Modeling the Economics of the Shale Revolution: What Have We Learned?

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Ancient Natural Gas Myths

• FPC Chairman predicts running out of natural gas
• Key policy issue: deregulation of interstate wellhead prices
• Curtailments: gas too valuable for power sector
• Natural gas would sell at 10% premium above distillate oil
Why Use Models?

“The purpose of computing is insight, not numbers.”
- R. W. Hamming

“All models are wrong, but some are useful.”
- George E. P. Box

Conditional Statements

Forecasts
Shale Gas as a Game Changer?

- Re-industrialize the US economy
- Panacea for global climate change damages
- Shift geopolitical power to the USA
- Transform energy markets
Natural Gas, Fuel Diversity and North American Energy Markets

- 2020 prices could range between 58% and 118% of June 2003 level.
- Investments in resources/technologies play a critical role.
- Fuel-substitution opportunities provide a more stable long-run price path.
The New ‘Normal’ for Natural Gas Prices
A Policy Framework for Evaluating North American Natural Gas Exports

• Global framework evaluates major market risks
• US LNG exports face increasing world competition
• Policymakers should expect considerable export uncertainty

• Apply to US strategies for cleaner power
• Link: https://web.stanford.edu/group/emf-research/docs/exports.pdf
• Improves policy decisions by emphasizing uncertainty in market outcomes
‘Irrational Exuberance' Déjà Vu?

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<th>Bcf/d</th>
<th>% Total</th>
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<td>Long-term Non-FTA applications received</td>
<td>51.59</td>
<td>70.6%</td>
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<td>Long-term Non-FTA applications approved</td>
<td>21.35</td>
<td>29.2%</td>
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<td>Total Annual U.S. Dry Production</td>
<td>73.05</td>
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Source: DOE, Office of Fossil Fuel ; EIA

- Not all projects are under construction or will be built to licensed capacity.
- Demand for US LNG exports can grow from current levels.
Stanford EMF will be coordinating an effort to support trilateral discussion and sharing of energy information initiated by the Energy Secretaries and Minister from Canada, Mexico, and the United States for the North American region. This team effort will focus upon understanding:

- the availability of existing data,
- the opportunities for developing new metrics meeting investors’ and policymakers’ needs, and
- the sharing of market insights that flow from numerous analytical models and frameworks.

Background information about the agreement can be found at [http://www.nacei.org/en/](http://www.nacei.org/en/).
Thank you

Reports and Other Material are available at

https://emf.stanford.edu/

or contact Hill Huntington at hillh@Stanford.edu
Additional Slides
Prices/Trade in Globalizing Market

• Working group first met in December 2004
  ➢ No shale gas / No Great Recession on the horizon

• Western Europe
  ➢ Stable/declining production
  ➢ Growing consumption and trade

• United States
  ➢ Expanding production/consumption/trade
Gas Trade Expands in Europe

European Gas Markets (Bcf per Year)
North American Trade Share Remains Small

North American Gas Markets (Bcf per Year)
Several Other Insights

• Transition from contracts to arbitrage
• Market resiliency: change in gas use relative to price change
• Some models show 4x the resiliency of other models
Changing the Game?

• Returned to the topic with our North American “Changing the Game?” study, beginning in November 2011.

• Broad energy market impacts: displace coal, slow down nuclear and renewable expansion.
  ➢ Failed to anticipate renewable cost revolution.

• Boosts GDP by $70 billion annually over the next several decades, but that is only 0.46% of the total economy.

• Modest impacts on emissions: less coal but also nuclear and some renewable and energy efficiency (lower prices).

• Which price path?
Average U.S. Wellhead Gas Price (2010$/Mcf), 2010-2050

Supply assessments calibrated to EIA. EIA shows higher-cost production.
North American Transition

• Continued with a new study begun in October 2013.
• Sufficient flexibility for Clean Power Plan without changing prices or net U.S. gas exports.
• US exports from new LNG facilities must be competitive with the costs from other regions.
Diminishing Regional Differences

Natural Gas Prices ($/mmBtu)
Source: IMF/World Bank

German
Japan
Europe
USA
The Evaluation Framework

- GAMS model solves for market balances (equilibria) in 13 different world regions.
- Five-year intervals through 2040.
- Intertemporal optimization.
- US supply region competes against all other regions to provide gas to all demand centers.
- Both pipelines and LNG facilities provide transportation between regions.
Percent that **New US Exports in 2025 Will Reach at Least Some Level**

(Horizontal Axis)