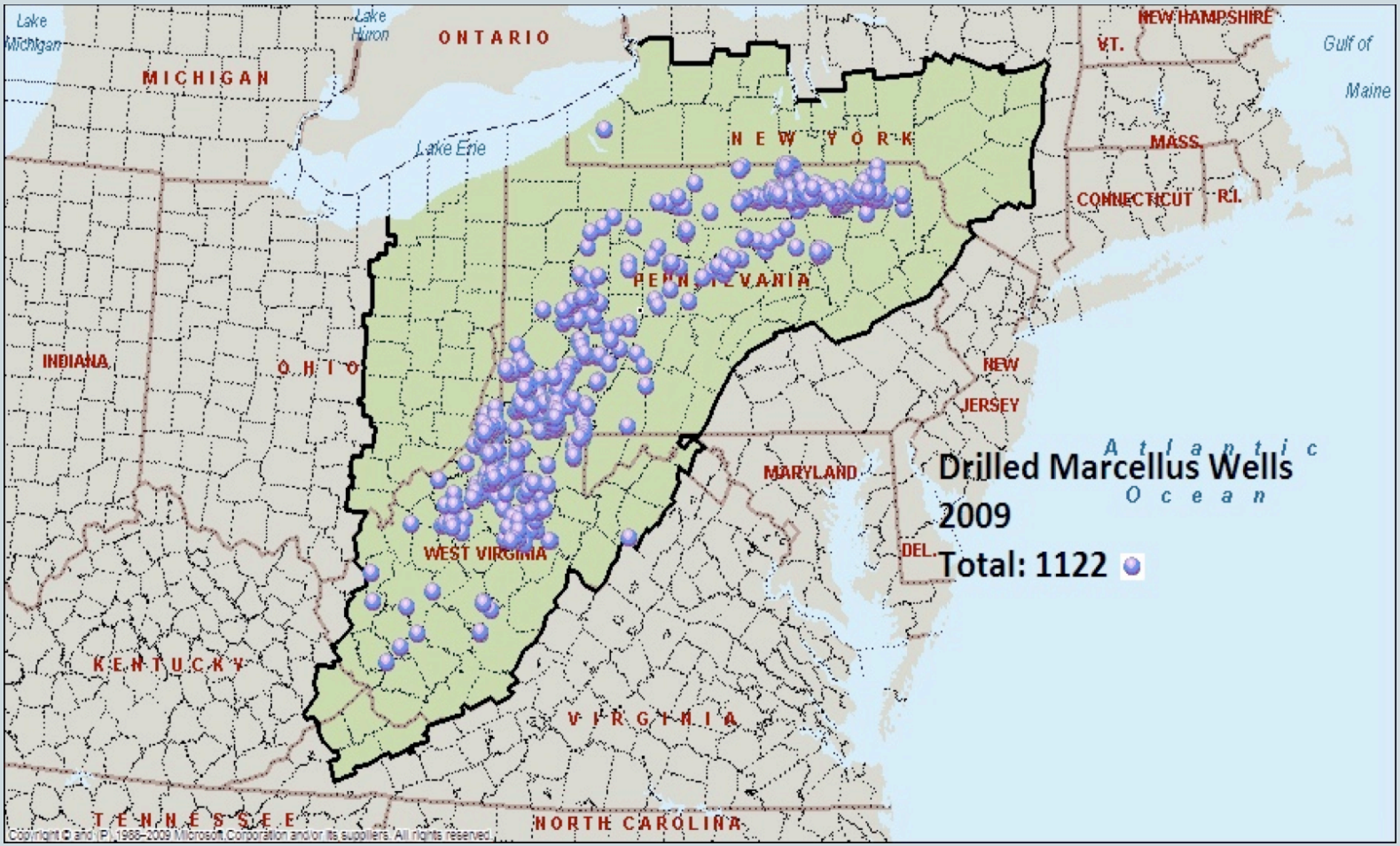


The Shale Plays Multiply

- 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



Marcellus Spending in millions of current dollars

	Pennsylvania		West Virginia	
	2008	2009	2008	2009
Total Spending	3,224.6	4,535.3	889.8	1,313.3
Lease & Bonus	1,837.7	1,728.8	475.2	657.6
Exploration	121.9	243.8	35.4	55.8
Drilling & Completion	857.8	1,700.4	249.2	392.7
Pipeline & Processing	329.4	695.8	95.7	150.8
Royalties	22.2	54.7	18.2	30.9
Other	55.5	111.8	16.1	25.4
Severance Taxes	0	0	10.8	14.2

Source: Estimates & based upon industry surveys.

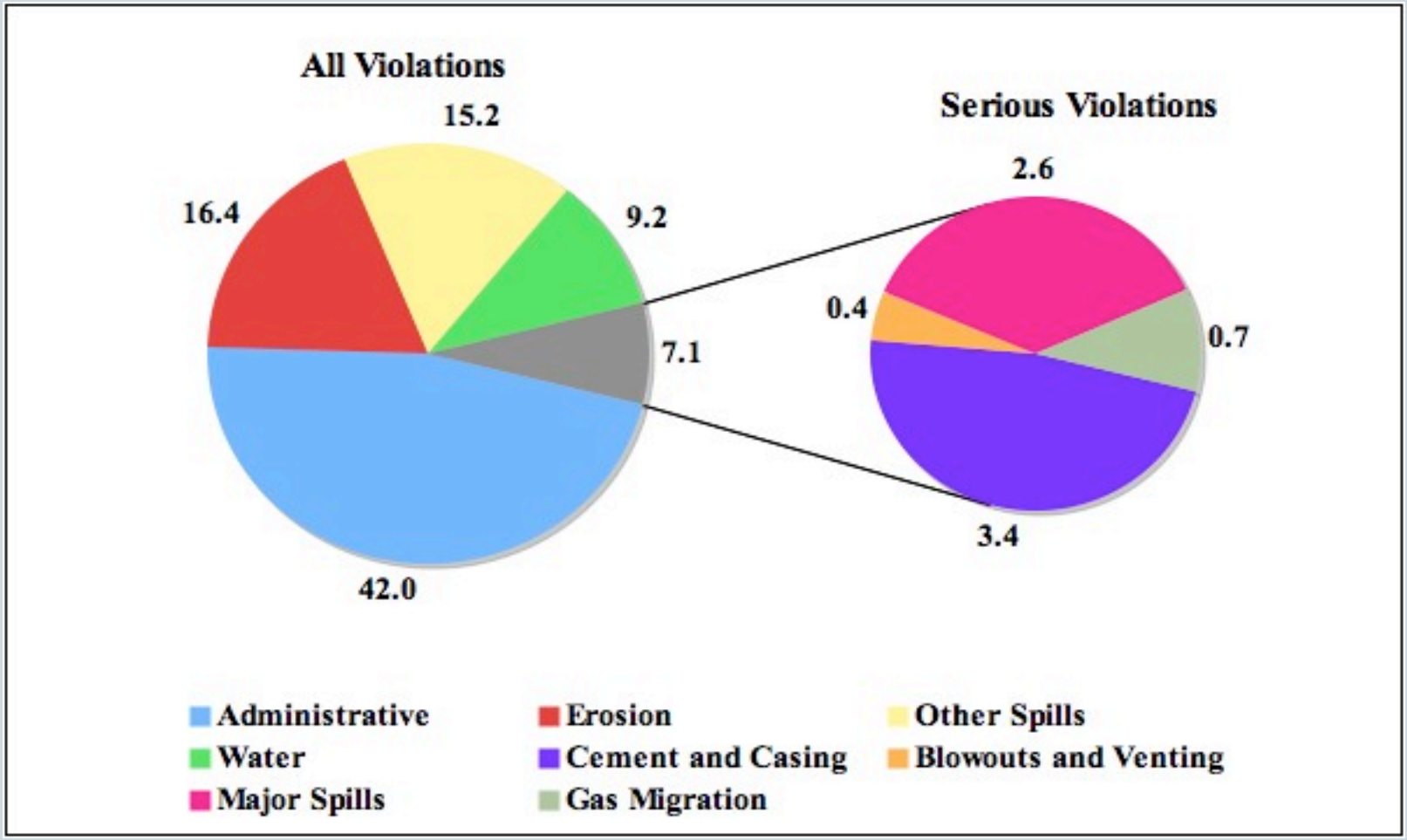
Economic Impacts

Millions of 2010 dollars			
Year	Value Added	State & Local Taxes	Jobs
2008	2,556	265	30,137
2009	3,877	389	44,098
		Planned	
2010	8,039	785	88,588
2011	10,129	987	111,413
		Forecast	
2015	14,415	1,417	160,205
2020	18,853	1,872	211,909

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



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?