US Shale Gas & Pacific Gas Market:
Pacific LNG Trade & Gas Pricing Issues

Tuesday, May 14th, 2013
Faculty House at Columbia University
64 Morningside Drive
New York, New York 20027
USA

Organized By: InfraBasic ,LLC
In Partnership with: New York International University Center and the Energy China Forum
With the Support of: CESNA GROUP (Marketing Partner); National Research Foundation, Korea (Government Partner); POSCO RIST (Corporate Partner)
Prospects for U.S. Natural Gas Exports

U.S. Shale Gas Development: Current Trends and Future Prospects

David L. Goldwyn
SIPA Center on Global Energy Policy
May 14, 2013
Shale Gas Reserves Reflect Updated Assessments

Technically recoverable natural gas resources reflect new information, a combination of assessments and EIA updates

Source: EIA, Adam Sieminski, March 2013
Shale Gas Production

Domestic production of shale gas has grown dramatically over the past few years.

Sources: LCI Energy Insight gross withdrawal estimates as of March 2013 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.

Source: EIA, Adam Sieminski, April 2013
Dry Gas Production Rises Even as Rig Count Falls

Pennsylvania natural gas production rose 69% in 2012 despite reduced drilling activity

Annual natural gas well starts and production in Pennsylvania

Rigs are moving from Dry Gas to Wet Gas and Oil

Source: Baker Hughes North America Rotary Rig Count
Even though the rig count dropped by over 50%, US natural gas production has continued to climb.

This is due to better completions, producing more gas with less rigs!!

Source: Colorado School of Mines, Will Fleckenstein
Gas Production is Tied to Prices

Figure 2.10  Global Gas Supply Cost Curve by EPPA Region; 2007 Cost Base

Breakeven Gas Price
$MMBtu

Source: MIT; ICF Global Hydrocarbon Supply Model

Source: MIT “Future of Natural Gas” 2011
**U.S. Gas Supply Cost Curve**

**Breakeven Gas Price**

$/MMBtu

**Breakdown of Mean U.S. Supply Curve by Gas Type**

Breakeven Gas Price

$/MMBtu


Source: MIT “Future of Natural Gas” 2011
Supply and Demand Balance

Domestic natural gas production grows faster than consumption and the U.S. becomes a net exporter of natural gas around 2020

Source: EIA, Annual Energy Outlook 2013

Source: EIA, Adam Sieminski, April 2013
Likely Impacts of Exports

Export Volume

- Brookings Institution, Charles Ebinger and Govinda Avasarala: “Most analysts, including us, estimate that 4–6 bcf/day of LNG would be exported under reasonable market conditions.”

- Rice University, Kenneth Medlock: [His] “models found a market for no more than 1.2 billion cubic feet per day of US LNG.”

- Bentek Energy, LLC., Anthony Sweet: “expects total LNG exports of just 3 billion cubic foot per day by 2018.”

- Jensen Associates, Jim Jensen: “U.S. Lower 48 projects would provide 7.7 billion cubic feet a day of new LNG capacity, about one-quarter of additional capacity built worldwide [by 2025].”

<table>
<thead>
<tr>
<th>Study</th>
<th>Average Price without Exports ($/MMBtu)</th>
<th>Average Price with Exports ($/MMBtu)</th>
<th>Average Price Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIA*</td>
<td>$5.28</td>
<td>$5.78</td>
<td>9%</td>
</tr>
<tr>
<td>Deloitte</td>
<td>$7.09</td>
<td>$7.21</td>
<td>2%</td>
</tr>
<tr>
<td>Navigant (2010)**</td>
<td>$4.75</td>
<td>$5.10</td>
<td>7%</td>
</tr>
<tr>
<td>(2 bcf/day of exports)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navigant (2012)**</td>
<td>$5.67</td>
<td>$6.01</td>
<td>6%</td>
</tr>
<tr>
<td>ICF International* **</td>
<td>$5.81</td>
<td>$6.45</td>
<td>11%</td>
</tr>
</tbody>
</table>

* Price impact figure for EIA study reflects the reference case, low-slow export scenario.
** The Navigant study did not analyze exports of 6 bcf/day.
*** Navigant (2010 and 2012) and ICF International studies are based on Henry Hub price.
Cost of Best Practices

Figure 1.7  Impact of the Golden Rules on the cost of a single deep shale-gas well

- Current cost
- Cost with Golden Rules

Notes:
- Materials include all tangible material that is used in the well construction and remains in the well when it is completed, such as steel casing, valves and plugs.
- Services include various services, other than hydraulic fracturing services, that are used in well construction: directional drilling services, cementing services, casing services, wire line and testing services.

Wild Cards

- EPA and BLM Regulations
- Flaring
- Infrastructure
- Domestic Demand
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Natural Gas Supply – Understanding Resource Performance & Variability

Dr. Francis O’ Sullivan

May 14th, 2013
Estimates of U.S. gas resources have grown dramatically since 2005 due to the emergence of shale as a recoverable resource – The resource’s ability to support rapid production growth has also been notable.

Illustration of growth in US natural gas proved reserve and resource estimates from ’90 to ‘10 Tcf of gas

Illustration of production growth in the main U.S. shale plays since 2005 Bcf of gas per day

Today, shale supplies 33% of US gas production

1. EIA 2010 assessment based on 2008 PGC assessment with updated estimates of technically recoverable shale gas volumes
Source: F. O’Sullivan, NPC data, PGC data, EIA data
However, shale gas production is still in its infancy and large uncertainty surrounds estimates of recoverable resources – The physics that govern production from shale are still not well understood.

**Comparison of mean estimates of shale gas resources in the United States**

Tcf of Gas

- **EIA/USGS ‘11**
- **EIA ‘11**
- **PGC ‘09**
- **ICF ‘08**
- **ICF ‘09**
- **NPC ‘03**

Recent focus on assessing the shale gas potential in the U.S. has resulted in dramatic increases in resource estimates with some notable exceptions.

**Breakdown of the PGC 2009 shale gas resource estimates by major U.S. shale play**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort Worth Basin: Barnett Shale</td>
<td>25</td>
<td>59</td>
<td>100</td>
</tr>
<tr>
<td>Arkoma Basin: Fayetteville/Woodford</td>
<td>70</td>
<td>110</td>
<td>146</td>
</tr>
<tr>
<td>E. TX &amp; LA Basin: Haynesville Shale</td>
<td>60</td>
<td>112</td>
<td>182</td>
</tr>
<tr>
<td>Appalachian Basin: Marcellus/Ohio/Utica Shale</td>
<td>92</td>
<td>227</td>
<td>549</td>
</tr>
<tr>
<td>Anadarko/Permian Basins: Barnett/Woodford Shales</td>
<td>3</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Other Basins:</td>
<td>51</td>
<td>100</td>
<td>224</td>
</tr>
</tbody>
</table>

**Total Mean Estimate:**

- **301**
- **616**
- **1217**

* Mean volumes represent the “most likely” estimates reported by the PGC and can be aggregated by arithmetic addition to yield an aggregated mean estimate of shale gas resources in the United States. The per basin min and max numbers reported here assume perfect statistical correlation within basins.

** US min and max totals are for illustrative purposes only, and are calculated by direct addition of volumes, not statistical aggregation.

Source: F. O’Sullivan, Various commercial and institutional resource assessments
The US has an abundance of relatively low cost gas resources, with more than 30 years worth available at or below $6.00/MMBtu – Remarkably, the shale gas resource makes up the majority of this low-cost resource.
An assessment of well performance in the Barnett Shale reveals interesting features – There is appreciable spread is in well-to-well performance and consistency in the shape of the distribution for different metrics.

Distribution of absolute peak month well productivity\(^1\)
All horizontal shale wells drilled in Barnett Shale between 2005 and 2011

- P10: 635 Mcf/day
- P90: 3,370 Mcf/day

Very significant variation is evident in the well-to-well production performance of Barnett and other shale play wells.

Understanding the drivers of this variability requires examination of many factors:
- Impact of geological variation
- Impact of well completion design
- Temporal impact of a creaming process
- Etc.

P90 – P10 Spread = 5.3X

---

1. Peak month production rate reported in units of Mcf/day
Source: F. O’Sullivan, HPDI production database
Since 2005, the mean *absolute* productivity of Barnett wells has increased; however, *specific* well productivity has actually fallen – It is noteworthy that the level of intra-vintage well performance variability has remained consistent.

- The *absolute* well productivity has been increased year-on-year in the Barnett Shale since 2005.
- Today’s wells are ~25% more productive than wells drilled in 2005.
- The P90-P10 performance spread has been relatively consistent year-to-year.

- *Specific* well productivity has actually fallen by ~17% between 2005 and today.
- The higher productivity of the 2005 well vintage may indicate some form of creaming process.
- The year with the lowest *specific* productivity, 2008, also happened to be the year when the highest number of wells were drilled and so it is likely that lower quality acreage was being developed.
The trends observed in the Barnett well performance data are also evident in the well data of other plays – In particular, the large spread in intra-vintage well performance seen in the Barnett data is also evident in the other major plays.

### Per-vintage cdf of Fayetteville Shale well absolute peak-month gas production
Horizontal wells only

2010 vintage peak-month production rate data for Fayetteville, Haynesville and Marcellus Shale horizontal wells
Mcf/day

<table>
<thead>
<tr>
<th>Play</th>
<th># of wells</th>
<th>Mean</th>
<th>Median</th>
<th>P90</th>
<th>P10</th>
<th>P90-P10 Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fayetteville</td>
<td>870</td>
<td>2.320</td>
<td>2.240</td>
<td>3,750</td>
<td>960</td>
<td>3.9</td>
</tr>
<tr>
<td>Haynesville</td>
<td>478</td>
<td>9.300</td>
<td>8,690</td>
<td>15,560</td>
<td>4,510</td>
<td>3.5</td>
</tr>
<tr>
<td>Marcellus</td>
<td>468</td>
<td>3,280</td>
<td>2,780</td>
<td>6,130</td>
<td>1,180</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Source: HPDI production database
Shale plays are generally characterized as having core and non-core acreage, but asset quality is in fact much more complex – in all plays, well performance is statistically random over operationally relevant length-scales.

Intra and inter-play variability in shale productivity has major implications for the economics of the resource – Extensive drilling has pushed supply up and prices down, but much of this gas has been produced below cost.

Retrospective U.S. shale gas curves for the ‘09, ‘10 and ‘11 well vintages

First 12 month gas production from shale well vintage
Tcf of Gas

$3.67

$4.48

$3.95

Fewer than half of the shale wells brought online over the past 4-5 years have yielded an acceptable commercial return.

Liquids targeted drilling is increasingly delivering ultra low-cost gas to the system

1. Supply curves include: Bakken, Barnett, Eagle Ford, Fayetteville, Haynesville, Marcellus and Woodford plays, and represent only gas produced by horizontal wells

Source: F. O'Sullivan
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Export of US Shale Gas & Northwest East Asia LNG Market

Younkyoo Kim
Center for Energy Governance & Security
Division of International Studies
Hanyang University, Seoul, Korea
May 14, 2013
1. Global LNG Supply and Demand Structure

- 8% Increase in LNG Trade (2011): Total Turnover of 241.5 MT

<table>
<thead>
<tr>
<th>2006-2011 LNG Trade Trends</th>
</tr>
</thead>
<tbody>
<tr>
<td>* [Total Turnover]</td>
</tr>
</tbody>
</table>

- Largest Exporter → Qatar 75.5 MT (31% of total supply)
  - Malaysia + Indonesia + Australia = 27% of total supply

- Largest Importer → Japan + S. Korea (48% of total demand)
Global gas trade growth – Pipelines, LNG and AP LNG


2. LNG Spot Market

- LNG is traditionally traded through Long-term deal contracts

- Spot Market Share

<table>
<thead>
<tr>
<th>Year</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>11.7%</td>
</tr>
<tr>
<td>2004</td>
<td>19.0%</td>
</tr>
<tr>
<td>2010</td>
<td>20.0%</td>
</tr>
<tr>
<td>2011</td>
<td>25% (62 MT)</td>
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</table>
### LNG Import by Country, 2006-11, bcm

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tr>
<td>China</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>India</td>
<td>8</td>
<td>10</td>
<td>11</td>
<td>13</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Japan</td>
<td>82</td>
<td>89</td>
<td>92</td>
<td>86</td>
<td>93</td>
<td>107</td>
</tr>
<tr>
<td>South Korea</td>
<td>34</td>
<td>34</td>
<td>37</td>
<td>34</td>
<td>44</td>
<td>49</td>
</tr>
<tr>
<td>Taiwan</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>12</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>AP Consumption</td>
<td>135</td>
<td>148</td>
<td>156</td>
<td>152</td>
<td>178</td>
<td>207</td>
</tr>
<tr>
<td>ROW Consumption</td>
<td>76</td>
<td>78</td>
<td>71</td>
<td>91</td>
<td>120</td>
<td>124</td>
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<tr>
<td>Global LNG</td>
<td>211</td>
<td>226</td>
<td>227</td>
<td>243</td>
<td>298</td>
<td>331</td>
</tr>
</tbody>
</table>

### Consumption Growth

- **China**
  - y-o-y %: 33%, 23%, 13% (30%)
- **India**
  - y-o-y %: 32%, 25%, 8% (17%)
- **Japan**
  - y-o-y %: 7%, 9%, 4% (-7%)
- **South Korea**
  - y-o-y %: 12%, 1%, 6% (-6%)
- **Taiwan**
  - y-o-y %: 6%, 7%, 11% (-2%)
- **Thailand**
  - y-o-y %: NA
- **AP**
  - y-o-y %: 10%, 9%, 5% (-2%)
- **AP 3Yr CAGR (%)**
  - 6.0%, 7.7%, 8.4%, 4.0%, 6.3%, 9.9%

Source: BP Statistical Review of World Energy June 2012, HSBC
CHINA’S NATURAL GAS SUPPLY AND DEMAND SCENARIOS (BCM)

- Natural Gas Demand (BCM)

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<tbody>
<tr>
<td></td>
<td>111</td>
<td>135</td>
<td>230</td>
<td>260</td>
<td>282</td>
<td>323</td>
<td>350</td>
<td>500</td>
<td>456</td>
<td>592</td>
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</table>

Source: EGS Korea
Center for Energy Governance & Security
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</thead>
<tbody>
<tr>
<td><strong>Demand</strong></td>
<td>127.3</td>
<td>150.7</td>
<td>178.4</td>
<td>211.2</td>
<td>250.0</td>
<td>274.6</td>
<td>301.7</td>
<td>331.4</td>
<td>364.1</td>
<td>400.0</td>
</tr>
<tr>
<td><strong>Growth rate</strong></td>
<td>18 %</td>
<td>18 %</td>
<td>18 %</td>
<td>18 %</td>
<td>18 %</td>
<td>10 %</td>
<td>10 %</td>
<td>10 %</td>
<td>10 %</td>
<td>10 %</td>
</tr>
<tr>
<td><strong>Conventional Production</strong></td>
<td>103.6</td>
<td>113.7</td>
<td>124.7</td>
<td>136.8</td>
<td>150.0</td>
<td>161.9</td>
<td>174.8</td>
<td>188.8</td>
<td>203.8</td>
<td>220.0</td>
</tr>
<tr>
<td><strong>CBM</strong></td>
<td>2.1</td>
<td>3.1</td>
<td>4.5</td>
<td>6.6</td>
<td>10.0</td>
<td>12.5</td>
<td>15.5</td>
<td>19.3</td>
<td>24.1</td>
<td>30.0</td>
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<tr>
<td><strong>Shale Gas</strong></td>
<td>-</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>1.0</td>
<td>1.5</td>
<td>2.3</td>
<td>3.4</td>
<td>5.1</td>
<td>10.0</td>
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<tr>
<td><strong>Domestic Supply</strong></td>
<td>105.8</td>
<td>116.9</td>
<td>129.4</td>
<td>143.9</td>
<td>161.0</td>
<td>175.9</td>
<td>192.6</td>
<td>211.5</td>
<td>232.9</td>
<td>260.0</td>
</tr>
<tr>
<td><strong>Turkmenistan</strong></td>
<td>12.0</td>
<td>15.0</td>
<td>22.0</td>
<td>25.0</td>
<td>30.0</td>
<td>30.0</td>
<td>35.0</td>
<td>35.0</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td><strong>Mynmar</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.0</td>
<td>9.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td><strong>Russia</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.0</td>
<td>10.0</td>
<td>10.0</td>
<td>12.0</td>
<td>15.0</td>
</tr>
<tr>
<td><strong>Pipeline Imports</strong></td>
<td>12.0</td>
<td>15.0</td>
<td>22.0</td>
<td>30.0</td>
<td>39.0</td>
<td>40.0</td>
<td>50.0</td>
<td>55.0</td>
<td>62.0</td>
<td>65.0</td>
</tr>
<tr>
<td><strong>LNG imports</strong></td>
<td>16.9</td>
<td>22.2</td>
<td>29.1</td>
<td>38.1</td>
<td>50.0</td>
<td>54.2</td>
<td>58.8</td>
<td>63.8</td>
<td>69.2</td>
<td>75.0</td>
</tr>
<tr>
<td><strong>Total Imports</strong></td>
<td>28.9</td>
<td>37.2</td>
<td>51.1</td>
<td>68.1</td>
<td>89.0</td>
<td>94.2</td>
<td>108.8</td>
<td>118.8</td>
<td>131.2</td>
<td>140.0</td>
</tr>
<tr>
<td><strong>Supply</strong></td>
<td>134.7</td>
<td>154.1</td>
<td>180.5</td>
<td>212.0</td>
<td>250.0</td>
<td>270.1</td>
<td>301.4</td>
<td>330.2</td>
<td>364.1</td>
<td>400.0</td>
</tr>
</tbody>
</table>

Gao (2012), NG61, The Oxford Institute for Energy Studies
Lack of PNG Infrastructure

Only 53 bcm ?!

- China
- Hong Kong
- Australia
- Singapore
- Malaysia
- Singapore
- Thailand
- China

Source: BP Statistical Review of World Energy 2012, HSBC
A Rebalancing of Global Oil and Gas

What about AFTER Shale?

Flow Before Shale: Regional Segmentation
A Rebalancing of Global Oil and Gas
Map 1: North American LNG Projects

North American LNG Import / Export Terminals

As of April 26, 2012

Approved Sites
Import Terminals Under Construction
1. Manzanillo, Mexico

Import Terminals Not Under Construction
2. Corpus Christi, TX
3. Freeport, TX
4. Hackberry, LA
5. Port Lavaca, TX
6. Baltimore, MD
7. Coos Bay, OR
8. Gulf of Mexico
9. Offshore Florida
10. Gulf of Mexico
12. Quebec City, Que.
13. Baja California, Mexico

Export Terminal Not Under Construction
14. Sabine, LA

Proposed / Potential Sites
Import Terminal
1. Robbinston, ME
2. Astoria, OR
3. Calais, ME
4. Corpus Christi, TX

Export Terminal
5. Freeport, TX
6. Corpus Christi, TX
7. Coos Bay, OR
8. Lake Charles, LA
9. Kitimat, B.C.
10. Kitimat, B.C.
11. Douglas Island, B.C.
12. Cove Point, MD
13. Hackberry, LA
14. Brownsville, TX
15. Astoria, OR
16. Prince Rupert Island, B.C.
17. Gulf of Mexico

Source: U.S. Department of Energy

Andrew Barr / National Post
A Rebalancing of Global Oil and Gas

Export Scenario 1:
- Only major shale producer
- Henry Hub $4 ~ 5
- Low environmental regulation
- Total 12 BCF (~95 mtpa)
A Rebalancing of Global Oil and Gas

Export Scenario 2:
- Worldwide shale revolution (China)
- Henry Hub $6 ~ 8
- Environmental issue
- Total 6 BCF (~48 mpta)
Impact of US Gas Exports

- Supply diversity
- LNG flexibility
- Global gas market
- LNG Trading Hub
US Shale Gas & Pacific Gas Market:
Pacific LNG Trade & Gas Pricing Issues

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With the Support of: CESNA GROUP (Marketing Partner); National Research Foundation, Korea (Government Partner); POSCO RIST (Corporate Partner)
THE OUTLOOK FOR GAS DEMAND IN EAST ASIA BY SOURCE OF SUPPLY

A Presentation to
The Conference on US Shale Gas & Pacific Gas Markets
Sponsored by The Center for Global Energy Policy, Columbia University
And The Center for Energy Governance & Security, Hanyang University
May 14, 2013

JAMES T. JENSEN
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Fax (781) 894 9130
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FOR YEARS, ASIAN GAS TRADE HAS BEEN DRIVEN BY JAPANESE AND KOREAN LNG

- But the Mantle is Now Passing to China, Whose First Imports Date Only from 2006

- Neither the IEA Nor the EIA are Optimistic About Demand Growth in Japan and Korea

- China Has Been an Enigma; Not Only the IEA and the EIA, But the Chinese Themselves, Have Been Steadily Increasing Their Estimates Over Time

- But, the Assumption That Import Estimates Can Only Go Up May No Longer be True; Several Factors Suggest That a Slowing of Growth May be Possible
PROJECTED INCREASE IN EAST ASIAN GAS DEMAND OVER 2011 BY SUPPLY SOURCE (ESTIMATES BASED ON EIA, IEA AND JENSEN ASSOCIATES DATABASE)

Chinese LNG Demand Increase is by Far the Largest, But it is Sensitive to Demand and Availability of Other Supply Sources

[1] Based on 90% of Contracted Volumes
[2] IEA Projects Total FSU; 2035 May Be Russian Pipeline, Russian LNG or Added Caspian Supply
[3] IEA Does Not Project Korea; Estimate From IEA and Assumes All LNG
THE SENSITIVITY OF CHINESE LNG DEMAND TO DETERMINING VARIABLES

Is China's High Economic and Energy Demand Growth Sustainable?

How Will China Resolve its Coal/Gas/Environment Dilemma?

How Will China Adapt its Pricing Policies as it Increasingly Relies on Imports?

How Much Optimism About Unconventional Gas is Justified?

What Will be the Balance Between Pipeline and LNG Imports?
THE UNDERESTIMATES HAVE BEEN CAUSED BY THE ECONOMIC/ENVIRONMENT DILEMMA

- Chinese Coal Has Been Cheap; Gas is Expensive and it is Hard to Justify Replacing Coal With Gas Economically

- But Environmental Concerns Have Overridden Pure Economics

- However, Chinese Growth is Slowing, Subsidized Prices are Being Eliminated and Shale Gas Resources are Large

- But One of the Largest Uncertainties is the Choice Between Pipeline and LNG Imports

- The West Siberian Project from Russia is Equivalent to Half the LNG That Qatar Put on the Market in 2009/2010
US Shale Gas & Pacific Gas Market:
Pacific LNG Trade & Gas Pricing Issues

Tuesday, May 14th, 2013
Faculty House at Columbia University
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USA

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Security and Politics of Increased Natural Gas Trade
Outline

- Basic Assumptions
- Impacts Abroad
  - Lessons from Europe
  - Prospects for Asia
  - Supplier Impacts
- Impacts at Home with Global Consequences
  - Price Linkages
  - Oil Substitution
  - Climate Change
- Consequences of a U.S. export decision
Basic Assumptions

- Market for U.S. exports is modest
  - Liquefaction, shipping, and regasification costs limit commercial attractiveness of U.S. exports
  - Demand-side response is limited at likely prices

- Large-scale overinvestment is unlikely
  - High capital costs, long construction periods
  - But long-term uncertainty in overseas output, prices

- Pricing is likely to be mostly (but not only) under liquefaction tolling agreements (or similar)
  - Risk profile of individual companies is central

- Price and politics are intimately connected
Lessons from Europe

- Major impact from failure of U.S. to import
  - Steady shift to transparent gas-on-gas pricing
    - Part automatic, part result of Qatari discretion, part consequence of importers’ willingness to negotiate
  - Helped by little substantial support for oil-gas link
  - Aided by existence of market infrastructure

- Impact of U.S. exports likely to be indirect
  - Little price-based reason for imports from U.S.
  - Prospect of imports should help maintain pressure
Prospects for Asia

- Asia appears to make most sense as destination at likely prices
  - But price not the only criterion determining export destinations

- Central question: Will Asia abandon oil-linked pricing for “gas-on-gas” pricing?

- U.S. exports could create some pressure, but…
  - Henry Hub pricing is not a viable substitute
  - Underlying oil link still has some foundation
  - Physical hub still required for transformation
    - Singapore? Japan? China?
    - Barriers exist in each case
Asian Impacts Beyond Price Regime

- Diversification of price risk
  - Partial decoupling from oil price risk
  - But some compensating risk from U.S. prices

- Reduced volume risk
  - Sea lane disruption
  - Middle East events
  - Limited if most U.S. LNG already destined for Asia
Producers Impacts

- Limited for low-cost and established suppliers
  - Qatar, Algeria, etc

- Possible revenue challenges for high-cost established suppliers
  - Russia is most prominent

- Market entry challenges for high-cost prospective suppliers
  - East Africa, possibly Australia (but less important)
Impacts at Home (with Global Consequences)

- **Price linkage**
  - Requires (and limited by scale of) overinvestment

- **Oil substitution**
  - Large effect unlikely
    - “What if this were used in cars” = fallacy
    - $1/MMBtu = $5.55/bbl
  - Overseas substitution has some (small) price effect
  - Most export decisions unchanged if externality priced

- **Climate change**
  - Net global emissions impact likely neutral to negative
  - Domestic emissions impact almost certainly positive
  - Too small to have diplomatic consequences
    - EIA implied estimate ~0.5 percent by 2020
Impacts of a U.S. Exports *Decision*

- Policy decision to *allow* exports different from commercial decision to export natural gas
- Ramifications for trade diplomacy
  - Legal
  - Political
- Consequences would be varied
  - Korea vs. Japan vs. China vs. Europe
- Limited impact on actual markets?
  - Increased Canadian exports
    - Reduced volumes and different pricing schemes
US Shale Gas & Pacific Gas Market:
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Outlook for shale gas and tight oil development in the U.S.

For
Joint Forum on US Shale Gas & Pacific Gas Markets
May 14, 2013 | New York, NY

By
Adam Sieminski, Administrator
U.S. Shale Gas
Domestic production of shale gas has grown dramatically over the past few years.

shale gas production (dry)
billion cubic feet per day

Sources: LCI Energy Insight gross withdrawal estimates as of March 2013 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.
Shale gas leads growth in total gas production through 2040 to reach half of U.S. output

U.S. dry natural gas production
trillion cubic feet

Source: EIA, Annual Energy Outlook 2013
Domestic natural gas production grows faster than consumption and the U.S. becomes a net exporter of natural gas around 2020

Source: EIA, Annual Energy Outlook 2013

Adam Sieminski, May 14, 2013
U.S. natural gas imports and exports

Reference case

High resource case

trillion cubic feet

Exports to Mexico
Exports to Canada
Lower 48 states LNG exports
Alaska LNG exports
Imports from Canada
LNG imports

Source: EIA, Annual Energy Outlook 2013

Adam Sieminski, May 14, 2013
Uncertainties that could slow global growth of shale gas and tight oil

- Resource quantities and distribution
- Surface vs. mineral rights
- Risk appetite of industry participants
- Infrastructure and technology
- Environmental constraints
U.S. Tight Oil
Domestic production of tight oil has grown dramatically over the past few years.

Tight oil production for select plays million barrels per day

Source: Drilling Info (formerly HPDI), Texas RRC, North Dakota department of mineral resources, and EIA, through December 2012

Adam Sieminski, May 14, 2013
U.S. tight oil production leads growth in domestic production

Source: EIA, Annual Energy Outlook 2013 and Short-Term Energy Outlook, May 2013

Reference case

High resource case

million barrels per day

10

8

6

4

2

0

1990 2000 2010 2020 2030 2040

History 2011 Projections

STEO May 2013 U.S. crude oil projection

Tight oil

Alaska

Lower 48 states offshore

Other lower 48 states onshore

Tight oil

Alaska

Lower 48 states offshore

Other lower 48 states onshore
U.S. dependence on imported liquids depends on both supply and demand

U.S. liquid fuel supply
million barrels per day

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption</th>
<th>Net imports</th>
<th>Domestic supply</th>
<th>Petroleum Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>1985</td>
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<td>2000</td>
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<td>2005</td>
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<td>2010</td>
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<td>2015</td>
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<tr>
<td>2020</td>
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<td>2025</td>
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<tr>
<td>2030</td>
<td></td>
<td></td>
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<tr>
<td>2035</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

History

2012

Projections

32% STEO forecast for 2014

-8%

37%

Source: EIA, Annual Energy Outlook 2013 and Short-Term Energy Outlook, April 2013

Adam Sieminski, May 14, 2013
2013 EIA ENERGY CONFERENCE

Keynote Speakers

Thomas Fanning
Chairman, President and CEO
Southern Company

Aldo Flores-Quiroga
Secretary General
International Energy Forum

Hans Rosling
Chairman
Gapminder

Register at: www.fbcinc.com/EIA
June 17-18, 2013 · JW Marriott · Washington, DC
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U.S. Energy Information Administration home page | [www.eia.gov](http://www.eia.gov)

Annual Energy Outlook | [www.eia.gov/forecasts/aeo](http://www.eia.gov/forecasts/aeo)

Short-Term Energy Outlook | [www.eia.gov/forecasts/steo](http://www.eia.gov/forecasts/steo)

International Energy Outlook | [www.eia.gov/forecasts/ieo](http://www.eia.gov/forecasts/ieo)

Today In Energy | [www.eia.gov/todayinenergy](http://www.eia.gov/todayinenergy)

Monthly Energy Review | [www.eia.gov/totalenergy/data/monthly](http://www.eia.gov/totalenergy/data/monthly)

Annual Energy Review | [www.eia.gov/totalenergy/data/annual](http://www.eia.gov/totalenergy/data/annual)
US Shale Gas & Pacific Gas Market:
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The LNG Export Permitting Process

David L. Goldwyn
SIPA Center on Global Energy Policy
May 14, 2013
Background

- Natural Gas Act of 1938, Section 3
  - Transferred authority over natural gas imports and exports from the Federal Power Commission (FPC) to DOE
  - Secretary of Energy delegated responsibilities:
    - DOE: the right to approve exports and imports unless “the proposed exportation or importation will not be consistent with the public interest.”
      - Exports to FTA-countries were exempted following the Energy Policy Act of 1992
    - FERC: siting authority to approve or deny the construction and operation of import or export facilities, the site at which such facilities shall be located, and the place of entry for imports or exit for exports.
      - Energy Policy Act of 2005 named FERC the lead Agency for coordinating Federal authorizations and complying with NEPA, and made it responsible for coordinating the actions of approximately 20 cooperating agencies
FERC Process: Pre-Filing

- Grants time for the applicant to speak directly to FERC, explaining process and soliciting advice.

- Intended to be used as time to troubleshoot potential problems and shorten total process.

- Public meetings held so that public, agencies and FERC can all communicate openly with applicant.

Resource Reports:
1. General Overview
2. Water Use and Quality
3. Fish, Wildlife & Vegetation
4. Cultural Resources
5. Socioeconomics
6. Geological Resources
7. Soils
8. Land Use, Recreation, & Aesthetics
9. Air & Noise Quality
10. Alternatives
11. Reliability and Safety
12. PCB Contamination
13. Engineering & Design Material
FERC Process: Filing

Environmental Review Timeline:
- FERC has 90 days after submission to describe schedule for EA/EIS review
- EA/EIS review carried out
  - EA- posted as final with 30 day comment period
  - EIS- posted as draft with comment period. After comment period, those comments are integrated and the FERC Commissioners vote
- Once final EA/EIS is issued, other agencies have 90 days to make final decisions on request for federal authorizations
- EA will require a minimum of 20 months
- EIS will require a minimum of 26 months
- Compliance requires extensive engineering and design work in addition to a battery of safety and environmental surveys/testing
- Much more cost-intensive than pre-filing or applying for a DOE permit
DOE Process: Conditions

1. The scope of the project, including the volumes of natural gas involved, the dates of commencement and completion of the proposed import or export, and the facilities to be utilized or constructed;
2. The source and security of the natural gas supply to be imported or exported, including contract volumes and a description of the gas reserves supporting the project during the term of the requested authorization;
3. Identification of all the participants in the transaction, including the parent company, if any, and identification of any corporate or other affiliations among the participants;
4. The terms of the transaction, such as take-or-pay obligations, make-up provisions, and other terms that affect the marketability of the gas;
5. The provisions of the import arrangement which establish the base price, volume requirements, transportation and other costs, and allow adjustments during the life of the project, and a demonstration as to why the import arrangement is and will remain competitive over the life of the project and is otherwise not inconsistent with the public interest;
6. The demonstration of a lack of a national or regional need for the proposed exports; and
7. The potential environmental impact of the project.
## Implications: Natural Gas Price Increase

Study-by-study comparison of the Average Price Impact from 2015-2035 of 6 bcf/day of LNG exports (unless otherwise noted)

<table>
<thead>
<tr>
<th>Study</th>
<th>Average Price without Exports ($/MMBtu)</th>
<th>Average Price with Exports ($/MMBtu)</th>
<th>Average Price Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EIA</strong></td>
<td>$5.28</td>
<td>$5.78</td>
<td>9%</td>
</tr>
<tr>
<td>Deloitte</td>
<td>$7.09</td>
<td>$7.21</td>
<td>2%</td>
</tr>
<tr>
<td>Navigant (2010)** (2 bcf/day of exports)</td>
<td>$4.75</td>
<td>$5.10</td>
<td>7%</td>
</tr>
<tr>
<td>Navigant (2012)*****</td>
<td>$5.67</td>
<td>$6.01</td>
<td>6%</td>
</tr>
<tr>
<td>ICF International***</td>
<td>$5.81</td>
<td>$6.45</td>
<td>11%</td>
</tr>
</tbody>
</table>

* Price impact figure for EIA study reflects the reference case, low-slow export scenario.

** The Navigant study did not analyze exports of 6 bcf/day.

*** Navigant (2010 and 2012) and ICF International studies are based on Henry Hub price.

Source: EIA, Deloitte, Navigant, ICF International
Implications: Electricity and Industrial Sectors

- Power and industrial sectors will not see dramatic changes in prices or competitiveness

**Increase in Electricity Prices as a Result of 6 bcf/day of exports, 2035**

<table>
<thead>
<tr>
<th>Source</th>
<th>Estimated Increase in Electricity Prices ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIA*</td>
<td>$1.40-$2.90/MWh</td>
</tr>
<tr>
<td>Deloitte</td>
<td>&lt;$1.65/MWh</td>
</tr>
<tr>
<td>ICF International</td>
<td>$1.66-$4.97/MWh</td>
</tr>
</tbody>
</table>

* EIA range does not include high-rapid export scenario

Source: EIA, Deloitte, ICF International

**Brent-to-Henry Hub Price Ratio, 2000-2012**

* 2012 prices average of prices from January-March 2012

Source: EIA
Implications: Macroeconomy and Jobs

• The macroeconomic impact of exports is likely to be modest
  • NERA predicts that net welfare gains to the US will range between 0.0038% and 0.0291%
  • Price increases will have marginal impact on industrial consumers’ competitiveness
  • Liquefaction projects will create temporary construction employment but will require few permanent employees
  • 65% of exported gas will come from new production: new production will increase employment demand

• Trade and exchange rate impacts are modest
  • LNG exports will result in gains from trade
  • All oil and gas exports estimated to cause dollar appreciation by between 1% and 5% by 2020
Domestic demand: the U.S. Power Sector is the immediate beneficiary of shale gas

![Graph of US Monthly Net Electric Power Generation (Million MWh)](image)

Source: EIA
Domestic demand: Gas has stoked visions of an industrial sector “renaissance”

Source: EIA
US LNG: An economically bound opportunity

Global LNG Supply/Demand Balance, 2015-2020 (bcf/day)

Source: Brookings Estimates, IEA, EIA, Morgan Stanley, JP Morgan, Credit Suisse
US LNG competes with other gas: international pipelines and post-2020 LNG supplies aplenty

~13 bcf/day of non-U.S. LNG Projects post-2020

... And with Pipeline Gas

Existing/Expansion
- East-West Pipeline (Turkmenistan to China)

Under Construction
- Myanmar-China Pipeline

Potential/Speculative
- Russia-China
- Turkmenistan-Afghanistan-Pakistan-India
- Iran-Pakistan-India
- Oman-India
- ASEAN Interconnection
- Russia-North and South Korea

Source: Credit Suisse, Brookings, company reports
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Exports of U.S. Shale Gas: A Chinese Perspective

Kevin Jianjun Tu, Senior Associate
Carnegie Endowment for International Peace

US Shale Gas & Pacific Gas Market
Columbia University, New York

May 14th, 2013
Drivers Underlying Global Energy Trend

China/U.S. in 2011

<table>
<thead>
<tr>
<th>Category</th>
<th>Absolute</th>
<th>Per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>3.66</td>
<td>0.85</td>
</tr>
<tr>
<td>Oil</td>
<td>0.55</td>
<td>0.13</td>
</tr>
<tr>
<td>Gas</td>
<td>0.19</td>
<td>0.04</td>
</tr>
<tr>
<td>Nuclear</td>
<td>0.10</td>
<td>0.02</td>
</tr>
<tr>
<td>Hydro</td>
<td>2.11</td>
<td>0.49</td>
</tr>
<tr>
<td>Renewables</td>
<td>0.39</td>
<td>0.09</td>
</tr>
<tr>
<td>Energy</td>
<td>1.15</td>
<td>0.27</td>
</tr>
<tr>
<td>CO₂</td>
<td>1.49</td>
<td>0.35</td>
</tr>
</tbody>
</table>

China: a Hybrid Economy at Crossroad

Source: World Bank, IEA, own estimation
Concern of Energy Security

Source: China Customs.
Dependency on Foreign Oil: China vs. US

Source: NBS, US EIA.
Environmental Constraints

Gt of CO₂ Emissions

Source: US EIA, NBS, ERI, IEA, own estimation.
Why Gas Matters for China

- The urgent need to substitute coal at scale.
- Problems with nuclear, hydro, solar and wind development.
- 12th Five Year Plan: 1) Shale Gas, 2) Natural Gas, 3) Energy
Beijing’s Problem with Shale

Source: Chinese Ministry of Land and Resources.
Sources of China’s Gas Supply

- Can conventional fields deliver as expected?
- Problem with CBM development.
- Is coal-to-gas compatible with China’s conservation goals?
- Can shale gas be kicked off?
- Can pipeline gas deal with Russia overcome pricing dispute?
- Is U.S. a potential LNG supplier?
Bilateral Coal Trade: An Example

Source: China Customs.
## North American LNG Import/Export Terminals

### A Chinese Perspective

**Import Terminal**
- **PROPOSED TO FERC**
  1. Robbinston, ME: 0.5 Bcf/d (Kestrel Energy - Downeast LNG)
  2. Astoria, OR: 1.5 Bcf/d (Oregon LNG)
  3. Corpus Christi, TX: 0.4 Bcf/d (Cheniere – Corpus Christi LNG)

**POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS**
  4. Offshore New York: 0.4 Bcf/d (Liberty Natural Gas)

**Export Terminal**
- **PROPOSED TO FERC**
  5. Freeport, TX: 1.8 Bcf/d (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction)*
  6. Corpus Christi, TX: 2.1 Bcf/d (Cheniere – Corpus Christi LNG)*
  7. Coos Bay, OR: 0.9 Bcf/d (Jordan Cove Energy Project)
  8. Lake Charles, LA: 2.4 Bcf/d (Southern Union - Trunkline LNG)
  9. Hackberry, LA: 1.7 Bcf/d (Sempra – Cameron LNG)*
  10. Cove Point, MD: 0.82 Bcf/d (Dominion – Cove Point LNG)*
  11. Astoria, OR: 1.30 Bcf/d (Oregon LNG)
  12. Lavaca Bay, TX: 1.38 Bcf/d (Excelsior Liquefaction)
  13. Elba Island, GA: 0.35 Bcf/d (Southern LNG Company)
  14. Sabine Pass; LA: 1.3 Bcf/d (Sabine Pass Liquefaction)
  15. Lake Charles, LA: 1.07 Bcf/d (Magnolia LNG)
  16. Plaquemines Parish, LA: 1.07 Bcf/d (CE FLNG)

**PROPOSED CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS**
  17. Kitimat, BC: 0.7 Bcf/d (Apache Canada Ltd.)
  18. Douglas Island, BC: 0.25 Bcf/d (BC LNG Export Cooperative)

### Table 5 End-user prices in selected Chinese cities, 2011

<table>
<thead>
<tr>
<th></th>
<th>Residential</th>
<th>Industry</th>
<th>Power</th>
<th>NGVs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CNY/m³ USD/MBtu</td>
<td>CNY/m³ USD/MBtu</td>
<td>CNY/m³ USD/MBtu</td>
<td>CNY/m³ USD/MBtu</td>
</tr>
<tr>
<td>Beijing</td>
<td>2.05</td>
<td>2.84</td>
<td>2.84</td>
<td>4.73</td>
</tr>
<tr>
<td>Tianjin</td>
<td>2.20</td>
<td>3.15</td>
<td>3.15</td>
<td>3.95</td>
</tr>
<tr>
<td>Shanghai</td>
<td>2.50</td>
<td>3.69</td>
<td>3.89</td>
<td>4.70</td>
</tr>
<tr>
<td>Guangxi</td>
<td>4.37</td>
<td>5.73</td>
<td>5.73</td>
<td>4.95</td>
</tr>
</tbody>
</table>

Source: CNPC.
Thank You!

www.weibo.com/tujianjun
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EXPORT OF US SHALE GAS:
PERSPECTIVE FROM JAPAN

A Presentation to
The Conference on US Shale Gas & Pacific Gas Markets
Sponsored by The Center for Global Energy Policy, Columbia University
And The Center for Energy Governance & Security, Hanyang University
May 14, 2013

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E Mail JAI-Energy@Comcast.Net
Since the 2009 recession, Japan has increasingly been forced to face severe challenges to its energy and environmental policies.

- The Fukushima disaster in March 2011 placed the future of nuclear energy under a cloud, and led to a policy statement in September 2012 which called for the phase-out of all nuclear plants by sometime in the 2030s.

- Then, after years of debate, in October 2012, Japan finally addressed the carbon emissions issue by introducing a phased-in carbon tax.

- These two policies, designed to reduce dependence on coal and nuclear, effectively downgraded the two energy sources that supplied 53% of Japanese power generation in 2010 and were relied on for base load.
While These Policies May Not Survive the Recent Change in Government, They Imply Greater Reliance on LNG-Fired Power Generation and Advanced Coal Technology; LNG Had Accounted for Only 27% of Generation in 2010 (Non-Hydro Renewables Were 3%)

Because of its Higher Costs, LNG Has Historically Been Relegated to Intermediate Dispatch Where its Generation Share - Pre-Fukushima - Had Never Exceeded 28%

Gas Has a Lower Industrial Share - !0% To Coal's 56%

But Just as Japan is Attempting to Place Greater Emphasis on Gas, LNG Costs Have Been Rising Substantially; Import Prices in 2012 Were at an All Time High

Thus the Appeal of Importing LNG From the U.S., Where the Development of Shale Gas Has Driven Gas Prices There to Levels Not Seen Since the 1990s
The Current High Cost of Japanese LNG Tends to Restrict CCGT Units to Intermediate Dispatch, Preserving Coal and Nuclear for Base Load.
THE 2009/2010 GAS MARKET SURPLUS SET OFF REGIONAL GAS PRICE COMPETITION, AND FORCED A POSSIBLY PERMANENT RESTRUCTURING OF THE INTERNATIONAL GAS PRICING SYSTEM

For Some Time, It Has Been Common Among Energy Analysts to Speculate That Growing LNG Trade Would Ultimately Create a "World Gas Market" by Linking Previously Isolated Regional Markets

The LNG Surplus of 2009/2010 Finally Made it Happen, But the Result Bears Little Resemblance to the Relatively Uniform Regional Price Structure of the World Oil Market

As a Result of the Surplus, International Gas Prices Today Are Experiencing Unprecedented Divergence
Just How Far Out of Balance They Are is Illustrated by Average Regional Prices in 2012
U.S. Commodity Prices at Henry Hub - $2.74
Dutch Commodity Prices at the TTF Hub - $9.34
German Contract Prices from Russia - $12.56
And Japanese LNG (as Liquid) - $16.55

This is a Radically New Pricing Environment; In the Five Years Preceding 2008, the Average Price Spread Between Highest of the Four (Japan) and Lowest (TTF) was Only 10%; Japanese Prices Were Only 3% More Than Henry Hub

Some of the Disparity is Due to Transient Market Conditions - Distress Pricing in the U.S. and the Japanese Response to Post-Fukushima Nuclear Shutdowns

But Part of it Represents a Permanent Restructuring of International Gas Pricing in Which Japan is Vulnerable
The Restructuring Puts Great Stress on Finding Ways to Reduce the Costs of Imported Asian LNG in Order to Maintain Industrial Competitiveness

Much of the Interest in U.S. LNG Exports is Based on This Huge Disequilibrium Between U.S. Commodity Prices and European and Asian Contract Prices

It Has Been Possible to Talk of "World Oil Prices" Because the Costs of Marine Oil Transportation are Relatively Low; The Same is True for Coal

But One Cannot Talk About "World Gas Prices" Because Gas, Like Those Legendary Local French Wines "Does Not Travel Well"

Thus LNG Importing Countries Will Inevitably Have Higher Prices Than Exporting Countries
ILLUSTRATIVE 2011 COSTS OF GAS, OIL AND COAL TRANSPORTATION
SHOWING GAS’S HIGHER COSTS AND THE EFFECT OF SCALE
(Gas Delivery Capability in MMCFD)
PRICES HAVE BEEN DRIVEN BY DIFFERENT FORCES IN EACH OF THE FOUR MARKETS

- The Full Effect of the U.S. Shale Gas Surplus Began to Make Itself Felt in Mid 2008 and Henry Hub Prices Fell

- But the Oil-Linked Continental and Asian Contract Prices Were Driven by Oil Prices - First Rising, then Briefly Falling and Then Rising Again; Europe Has Now Partially Adjusted to Commodity Competition

- Traditionally, the Typical Japanese Formula Provided a Higher Price Level for a Given Level of Oil Prices Than the European One; While for a Time This Premium was Partly Offset by Price Capping Clauses Called "S Curves", Many of These Have Now Been Eliminated

- TTF Was First Influenced by Weak Surplus LNG Prices; Later by Continental Prices as Markets Tightened
THE EMERGENCE OF REGIONAL PRICE DIVERGENCE
FOLLOWING THE GAS MARKET SURPLUS OF 2009/2010
(12 MONTH MOVING AVERAGES)
THE DEPARTURE OF REGIONAL GAS PRICES FROM THEIR AVERAGES FROM 2004 THROUGH 2008

Price Relative to 2004/2008 Average

AVERAGES 2004/2008
Henry Hub - $7.46
TTF - $6.92
Russian Contract - $7.08
Japanese LNG - $7.68

Japanese LNG Price Influenced by Oil But Usually Higher Than Europe

TTF Weakens in Surplus But Rises Again as Market Tightens
Shale Gas Brings Down Henry Hub
A LEGITIMATE QUESTION - "WHAT MIGHT A THEORETICAL WORLD COMPETITIVE COMMODITY GAS MARKET LOOK LIKE?

- One Can Devise an "Equilibrium" Set of Basis Differentials Between Markets by Assuming That Transportation Alone Sets the Price Differences

- Alone Among the Major LNG Trading Partners, North America Has a Truly Gas-to-Gas Competitive Commodity Market; While the U.K Also Has a Competitive Commodity Market, It Tends to be Influenced by Continental Oil-Linkage When LNG Markets are Tight

- The "Equilibrium" Commodity Pricing System Thus Might be Based on Henry Hub Pricing
And Although it lacks the Liquidity and Transparency of Henry Hub, Qatar plays a similar "Hub" role in LNG, since it can arbitrage Atlantic Basin and Pacific Basin Prices.

In such a Theoretical System, the European Gas Value might be based on U.S. Prices plus the cost of Transportation from the U.S. Gulf Coast to Europe; then those Prices might be netted back to Qatar where they would in turn establish Asian "Equilibrium" Prices.

The following Figure is just such an estimate; the Equilibrium Differential between U.S. and Europe for 2012 is $5.21 and between U.S. and Japan $3.97 ex Ship (Before Regasification).
HYPOTHETICAL WORLD LNG PRICE STRUCTURE [1] ASSUMING MARKETS ARE IN EQUILIBRIUM WITH U.S. 2012 COMMODITY PRICES, TRANSPORT COSTS TO EUROPE SET EUROPEAN PRICES AND EUROPEAN NETBACKS FROM EUROPE TO QATAR SET ASIAN PRICES

Distance from Qatar

<table>
<thead>
<tr>
<th>Hypothetical Eqilibrium Price - $/MMBtu</th>
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<tr>
<td>$2.00</td>
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<td>$4.00</td>
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<td>$6.00</td>
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<td>$10.00</td>
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<tr>
<td>$12.00</td>
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</tbody>
</table>

2012 Actual Prices

- Henry Hub $2.74
- Japan LNG ex Ship $16.66
- Dutch TTF $9.26
- Hypothetical $7.95

The "Asian Premium" - $7.29

Liquefaction, Regas Costs

[1] Hypothetical Equilibrium Set by Henry Hub 2012 Prices; European Prices Set by LNG Transport to Rotterdam; Asian Prices Established by Qatar Netback from Europe Plus Asian Transportation
In This Case $5.21 Out of the Total $6.52 Margin Between the U.S. (Henry Hub) and Europe (TTF) Represents the Underlying Transportation "Basis Differential"; Only $1.31 is the Disequilibrium Between the U.S.'s Fully Competitive Commodity Market and Northwest Europe's Mixed Commodity/Contract Market

But Because the Theoretical Equilibrium Value of LNG in Japan is Not Far Different From That in Rotterdam (the Tanker Distances from Qatar are Similar) the Disequilibrium in Japan is Very Large - $7.29

It is This Very Large "Asian Premium" That Attracts Japanese Customers to U.S. Supply; And While 2012 Market Conditions Accentuate the Disequilibrium - Weak U.S. Prices and Very Strong Japanese Prices - The IEA in its WEO Projections Expects Some Premium to Persist
HYPOTHETICAL WORLD LNG PRICE STRUCTURE [1] ASSUMING MARKETS ARE IN EQUILIBRIUM WITH U.S. 2020 COMMODITY PRICES, TRANSPORT COSTS TO EUROPE SET EUROPEAN PRICES AND EUROPEAN NETBACKS FROM EUROPE TO QATAR SET ASIAN PRICES

Distance from Qatar
- $2.00
- $4.00
- $6.00
- $8.00
- $10.00
- $12.00

Hypothetical Equilibrium Price - $/MMBtu

IEA Projected Prices
- U.S. $5.40
- Japan LNG ex Ship $15.20

Liquefaction, Regas Costs

2020 US Price; European Prices Set by LNG Transport to Rotterdam:
Asian Prices Established by Qatar Netback from Europe
Plus Asian Transportation

The "Asian Premium" - $4.93

Hypothetical European Margin $5.21

Europe $10.50

Hypothetical $10.61

Japanese Margin $5.21

Qatar

Indian West Coast

Rotterdam

Shanghai

Japan

West

East

Distance from Qatar

LNG ex Ship

Value Regasified

IEA Projected Prices
THE TYPICAL JAPANESE PRICING CLAUSE IS BASED ON A SIMPLE FORMULA

- It is Linked to the Japanese Customs Cleared Price for Crude Oil - JCC or the "Japanese Crude Cocktail"

- "It is in the Form of:
  \[ P = C + S \times \text{JCC} \]

- Where \( P \) is the Price in \$/MMBtu, \( C \) is a Constant Expressed in \$/MMBtu and \( S \) is the "Slope", a Dimensionless Number

- Discounting is Most Often Done by Changing the Slope and Sometimes the Constant; But its Simplicity Limits the Contract Options for Competitive Discounting and, Once Negotiated, the Only Thing That Changes is the Oil Price
- Northwest Europe Has Benefitted from the Price Competition That Was Unleashed by the LNG Surge in 2009/2010

- There LNG Arbitrage Together With North Sea Commodity Competition Exported Weak North American Prices to the Continent Through the Open Access EU Pipeline System and Undermined Oil-Linkage

- No Similar Price Competition Has Been Possible in Asia Because There Is No Access to Commodity Gas; This Has Been a Powerful Driving Force Behind the Asian Interest in U.S. Exports Since it Gives Asia a Source of Gas-to-Gas Competitive Commodity Supply Similar to That Which Has Already Benefitted Europe
The Most Common Type of LNG Contract is the Delivered ex Ship (DES) Contract in Which the Seller Delivers to the Buyer's Receipt Terminal; The Price Clause is Based on Destination Market Conditions

Less Common is the fob Contract in Which the Delivery is Made at the Outlet of the Liquefaction Plant; But the Pricing is Commonly Based on Destination Pricing and Adjusted for Tanker Transportation

All of the U.S. Export Contracts so Far are Also fob Contracts, But They are Unique in That Their Pricing Clauses are Based on Origin Pricing - Keyed to the North American Commodity Price at Henry Hub

Thus Unlike Traditional Clauses, the Economic Rent - and the Price Risk - Go to the Buyer, Not the Seller

That is Their Appeal to Oil-Linked Contract Buyers
JAPAN, NOT HAVING A FREE TRADE AGREEMENT WITH THE U.S., REQUIRES DOE APPROVAL TO IMPORT U.S. LNG


- The IEA is Not Optimistic About Long-Term Japanese Gas Demand; In WEO 2012 it Foresees a Slight Increase to 2015 and a Slight Decrease to 2020

- Thus the Real Opportunity for U.S. Imports Depends on Expiration of Current Contracts; This is Expected to Occur Significantly in 2019/2021

- By 2021, the Tentative Utility Contracts Account for 45% of the New Requirements and the Traders Portfolios 43%

Direct Utility Contracts are 45% of 2021 Requirements and Uncommitted Traders Portfolios are Another 43%

THE JAPANESE PRICES HAVE BEEN PARTIALLY SUPPORTED BY THE HIGH-COST OF AUSTRALIAN PROJECTS

- The Following Slide Uses Pluto for Australian Offshore Costs and GLNG for Coal Seam Costs; Some of the Proposed Projects May be More Costly

- The New Australian Projects Are Threatened, Not Only by U.S. Exports, But Also Potential New Projects Such as Those in British Columbia and Mozambique; Mozambique's Field Costs May be as Low as $3, But No Tax Regime is Yet in Place

- These Projects, as Stranded Gas, Will Presumably Utilize Traditional DES Contracts; The U.S fob Contacts Thus Have a Potential Market Advantage to a Buyer Seeking the Rent and Willing to Accept the Price Risk
ILLUSTRATIVE COSTS OF DELIVERING LNG TO JAPAN IN 2020
ASSUMING 2011 COSTS AND PROJECTED 2020 IEA WEO 2012 PRICES

[1] 2012 Actual, EIA and IEA Prices
[3] Taken as 2%
IN CONCLUSION

- Japan Faces Serious Energy Cost Challenges as it Attempts to Deemphasize Coal and Nuclear in Favor of Expensive Imported LNG

- Imports of Low-Cost U.S. Shale Gas Thus Have a Powerful Appeal

- To Date Four Japanese Utilities and Three Trading Houses Have Signed U.S. LNG Contracts in the Hope That Exports to Japan Will be Approved

- And While the Present Price Spread Between U.S. and Japanese Prices May be Unrealistically Large, Some Spread Will Remain; Thus a Major Appeal of U.S. Imports is the Ability to Introduce Commodity Price Competition Into the High-Priced, and Structurally Rigid, Traditional Asian Oil-Linked Pricing Formula
US Shale Gas & Pacific Gas Market:
Pacific LNG Trade & Gas Pricing Issues

Tuesday, May 14th, 2013
Faculty House at Columbia University
64 Morningside Drive
New York, New York 20027
USA

Organized By: InfraBasic ,LLC
In Partnership with: New York International University Center and the Energy China Forum
With the Support of: CESNA GROUP (Marketing Partner); National Research Foundation, Korea (Government Partner); POSCO RIST (Corporate Partner)
Implications of North America’s Shale Gas Boom On Korea’s Energy Security

Oh Sung-hwan
Director of Global Energy Cooperation Center

2013.5.14

Ministry of Foreign Affairs
1. Energy Cooperation in the Northeast Asian Region
2. The Shale Gas Revolution and the Pan-Pacific Energy Cooperation
3. The Korean Government’s Energy Policy
1. Energy Cooperation in the Northeast Asian Region
Overview of the Northeast Asian Region

The World's Largest Energy Consumer
Fossil Fuels as a Dominant Energy Source in the Region

Population

- 1.6 billion people (1/4 of world population)
  * 1.3 billion people in China (world's largest population)
  * 2.7 million people in Mongolia

75% of the world's population will reside in Asia Pacific and Africa by 2040. India will have the largest population, post-2030.
Energy Security in the Northeast Asian region

<Competition and cooperation are likely to co-exist>
- Changes exist in the environment of energy security due to the Fukushima nuclear accident and shale gas revolution

<Trends of Each Country>
- **Russia**: Turning to Northeast Asia as a new market for exporting gas to expand its market beyond Europe
- **Japan**: Declared the ‘Zero Nuclear Power Operation Policy’ following the Fukushima nuclear accident
- **China**: Encouraging the consumption of gas instead of coal
- **ROK**: Planning to import 8 million tons of North American shale gas by 2020
The keywords for policy in the Northeast Asian region for the past several years has been: “Securing Energy Resources in the Eastern Siberia and the Russian Far East”
Prospect of Russian Energy Supply in the Northeast Asian Region

- As demand in Europe decreases due to the economic crisis in the region and North America's shale boom, Russia looks for the new opportunities in Asian market, which has huge potential due to the continued increase in gas demand.

- Oil and gas accounts for 57% of Russia's total export and 48% of the country's financial revenue.

**Russia**
- Natural Gas Reserves: 44.8 trillion cubic meters (world’s no. 1, 23.9%)
- Oil Reserves: 77.4 billion barrel (world’s no. 7, 5.6%)
- Coal Reserves: 157 billion ton (world’s no. 2, 15.9%)
**Prospect of Russian Energy Supply in the Northeast Asian Region**

**Russia Energy Forum on 8-11 April**

"The Russia Energy Strategy 2030, which has only been three years since its release, wasn't able to reflect recent changes in international gas market including shale revolution and decrease in gas demand in European market."

"Unless Russia reduce price for the export of its gas, the demand for Russian gas could be significantly decreased by more than 30%. Therefore, Next 10-15 years are the most critical period for Russia as rapid increase in shale gas production is expected during the period."

**Report of Russia's Ministry of Economic Development (April, 12th, '13)**

"Competition from North American shale gas exports will force Gazprom to lower its export prices by 2016."

The Russian company will have to compromise on its pricing schemes in order to remain competitive.
1) Russia-Korea Energy Cooperation

Oil

Korea has been importing ESPO oil since 2009 and imported 3.3 million barrels of ESPO oil, accounting for 3.6% of its total oil imports in 2011.

LNG

Korea has been importing 1.5 million tons of Sakhalin-II LNG per year since April 2009 accounting for 5% of its total gas imports.

- Continued import of Russia’s LNG for 5% of Korea’s total gas imports every year until 2025.
  * Development of the Chayanda Field
  * Yakutia-Khabarovsk-Vladivostok gas pipeline construction
  * Vladivostok LNG plant construction
1) Russia-Korea Energy Cooperation

- KOGAS and Gazprom signed the Memorandum of Understanding (MOU) on natural gas supplies from Russia to Korea in September 2008.

The North Korea Risk vs. Gas Price Premium

- If Russia is in charge of construction of pipeline in North Korea, that will cause premium in gas price while the North Korea risk could be reduced.
2) Russia-Japan Energy Cooperation

Japan began importing LNG from Russia’s Sakhalin terminal in 2009. In 2012, Japan imported 8.3 million tons of Russian LNG, accounting for 10% of its total LNG imports.

Japan plans to stop the operation of its nuclear power plants until 2030 since the Fukushima nuclear accident so alternative energy sources such as gas has been increased and is expected to continue to increase.

In July 2010, Japan and Russia signed a preliminary agreement to build an LNG terminal with liquefaction capacity of 244 Bcf/y by 2017.
3) Russia-China Energy Cooperation

President Xi Jinping of China’s visit to Russia (3.22-24)

“China will make developing relations with Russia a priority in its foreign policy orientation and agreed on cooperation in oil and gas sector”

- Oil
  i) Increase in Russia’s oil Supply to China
  ii) Building Oil Refinery in Tianjin
  iii) Upstream cooperation between Russia and China

- Gas
  - Gazprom and CNPC agreed that 38 bcm per year of Russian gas would flow to China starting in 2018 and come only from Russia's East Siberian fields, Chayanda gas field. However, the current MOU still falls far short of a final accommodation on price.
3) Russia-China Energy Cooperation

**Implication**

**China**
- could expand resource development business in the region and secure energy sources on a long-term basis.

**Russia**
- could begin full-scale East Siberia development
- could establish a foothold in the Asia and Pacific downstream market by securing the sales right of petroleum product of Tianjin refinery

Increase in Russia's oil supply to China could lead to China's monopoly on ESPO oil

Russia needs to consider how to resolve its high dependency on China for its oil imports
3. The Shale Gas Revolution and the Pan-Pacific Energy Cooperation
## Shale Gas Revolution

### Shale Reserves

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Shale Reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>36.10</td>
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<tr>
<td>2</td>
<td>U.S.</td>
<td>24.41</td>
</tr>
<tr>
<td>3</td>
<td>Argentina</td>
<td>21.92</td>
</tr>
<tr>
<td>4</td>
<td>Mexico</td>
<td>19.28</td>
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<tr>
<td>5</td>
<td>South Africa</td>
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<tr>
<td>11</td>
<td>Poland</td>
<td>5.30</td>
</tr>
<tr>
<td>12</td>
<td>France</td>
<td>5.10</td>
</tr>
</tbody>
</table>

(source: EIA, 2011)
Impacts of Shale Boom - U.S.

To increase imports of shale gas by 20% of total natural gas imports by 2020

* Total annual LNG Imports : 36.7 million tons (‘11)

- (Korea-US) To import 2.8 million tons of U.S. LNG every year from 2017 for 20 years

- (Korea-Canada) Procured the import of 3.5 million tons of Canadian LNG every year from 2020
  * KOGAS has a 20% stake in ‘LNG Canada Project’
Expected Advantages of North America’s Natural Gas

1) U.S. natural gas

Due to the increased production of shale gas, the U.S. plans to export its natural gas to Asian market.

- Compared to the contracts with Middle East suppliers, U.S. suppliers could provide lowered gas prices and increased flexibility in use of imported volume of gas

- U.S. natural gas is a gas-to-gas price competition (Henry hub); therefore, introduction of U.S. gas could lower the gas prices in the Asian market compared to oil-linked contracts
  * gas price (12.10): Asia $13.4, Europe $11.1, North America $3.4

- Contracts with the U.S. provides flexibility in the use of imported natural gas as the contract does not require the designation of final destination clause.

- Contracts with the U.S. does not require the ‘Take or Pay’ clause
  * Take or Pay contract: Buyers either take the product from the supplier or pay the supplier a penalty
Impacts on Northeast Asia

[Asian Premium]

World LNG Estimated November 2012 Landed Prices

[The Need of the Gas Trading Hub in the Asian Region]

“...the Asia region is in need of gas trading hubs to provide an alternative to oil-linked imports amid the rising volume of gas consumption and trade.”

– Maria van der Hoeve, Chief, IEA

North America: Henry Hub, Europe: National Balancing Point (NBP)
Asia: Japan Crude Cocktail (JCC)
Impacts of U.S. Shale Boom - Canada

Canada needs to find new importers of its natural gas
Expected Advantages of North America’s Natural Gas

Canadian natural gas

Due to the increase in natural gas production in the U.S., which is Canada’s major importer of natural gas, Canada needs to find new market to exports its natural gas and is interested in Asian market.

- Canada has competitive advantages such as abundant reserves advanced technology and financing market, and investment-friendly environment.
  * Particularly, the western part of the country has the advantage of proximity to the Asian Market.

- However, Canadian suppliers need to promote hybrid method of pricing, combining oil-linked price and gas-to-gas competition to attract Asian buyers.

Traditionally, only the Middle Eastern countries has been considered to be energy partners. However, North America became a promising energy provider!
Paradigm Shift in Energy Security

Due to the rapid increase in unconventional resources, the North America has become a promising energy provider.

- North America became interested in exporting its natural gas to the Asian market.
- Asian countries became interested in importing North America’s natural gas.

Paradigm Shift in Energy Security

[Traditional] Politics, Defense and Security → [Non-Traditional] Energy Security → Northeast Asia (Korea, China, Japan, Russia, Mongolia) → North America + North-East Asia

(Example)
* KOGAS signed a contract with Cheniere Energy to purchase 2.8 million tons of US natural gas annually from the company’s Sabine Pass export plant by 2017 under a 20-year deal.
Implementing A New Energy Market

Australia

Australia plans to supply its new LNG to Northeast Asian market by 2016 or 2017

(Korea-Australia) Korea Currently imports Australia’s LNG for 2% (780 thousand tons/year) of its total imports.
- Korea plans to increase its imports by 20% by 2016

As one of the major conventional gas suppliers, Australia has to compete with North American shale gas suppliers.

Among unconventional gases, Australia has promoted large-scale developments of CBM (Coal Bed Methane), rather than shale gas of which Australia has the world's 6th largest reserve.

➢ As a major gas developer, Australia could use existing infrastructures in developing unconventional gas.

➢ Australia’s stable political environment, substantial hydrocarbon reserves, and proximity to Asian markets make it an attractive place for foreign investment.
Korean Government’s Energy Policy

Former President Lee Myung-bak on Energy

- Former president Lee Myung-bak focused on the enhancement of energy self-sufficiency rate
- He categorized the world’s resource-rich countries into 5 regional groups based on the regions’ characteristics and established tailor-made plans accordingly

- Key Outcomes -

Strengthened Korea’s state-owned companies such as Korea National Oil Corporation (KNOC) and Korea Resources Corporation (KORES)

* KNOC (2007 → 2012)
  (Oil production) 50 thousand b/d → 240 thousand b/d
  (Rank in the world) #90 → #70
* KORES (2007 → 2012)
  (Mineral resources production/year) $300 million → $2.1 billion
  (Rank in the world) #105 → #70

Advanced into the key oil market (UAE / Mozambique)

* Signed an MOU (2011.3) with the UAE on oil and gas development
  - Participated in 3 mining development projects
* Discovered a massive gas resources base (30Tcf) in Mozambique (2010.11)

Secured unconventional energy resources

* Canadian oil sand (Black Gold, 2010.8)
* U.S Texas shale gas (Eagle Ford, 2011.4)
The Direction of the New Government’s Energy Policy

President Park Geun-hye’s vision – Energy

**Energy Security**

- Enhanced energy cooperation diplomacy through stability and liability.
- Pursuit of a long-term energy diplomacy that puts more emphasis on energy security rather than the achievement of short-term goals on energy resources development.

Aiming to promote the “Northeast Asian Peace Cooperation Initiative” to achieve peace and economic development in non-political areas first!!

**Main Plan**

1. Ensuring a stable energy demand and supply
2. Increasing energy cooperation in the Northeast Asian region
3. Improving the quality of overseas resource development
The New Government’s Energy Policy

1. Ensuring stable energy demand and supply

- Responding actively to changes caused by shale gas in the global gas market
  - The share of natural gas is expected to increase according to the energy mix plan.
  - North America’s increased shale gas production is expected to contribute to Korea’s diversification of LNG import routes.

- Expansion of gas storage capability such as the construction of additional storage facilities
  - Implement advanced techniques for gas resources development, and increase the capacity for gas storage.
    - With three tanks in operation, the reserve rate has increased (10.4% → 12.3%)
    - Three reserve tanks (Pyeongtak(2), Tongyeong) are to be completed
The New Government’s Energy Policy

2 Increasing energy cooperation in the Northeast Asian region

The Northeast Asian region has major energy consumers including Korea, China, and Japan, and a major energy provider like Russia.

Regional energy cooperation should be promoted!!

Due to the political tensions rising from the historical background and territorial disputes among these countries → “No Progress at all!!”

- Promote the gas pipeline project connecting the Russian federation and the Republic of Korea via the territory of the Democratic People’s Republic of Korea.

- Promote initiatives for subregional energy connectivity, including those focused on cross-border infrastructure development, considering possible ways to develop an intrasubregional power network and supply system, to strengthen subregional cooperation and interdependence.

- Promote regional oil and gas hub to ensure a stable energy supply and respond to increased risk in the energy market due to intensified resource nationalism and high resource prices.
The New Government’s Energy Policy

The First National Basic Plan for Energy (’08~’30)
Korea established the National Basic Energy Plan (2008-2030) in 2008 aiming to reduce dependency on fossil fuels and to increase the share of nuclear and renewable energy in the nation’s energy mix.

The compilation of the 2nd National Basic Energy Plan

2nd National Basic Energy Plan is expected to take off in the second half of 2013.

11th Long-Term Plan on Natural Gas Demand and Supply (April, 2013)
4th National Basic Plan on Renewable Energy (Second half)
5th National Basic Plan on Overseas Energy Resources Development (Second half)
Seminars on Shale Gas Cooperation

**The 1st International Shale Gas Conference (2012.9)**
- Invited Department of Energy (U.S), Shell (Netherland), Statoil (Norway), Encana (Canada)

[Future Events]

**The 2nd International Shale Gas Conference (Second half of 2013)**

**The 1st Seminar on Shale Gas with Diplomats in Korea (Second half of 2013)**
- The MOFA Plans to invite diplomats from the U.S., Canada, and Australia to introduce their countries’ plans and projects for natural gas exports to Korean energy companies
US Shale Gas & Pacific Gas Market: Pacific LNG Trade & Gas Pricing Issues

Tuesday, May 14th, 2013
Faculty House at Columbia University
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“US Shale gas and Pacific Gas Market”

- What is ‘Shale gas’ for you? -

Tuesday, May 14th, 2013
Columbia University
New York, U.S.A

Paul (Boyoung) KIM, Ph. D.
President, KOGAS America
Preface
Scene I: Butterfly Effect (Chaos Theory)

“IT HAS BEEN SAID THAT SOMETHING AS SMALL AS A FLUTTER OF A BUTTERFLY’S WING CAN ULTIMATELY CAUSE A TYPHOON HALF WAY AROUND THE WORLD”

Chaos Theory
Larva → Butterfly → Typhoon

Shale gas in the US

Technique of drilling (vertical & horizontal)

World Gas Market
Joseph Alois Schumpeter
(Economist, U.S.A)

“Creative destruction”
Innovations in techniques

combination technique of vertical and horizontal drilling
ACT II

Change of Energy Policy
Scene I: What’s happened in 2005 and 2010?

LNG Receiving Terminals

LNG Exporting Projects

Source: FERC

February 2005

October 2010
Shale Gas production, 2005-2010

U.S. Natural Gas Production, 1990-2035

What is unconventional gas, ‘shale gas’?
Scene II: Meaning of “Oil & Gas Independence”

Energy dependence of U.S.A: 53.5%

Energy dependence of China: 55.2%
Change of International Relations

Latin America

Japan asks US to start shale gas supplies asap

Japanese Prime Minister Shinzo Abe has asked US President Barack Obama to start shipments of US shale gas to Japan as soon as possible.
Butterfly effect on Russia

- Increasing of Shale gas production in the United State
- Low gas price in the United State
- Many LNG vessels will go to EU (or Asia)
- This makes EU reduce natural gas import from Russian
- Negative result on Russia’s government fiscal balance
ACT III

Golden Age of Natural gas
Scene I: Golden Age of Natural Gas

By 2040, oil and natural gas will be the world’s top two energy sources, accounting for about 60 percent of global demand, compared to about 55 percent today. Gas is the fastest-growing major fuel source over this period, growing at 1.6 percent per year from 2010 to 2040. Investments and new technologies, applied over many years and across multiple regions, will enable energy suppliers to grow and diversify (see page 56).

From its peak in 2025, coal will decline by more than 10 percent by 2040.

Latin America and China are the biggest users of hydro power, which makes up over 80 percent of total Hydro/Geo supplies.

Source: The Outlook for Energy: A View to 2040
According to the Outlook of ExxonMobil ….

A rising share of global natural gas demand will be met by supplies produced from shale and other rock formations – commonly referred to as unconventional gas. By 2040, unconventional gas will account for 30 percent of global production, up from 10 percent in 2010. The application of existing technologies to these unconventional supplies has helped unlock up to 250 years of global gas supply at current demand levels.

Different countries rely on a different mix of sources to meet their natural gas needs. In the chart at left, each bar shows the net growth – or loss – for each source of natural gas in major world regions from 2010 to 2040. The largest increase in demand will be seen in the Asia Pacific region, which will continue to draw the largest share of global LNG exports, followed by Europe. Unconventional gas is expected to play a larger role in meeting demand growth in North America, Asia Pacific, Latin America and Europe.

Source: The Outlook for Energy: A View to 2040
Scene II: LNG export Terminals proposed to FERC

North American LNG Import/Export Terminals
Proposed/Potential

Import Terminal
PROPOSED TO FERC
1. Robbinston, ME: 0.5 Bcf/d (Kochel Energy - Downeast LNG)
2. Astoria, OR: 1.5 Bcf/d (Oregon LNG)
3. Corpus Christi, TX: 0.4 Bcf/d (Cheniere - Corpus Christi LNG)

POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS
4. Offshore New York: 0.4 Bcf/d (Liberty Natural Gas)

Export Terminal
PROPOSED TO FERC
5. Freeport, TX: 1.8 Bcf/d (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction)
6. Corpus Christi, TX: 2.1 Bcf/d (Cheniere - Corpus Christi LNG)
7. Coos Bay, OR: 0.9 Bcf/d (Jordan Cove Energy Project)
8. Lake Charles, LA: 2.4 Bcf/d (Southern Union - Trunkline LNG)
9. Hackberry, LA: 1.7 Bcf/d (Sempra - Cameron LNG)
10. Cove Point, MD: 0.75 Bcf/d ( Dominion - Cove Point LNG)
11. Astoria, OR: 1.30 Bcf/d (Oregon LNG)
12. Lavaca Bay, TX: 1.38 Bcf/d (Reliant Energy)

PROPOSED CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS
13. Kitimat, BC: 0.7 Bcf/d (Apache Canada Ltd.)

POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS
15. Brownsville, TX: 2.8 Bcf/d (Gulf Coast LNG Export)
16. Pascagoula, MS: 1.5 Bcf/d (Gulf LNG Liquefaction)
17. Elba Island, GA: 0.5 Bcf/d (Southern LNG Company)
18. Sabine Pass, TX: 2.6 Bcf/d (Tronox - Golden Pass)
19. Plaquemines Parish, LA: 1.07 Bcf/d (CE FLNG)
20. Cameron Parish, LA: 0.16 Bcf/d (Waller LNG Services)
21. Ingleside, TX: 1.09 Bcf/d (Pangea LNG (North America))
22. Lake Charles, LA: 0.94 Bcf/d (Magnolia LNG)

POTENTIAL CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS
23. Cameron Parish, LA: 0.20 Bcf/d (Gashin Development)
24. Prince Rupert Island, BC: 1.0 Bcf/d (Shell Canada)
25. Goldboro, NS: 0.67 Bcf/d (Petrel Energy Canada)
26. Kitimat, BC: 2.0 Bcf/d (LNG Canada)

As of February 21, 2013
What are constraining conditions on US exports?

1. Popular feeling
2. World Economy & Monetary circulation
3. Legal Intervention & Government regulation
4. Competition among Gas projects
Competition in World Gas Market

Conventional gas

Unconventional gas

SOURCE: Wood Mackenzie, CREDIT SUISSE

Existing Sellers

Emerging Sellers
Between USA and Australia

Exxon urges US to pursue gas export policy

Published 5:55 AM, 29 Jan 2013 Last update 5:55 AM, 29 Jan 2013

Pressure is rising on the United States to decide whether to pursue a large-scale gas export strategy that would result in gas exporting nations such as Australia losing billions of dollars, with a submission by oil giant ExxonMobil urging the US to target export markets, as reported by The Australian.

Global LNG capacity – 2011A

Global LNG capacity – 2020E

SOURCE : Waterborne LNG Reports, US DOE, PFC Energy, Credit Suisse Research estimates
Among projects in the United States

Parnell, the Governor of the State of Alaska, pushes gas pipeline, oil tax cut (for supporting LNG export in Alaska) in his fourth State of the State address.
Shell Plans to Spend $1 Billion a Year on China Gas

By Bloomberg News - Mar 27, 2013

(Corrects to show annual spending is on unconventional gas in first paragraph of March 26 story.)

Royal Dutch Shell Plc (RDSA) will spend $1 billion a year developing China's unconventional gas reserves, including shale deposits, according to Peter Voser, the company's chief executive.
Scene III: Butterfly effect on Asia Gas Market

- Europe
- Northeast Asia
- North America

Historical gas price differential across global regions ($ / MMBtu)

- Japan LNG Import
- NBP (UK)
- Henry Hub (US)

- Existing
- Emerging
IEA Releases “Developing a Natural Gas Trading Hub in Asia” Report

Posted on Feb 26th, 2013 with tags asia, Developing, gas, Hub, IEA, Natural, News, Releases, Reports, Trading.

Amid region’s growing reliance on imports, Developing a Natural Gas Trading Hub in Asia identifies obstacles and opportunities for establishing a gas market that reflects supply-demand fundamentals.
Scene VI: Timing, term & conditions
Thank you

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US Shale Gas & Pacific Gas Market: Pacific LNG Trade & Gas Pricing Issues

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