Pacific Rim Impacts of US Shale Boom

Jason Bordoff

2013 EIA Energy Conference

June 17, 2013
Asia Pacific Pipeline vs. LNG Demand

Observed

IEA 2012 Forecast

Bcf/d

Source: IEA
Asia Country Level Forecast

Bcf/d

**Korea**

- 2010: 3.6
- 2015: 4.1
- 2020: 4.4
- 2035: 5.2

**Japan**

- 2010: 10.06
- 2015: 11.61
- 2020: 11.80
- 2035: 11.90

**China**

- 2010: LNG Imports: 1.2, Pipeline Imports: 0.3, Production: 3.8
- 2015: LNG Imports: 0.3, Pipeline Imports: 2.1, Production: 9.2
- 2020: LNG Imports: 6.9, Pipeline Imports: 6.0, Production: 13.0
- 2035: LNG Imports: 9.1, Pipeline Imports: 13.4, Production: 16.9
- 2020: LNG Imports: 13.0, Pipeline Imports: 16.9, Production: 30.8

Source: IEA WEO2012, EIA, Jim Jensen
Japanese Power Generation

Billion kWh (left) and trillion BTU (right)

POWDER GENERATION BY SOURCE (BN KWH)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fossil Fuel</th>
<th>Nuclear</th>
<th>Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>514</td>
<td>264</td>
<td>58</td>
</tr>
<tr>
<td>2008</td>
<td>539</td>
<td>242</td>
<td>55</td>
</tr>
<tr>
<td>2009</td>
<td>458</td>
<td>260</td>
<td>56</td>
</tr>
<tr>
<td>2010</td>
<td>473</td>
<td>278</td>
<td>66</td>
</tr>
<tr>
<td>2011</td>
<td>559</td>
<td>61</td>
<td>157</td>
</tr>
<tr>
<td>2012</td>
<td>677</td>
<td>57</td>
<td>15</td>
</tr>
</tbody>
</table>

FOSSIL FUEL CONSUMED FOR POWER (TRILLION BTU)

<table>
<thead>
<tr>
<th>Year</th>
<th>Oil</th>
<th>LNG</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>2,123</td>
<td>734</td>
<td>1,551</td>
</tr>
<tr>
<td>2008</td>
<td>2,156</td>
<td>879</td>
<td>1,599</td>
</tr>
<tr>
<td>2009</td>
<td>2,035</td>
<td>1,430</td>
<td>1,512</td>
</tr>
<tr>
<td>2010</td>
<td>2,107</td>
<td>379</td>
<td>1,500</td>
</tr>
<tr>
<td>2011</td>
<td>2,533</td>
<td>678</td>
<td>1,503</td>
</tr>
<tr>
<td>2012</td>
<td>2,920</td>
<td>1,188</td>
<td>1,588</td>
</tr>
</tbody>
</table>

Source: Federation of Electric Power Companies (FEPC) via Bloomberg
Chinese Power Generation by Type

IEA Projections, Gigawatts

Source: IEA’s “New Policies Scenario” from the 2012 World Energy Outlook

420 W 118th St, New York, NY 10027 | http://energypolicy.columbia.edu | @ColumbiaUEnergy
China’s Acrd Air

PM 2.5 microns per cubic meter

- Beijing: 10
- Pittsburg: 6
- Los Angeles: 4.8
- Phoenix: 4.2
- Chicago: 2.9
- New York: 2.7
- Houston: 2.6
- Detroit: 2.1
- Atlanta: 2.1
- Washington, DC: 1.7
- Seattle: 0.8
- San Francisco: 0.2

Source: WHO, Steven Q Andrews and RHG estimates
Global Gas Supply Forecast

Source: IEA WEO2012
Top 10 countries with technically recoverable shale gas resources

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Shale Gas (tcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>1,115</td>
</tr>
<tr>
<td>2</td>
<td>Argentina</td>
<td>802</td>
</tr>
<tr>
<td>3</td>
<td>Algeria</td>
<td>707</td>
</tr>
<tr>
<td>4</td>
<td>U.S. ¹</td>
<td>665 (1,161)</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>573</td>
</tr>
<tr>
<td>6</td>
<td>Mexico</td>
<td>545</td>
</tr>
<tr>
<td>7</td>
<td>Australia</td>
<td>437</td>
</tr>
<tr>
<td>8</td>
<td>South Africa</td>
<td>390</td>
</tr>
<tr>
<td>9</td>
<td>Russia</td>
<td>285</td>
</tr>
<tr>
<td>10</td>
<td>Brazil</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td><strong>World Total</strong></td>
<td><strong>7299 (7,795)</strong></td>
</tr>
</tbody>
</table>

¹ EIA estimates used for ranking order. Advanced Resources International estimates in parentheses

Source: EIA
Global Gas Trade 2013-2017

Source: IEA Medium Term Gas Report 2012
Global Gas Supply Forecast

Source: IEA Medium Term Gas Report 2012
Impact of US Shale Boom

Economic
- LNG Exports
- Coal Exports
- Displaced LNG Imports

Geostrategic
- Russia
- Qatar
- Australia
- Other

Environmental
- Substitution of gas for coal?
- Substitution of gas for renewables and nuclear?
- Impact of lower gas prices on consumption?
Regional Gas Price Forecast

$/MMBTU

Source: IEA WEO2012
### Summary of Projected US LNG Exports

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRA (2013)</td>
<td>20 bcf/day*</td>
</tr>
<tr>
<td>ICF (2013)</td>
<td>8 bcf/day**</td>
</tr>
<tr>
<td>Moody’s (2013)</td>
<td>6 bcf/day</td>
</tr>
<tr>
<td>Navigant (2012)</td>
<td>5-6 bcf/day</td>
</tr>
<tr>
<td>Ken Medlock (2012)</td>
<td>No more than 1.2 bcf/day</td>
</tr>
<tr>
<td>NERA (2012)</td>
<td>0 bcf/day***</td>
</tr>
</tbody>
</table>

* Likely case. High case = 35 bcf/day.

** Middle case. Low case = 4 bcf/day. High case = 16 bcf/day.

*** In its analysis of global markets, NERA found that the U.S. would only be able to market LNG successfully with higher global demand or lower U.S. costs of production than in the Reference cases.
Market-based Pricing in Gas Trade by Region

North America

Europe

Asia Pacific

Additional 42 bcm/year or 4 bcf/day of North American LNG exports into Asia Pacific could increase volume of gas traded on gas-to-gas basis from 12% to 27%

Source: BP Statistical Review, IEA
Asia Pacific Pricing Mechanism

LNG Trade versus Pipeline

![Graph showing LNG Trade versus Pipeline](image)

- **Pipeline**: Gas-to-gas competition and Oil indexation.
- **LNG**: 95% in 2005, 81% in 2007, 87% in 2009, 86% in 2010.

Source: BP Statistical Review, IEA
Global LNG Majors

Export quantity and revenue as a share of GDP in 2011
Rising Australia LNG Construction Costs

$/tonne

Source: Press reports
Gas Substitution Effect on Emissions

3% lower CO₂ emissions than 2011 New Policies scenario in 2035

2011 “Golden Age of Gas” scenario

2012 “New Policies” scenario

Concluding Thoughts

**Economic**
- LNG exports can lower costs in Pacific and boost competition, but transportation costs mean regional price differential will persist.
- Oil linkage to remain, although with more flexible indexation clauses, but entering a period of more gas-on-gas competition in latter half of decade.

**Geostrategic**
- Ramp up in LNG export capacity to continue pressuring Russia gas terms.
- Huge Qatari surplus capacity has been absorbed; question is how they respond to surge in new export capacity.
- Keep an eye on Australian LNG project costs.

**Environmental**
- Low-cost natural gas tends to lower GHG emissions, but not a lot.
- Still need climate policy; gas makes policy cheaper, doesn’t solve climate.
- Need better information about lifecycle emissions (fugitive methane).
Thank you

For more information:

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Appendix
### U.S. LNG Export and Price Impact Forecast

<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></td>
<td>(2 bcf/day of exports)</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.

Source: EIA, Deloitte, Navigant, ICF International