Contemplations about the future of natural gas: the good, the bad and the ugly

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The View Today

Total US Energy Production (Quadrillion BTU)

source: EIA
Emerging Global NG Demand and LNG

**Gas plant orders** (select countries)

<table>
<thead>
<tr>
<th>Country</th>
<th>Avg. kW/capita</th>
<th>Avg. GW/y</th>
<th>Avg. last 5 years</th>
<th>Avg. next 5 years (forecast)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>3,600</td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>12,000</td>
<td>8.4</td>
<td>10.8</td>
<td>10.8</td>
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<tr>
<td>Saudi Arabia</td>
<td>9,300</td>
<td>5.0</td>
<td>4.8</td>
<td></td>
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<tr>
<td>Japan</td>
<td>7,400</td>
<td>3.0</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>2,100</td>
<td>2.3</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>800</td>
<td>0.7</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>4,400</td>
<td>0.8</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

Global NG imports, Trillion cubic feet

- Global NG imports, Trillion cubic feet
- percent of Global NG consumption via imports

source: GE, EIA
Variability in Renewables

- Large fluctuation with renewables
  - Over 24 hour period
  - Over course of year
- Implies need for flexible power supply to fill in gaps – NG
The Fracking Boom

Natural Gas Production

- US Natural Gas production took off after 2007
- led to steady decline in NG spot prices
  - major driver in shift from Coal to Gas in electricity
  - motivated push for LNG exports

Henry Hub Spot Price
The Fracking Boom

- US Natural Gas production took off after 2007
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- (how long) will this persist?
Fracking: A new approach to extraction

Conventional/Unconventional Geology

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MSEEL - Microseismic
Thomas Wilson - WVU

http://www.eia.gov/energy_in_brief/about_shale_gas.cfm
Natural gas production from major U.S. shale plays
Natural gas production: geography

Shale Gas Plays, Lower 48 States
WY NG distribution, basis effects

- pricing distortions when deliveries approach pipeline capacity
NG spot prices: Henry Hub vs. Dominion South

difference between spot prices at Dominion South and Henry Hub

![Graph showing the difference between spot prices at Dominion South and Henry Hub over time. The graph indicates a downward trend from 2010 to 2014.](image-url)
Pipeline Infrastructure in New England
Despite high prices, the Algonquin pipeline was often not fully utilized during the winters of 2013-14 and 2014-15.
Aggregating the same data by week more clearly shows levels. On average, 78,000 MMBtu (roughly 7%) of the pipeline’s capacity goes unused on days when the price of natural gas exceeds $10/MMBtu.
Patterns in average production per-well

- Natural gas production subject to “decline curve” effects
  - production rate falls off rapidly during first several months
- suggests need for “rolling frontier” of new wells
Aggregate production and the number of wells

![Graph showing the aggregate production and the number of wells from July 1992 to July 2013. The graph plots the quantity of gas in million Mcf (Mcf) and the number of operating wells against the months from July 1992 to July 2013. The graph includes two lines: one for quantity gas in million Mcf and another for the number of operating wells. The data shows an increase in both metrics over the years, with fluctuations during certain periods.](image-url)
Drilling Rig Counts: US and Marcellus

- Gas Drilling Rigs in the US
- Gas Drilling Rigs in the Marcellus

Date:
- 1Jan2010
- 1Jan2012
- 1Jan2014
- 1Jan2016

Gas Drilling Rigs in the US
- 150
- 100
- 50
- 0

Gas Drilling Rigs in the Marcellus
- 150
- 100
- 50
- 0
Henry Hub NG price return

Date

1Jul1997 1Jan2002 1Jul2006 1Jan2011 1Jul2015
Water concerns?

From left to right: Flowback water, treated flowback water ready for reuse, and produced water

Environmental concerns?
What’s in the Secret Sauce?

Source: Columbus Dispatch