Framework of Factors Controlling the U.S. Natural Gas Market Outlook*

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Search and Discovery Article #70056 (2008)
Posted November 11, 2008

*Adapted from oral presentation at AAPG Annual Convention, San Antonio, Texas, April 20-23, 2008

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Abstract

The price of natural gas has transcending importance in the new energy economy. Seemingly linked at times to oil, in 2007 its price (in the U.S.) has fallen below 50% of parity with WTI. Its price marches to a different drummer. This presentation summarizes research by the Electric Power Research Institute on the key factors shaping the natural gas supply-demand balance and price envelope over the intermediate term. The greatest single factor is the surge in LNG imports anticipated during 2008 and continuing thereafter. Also important is the outlook for U.S. gas production, which at record drilling levels has begun to increase. This is a significant turnaround from trends since 2000. Results from the Lippman Gas Supply Model quantify scenarios of drilling, in which the industry’s response to softening prices is an important question. On the negative side of the ledger are anticipated declines in imports from Canada, largely already realized and responding to Canada’s drilling-production cycles, oil sands’ requirements, and schedule for replacing coal-fired power generation. Over the next 3-4 years, the balance of these factors leads to a price-softening outlook; yet this will likely be followed by the opposite when, first, gas demands for power generation increase unexpectedly on account of the recent wave of withdrawals of proposed coal plants, and, second, the difficulties of tapping Arctic supplies constrain needed supplies. The resulting topsy-turvy outlook will be a challenge to technology planners, policy makers, and investors in the power, natural gas, and alternative energy industries.
Framework of Factors Controlling US NG Market Outlook

AAPG EMD Forum on Economics of Natural Gas and Alternative Energy
April 21, 2008

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Topics

• NG-Oil price and market synopsis
• Framework of factors
  – Sensitivities
• Topsy-turvy price outlook
• What to watch
NG-Oil price and market synopsis

• Sharp break from oil prices
• Power sector – only sector with growth
NG About 50% Oil Price

Nymex Closing Dates

SOURCE: EIA NATURAL GAS WEEKLY UPDATE: April 3 2008

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NG About 50% Oil Price

SOURCE: EIA NATURAL GAS WEEKLY UPDATE: April 17 2008
The Split Began in 2006

NYMEX Natural Gas Settlement Price
WTI Spot Price
Henry Hub Spot Price

Nymex Closing

SOURCE: EIA NATURAL GAS WEEKLY UPDATE: March 30 2006
Relative prices of oil and gas have varied greatly in recent years. The bars show the per barrel prices of oil for February delivery at the end of the first full week of November in each year. Gas prices shown are for the equivalent in energy of a barrel of oil, based on 5.8 million B.T.U.’s per barrel.

Source: Bloomberg Financial Markets

Source: NEW YORK TIMES, Nov. 10, 2007 “As Oil Soars…”, p.1ff. Business Section
Consumption Trends 1997-2007: Demand Destruction and Power Sector Growth

Source: EIA

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Framework of Factors

- The factors (biggest changes in supply and demand)
- US production scenarios
- Canada
- LNG
- Power sector demand for NG

Principal references
- Oct 2007 article: “Impacts of Coal Plant Withdrawals on NG Markets…”
Framework of Factors Shaping US NG Market

Possible Changes in US Gas Supply and Demand Balance, 2005-2011

- **Canadian Imports**: -1.7
- **U.S. Production**: +5.3
- **LNG Imports**: +2.3
- **U.S. Demand**: -
- **Net Change in Balance**: +?

US Production: Drilling Scenarios

- **Base Case**: Continued record drilling
- **10% Decline**: -10% in all regions in '09, stay at that level 2010-2011
- **I**: -10% (’08) and -20% (’09) for conventional NG only, then flat. No change for unconventional. Middle range for mixed areas.
- **II**: Rebound 2010-11
- **III**: ½ the decline Scenario I
- **IV**: Scen. III with rebound

US Production Analysis: Based on Lippman Gas Supply Model

- Play by play analysis of regional production by well vintage and estimated declines
- 150 performance curves

Example: Colo. Wattenberg Fld.

## US Production: Projected Increases by Region (Base Case)

<table>
<thead>
<tr>
<th>Region</th>
<th>2005-2011 Change (BCFD)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Mexico</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onshore</td>
<td>(2.3) 0.2 (Declining drilling activity; high decline rates.)</td>
<td></td>
</tr>
<tr>
<td>Offshore</td>
<td>(0.4) (2.2) (Increased drilling activity; mixture of trends.)</td>
<td></td>
</tr>
<tr>
<td>Mid-Continent</td>
<td>2.8 4.8 (Barnett, Fayetteville &amp; Woodford shales; increased drilling activity.)</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountains</td>
<td>2.5 2.8 (Tight sands and coalbed methane; increased drilling activity.)</td>
<td></td>
</tr>
<tr>
<td>Permian Basin</td>
<td>(0.1) (0.0) (Increased drilling activity but declining productivity.)</td>
<td></td>
</tr>
<tr>
<td>San Juan Basin</td>
<td>(0.2) (0.3) (Modest increase in drilling activity for conventional wells.)</td>
<td></td>
</tr>
<tr>
<td><strong>Total U.S.</strong></td>
<td><strong>2.3 5.3</strong> (High level of drilling activity for unconventional.)</td>
<td></td>
</tr>
</tbody>
</table>
Canada Factors: Flat/Declining Supply, Increasing Demand, Lower Exports to U.S.

NG Dry Production Scenarios

- Case A: Continuing Decline
- Case B: Modest Rebound
- Case C: Strong Rebound
- Case D: Delayed Rebound

Tar Sands Gas Consumption Scenarios

- No New Technology
- Slow Addition of New Technology


Photo: M. O'Driscoll, Greenwire, 2005.
Outlook for US LNG Imports*

- U.S. LNG Imports Will Increase Dramatically
  - U.S. LNG imports now about 8 to 9% of global market
  - Regas capacity will grow from 3.3 (2005) to >20 BCFD (~2012)

*incl. LNG to US via Mexico and Canada

Source: EVA, April 2008, personal communication.
Key Factors Underpinning LNG Outlook

• Record additions to global liquefaction capacity
• Expansion of existing terminals and greenfield LNG terminals
• Importance of competing (i.e. non-LNG) sources of gas to many countries: Europe, China, India
• Reasonable access to uncommitted supplies
Liquefaction

• Unprecedented boom
  – From 14 to 50 BCFD in 10 yrs
• Eng’g/const’n industries maxed out
• A “dynamic” process (estimates will change, basic message won’t)

Additions To Liquefaction Capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Trains</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>3</td>
<td>1.6</td>
</tr>
<tr>
<td>2002</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>2004</td>
<td>2</td>
<td>1.2</td>
</tr>
<tr>
<td>2006</td>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>2008</td>
<td>8</td>
<td>3.3</td>
</tr>
<tr>
<td>2010</td>
<td>3</td>
<td>2.9</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>4.3</td>
</tr>
</tbody>
</table>


Niger Delta, Bonnie Island LNG terminal


**Major Supply Points by 2013**

Total Supply Capacity = 50.4 BCFD

- Qatar 21%
- Nigeria 16%
- Rest of Persian Gulf 6%
- Malaysia/Brunei 8%
- Algeria 8%
- Indonesia 6%
- Other Atlantic Basin 15%
- Other Pacific Basin 7%

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- Disposition of new projects only (2000-2012); older supplies deemed committed to “iron-clad” contracts of the earlier era.
- US to garner a fair share of marketing and uncommitted volumes.
- US moving toward longer-term contracts.

Reference costs*:
- New liq. train: $2 B
- Upstream: $20 B

Uncommitted includes volumes not earmarked to a specific terminal but controlled by a marketing entity.

Source: EPRI, Global Natural Gas Market Assessment, 1014921. 2008

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Different Views of LNG Imports: EIA Annual Energy Outlook 2008 – Revised Early Release*

*March 2008
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NG Demand: Choosing NG or Coal for Electric Generation

NAT GAS $/1,000 CF Wellhead

COAL $/short ton Bituminous

NATURAL GAS PRICE
COAL PRICE

Capacity Additions (Actual and Likely as of MID-2007)

GW

NG Boom
Bust
Coal Resurgence

1999 2001 2003 2005 2007 2009 2011 2013 2015

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NG Demand: Turning to NG in Spite of High Prices – A “Mini-Boom” by Default?

Average New CC Capacity Utilization

47% … 43%  32%  34%  34%  34%

Forthcoming EPRI Program 67 newsletter on new power plants.

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NG Demand: Power Sector Growth Under “Business As Usual”

(BCFD) Power Sector Demand for Natural Gas

- Hot Summers
- Forecast

Principal Reasons for Variation
- Electricity load growth
- Summer weather (esp. peak)

Other Factors
- Fuel switching (not since 2005: oil prices >> NG)
- Hydro conditions

SOURCE: US Natural Gas Supply Equation and Price Envelope, 2007. 1014146 (updated 4-08 EVA pers. commun.)
US Tally of Coal Plants after 2007 Wave of Withdrawals, Cancellations, and Stalls

Progression of Estimates of “Likely” Coal-Fired Power Plants to ~ 2015

- **Mid 2005:**
  - Early Development: 19.4 GW
  - Advanced Development: 15,769 MW
  - Under Construction: 2,710 MW
  - Recently Completed: 2,966 MW

- **Mid 2006:**
  - Early Development: 35.2 GW
  - Advanced Development: 17,390 MW
  - Under Construction: 7,052 MW
  - Recently Completed: 788 MW

- **Mid 2007:**
  - Early Development: 35.8 GW
  - Advanced Development: 15,769 MW
  - Under Construction: 10,446 MW
  - Recently Completed: 788 MW

- **Fall 2007:**
  - Early Development: 33.7 GW
  - Advanced Development: 11,944 MW
  - Under Construction: 13,924 MW
  - Recently Completed: 2,710 MW

- **Feb. 2008:**
  - Early Development: 33.9 GW
  - Advanced Development: 9,578 MW
  - Under Construction: 15,294 MW
  - Recently Completed: 3,290 MW

**Source:** EPRI P67 newsletters on p-plant announcements; Feb’08 EVA personal communication.

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Business NOT as Usual: Impacts of Coal Plant Withdrawals

Focus to 2015
- No new nuclear; growth in renewables factored in.
- No realistic alternative to NG in the intermediate term

33% reduction: ~$7.50/MMBTU with add’l LNG imports

67% reduction: ~8.50/MMBTU with LNG at max, relinking to oil, and some fuel switching

100% reduction: $9.50-15.00++
with fuel switching at max

Many questions


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Conclusions

• Topsy-turvy price outlook
• What to watch?
Foreseeable Swings in NG Price Regimes
A Complicating Factor for Gen. Planning even in Normal Times

S. Specker, NAS En. Summit
March 14 2008

• Intermediate Term: Softening prices
  – Expanding storage
  – Strengthening production
  – Growing LNG (liquefaction, regasif.) and share of this world market
  – Major new pipeline unlocking Rockies nat. gas

• Longer Term: High prices, unstable conditions
  – Effects of coal plant cancellations on demand
  – Arctic pipelines critical to maintaining a balanced market
  – NG the default choice if there are any stumbles in the prism of responses to de-carbonize the electric sector
What to Watch?

• Stringent CO\textsubscript{2} legislation: huge NG impacts
• LNG outlook – why so far apart?
• Coal plant withdrawals and power sector NG demand
• The march of unconventional production
• Arctic gas development – how much, when?
• Logic of linkage of oil-LNG and LNG-NG
• And more…

“2 Oil Firms Plan Alaska Pipeline”
New York Times
April 9, 2008

~4 BCFD in 10 years (or longer)
Coal Retirements and NG Capacity Additions

Existing Capacity Retires
Pulverized Coal Capacity On-Line

New Coal with CCS Comes Later
Advanced Coal with CCS Capacity On-Line

Note: Superimposition added by EPRI.
Consumption of Coal and Natural Gas for Power Generation

- Coal
- Natural Gas

Note: BCFD change added by EPRI.

EPRI Response: Framework of EPRI NG and Power Studies

C. Global Gas Market Analysis 2008 (1014921)
   - Int’l Coal (1014922)
   - Int’l Capacity (1014920) 2008

B. Putting LNG into Perspective on a Global Basis 2006 (1013693)

F. Tensions in Global Power & Fuel Sector Development 2008 (P66)

E. Global NG/LNG Demand Assessment 2008 (?)

A. US Gas Supply Equation and Price Envelope 2007 (1014146)

D. The Unfamiliar US NG Infrastructure and Market Balance before Climate Change 2008 (P67, others?)

G. Characterization of NG Markets/Exchanges 2008 (P67)

Impacts of the Power Sector on Natural Gas Markets under Climate Change
   (Major Supplemental – 2008)

complete or forthcoming
EPRI Response:

Impacts of the Power Sector on Natural Gas Markets under Climate Change

Nine steps – Broad company participation is sought

1. Requirements
2. Background – The US Market is Tight under Business As Usual
3. US Supply Choices, Responses, and Their Limits
4. US Demand Shifts Across Sectors
5. Global Supply-Demand Balance – Impacts of a Doubling* of US LNG Requirements *several growth levels will be examined
6. NG/LNG Pricing and Trading
7. Regional Infrastructure Development – How Big a Hurdle?
8. Contracting for Natural Gas Supply and Delivery
9. Conclusions
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• Logic of linkage of oil-LNG and LNG-NG
• E&P cost escalation
• And more…