August 17, 2016

The Shifting Sands of Natural Gas Abundance

Richard Meyer | Manager, Energy Analysis & Standards
Here’s how global energy changed between 2014 and 2015. Winners were oil, natural gas, renewables.

Change in Global Primary Energy Consumption by Fuel, 2014-2015, Absolute & Percentage

Data: BP Statistical Review 2016
Natural Gas Records in 2015

- **Domestic Annual Production** – 27.1 Tcf
- **Proved Reserves** – 368 Tcf (dry)
- **Undiscovered Gas Resources** – more than 2,500 Tcf
- **Domestic Natural Gas Consumption** – 27.4 Tcf
- **Natural Gas Consumed for Power Gen** – 9.4 Tcf
- **Working Gas in Underground Storage** – 4,009 Bcf

Sources: Bentek Energy, Energy Information Administration, Potential Gas Committee
We have seen and continue to expect relatively low and stable natural gas prices.

Source: Energy Information Administration
Muted Price Response
This Winter & Summer

Natural Gas Prices
Prompt-Month Futures at Henry Hub

Price Range
2009-2014

Source: Energy Information Administration
Record natural gas levels falling back. Glut has slimmed to 18% above average.

Source: EIA
For years Growth was the name of the game.
New daily record in Feb 2016. Production has slowed, but stubborn.

Source: Bentek Energy LLC
“Drilled but uncompleted” gas well inventory helping sustain production, but for how much longer?

Source: Bentek
Oil and natural gas rigs are on the floor. But for how much longer?

**US Rotary Rig Count**

Number in Operation

Source: Baker Hughes

- **Oil**
- **Gas**

Uptick?
US oil production has begun to flatten

US Crude Oil Production
(thousand barrels per day)

Jan’11

Jan’15

Source: EIA
US demand of natural gas down slightly for the year after mild winter. Strong exports & power generation keeping levels strong.

Source: Bentek Energy LLC

US Natural Gas Demand YTD Difference 2015-16 (Bcfd)
Natural gas electricity setting records due to coal retirements, hot weather, low prices
Massive change underway in the US electric power sector: huge coal-to gas switching with renewable growth
Coal exports declined 23% in 2015. Deliveries are down further this year.
Energy-related CO2 emissions projected fall below 5.2 billion metric tons this year, lowest since 1992.
US Gas Exports to Mexico

Mexico’s natural gas pipeline expansions key to accessing U.S. exports

Source: EIA and industry sources
Let the LNG games begin!
Shippers waiting for Sabine Pass startup
(February 2016)
LNG Cargoes Have Been Delivered to Europe, South America, Asia, and the Middle East

<table>
<thead>
<tr>
<th>VESSEL</th>
<th>DESTINATION</th>
<th>DEPARTED</th>
<th>ARRIVED</th>
<th>Capacity (bcf)</th>
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<tbody>
<tr>
<td>Sestao Knutsen</td>
<td></td>
<td>8/2/2016</td>
<td></td>
<td>4.30</td>
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<tr>
<td>Maran Gas Sparta</td>
<td></td>
<td>8/2/2016</td>
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<td>4.93</td>
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<td>Maran Gas Delphi</td>
<td></td>
<td>7/30/2016</td>
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<td>5.08</td>
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<td>Maran Gas Apollonia</td>
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<td>7/19/2016</td>
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<td>Gaslog Greece</td>
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<td>7/16/2016</td>
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<td>Hispania Spirit</td>
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<td>7/13/2016</td>
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<td>Gaslog Salem</td>
<td>Brazil, Pecem FSRU</td>
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<td>3/26/2016</td>
<td>4.90</td>
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<td>Clean Ocean</td>
<td>India, Ratnagiri</td>
<td>3/15/2016</td>
<td>3/15/2016</td>
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<td>Asia Vision</td>
<td>Brazil, Guanabara Bay FSRU</td>
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<td><strong>22 Total Vessels</strong></td>
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<td></td>
<td></td>
<td><strong>115 Bcf</strong></td>
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</table>

Source: Bloomberg
On the heels of the first US LNG exports, Australia’s Gorgon LNG project prepared its first cargo.
How much US LNG can the global market absorb? Maybe not much ....

Source: Bloomberg New Energy Finance, Poten & Partners
Pipeline projects in the works to bring natural gas to New England
Midstream infrastructure continues to grow, but could soon outpace production.

App Basin Takeaway Capacity
Bcf/d

Takeaway pipeline capacity outpaces production growth

Production
Outlook is for continued low and stable prices

Henry Hub Natural Gas Price

$/MMBtu

- Historical spot price
- STEO forecast price
- NYMEX futures price
- 95% NYMEX futures upper confidence interval
- 95% NYMEX futures lower confidence interval

Note: Confidence interval derived from options market information for the 5 trading days ending Aug 4, 2016. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Source: Short-Term Energy Outlook, August 2016.
Consumer Natural Gas Prices Back to 1990s Levels

Residential Natural Gas Prices

Source: EIA STEO
Average household consumption of natural gas has *dropped by half* since 1970.

Residential Natural Gas Use per Customer, Weather Normalized (Mcf)

Source: Energy Information Administration, AGA Calculations
Natural Gas Used Directly In Homes and Businesses Reduces Greenhouse Gas Emissions

Space Heating System Carbon Dioxide Emissions
(Ton CO2 per 100 MW Useful Energy Consumption)

- Electric Furnaces: 74
- Oil-fired Furnaces: 45
- Air Source Heat Pumps: 31
- Gas-Fired Furnaces: 27

Source: MIT Future of Natural Gas
Appliance efficiencies Energy STAR compliant.
System Modernization Has Been a Decades Long Process and Will Continue

Cast Iron and Unprotected Steel Pipeline (Miles)

Source: Department of Transportation
Pipeline Replacement Lowers Emissions

Miles of installed main has increased 34% since 1990.

Even with this tremendous growth, estimated methane emissions from pipeline leaks declined 74%.

A consequence of increased removal of unprotected steel & cast iron pipe replaced with plastic & protected steel.

Source: AGA chart and calculations using data from EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014
The gas utility sector in flux?

Duke Energy to acquire Piedmont Natural Gas

Source: SNL Financial
Map credit: VitalVizor

Southern Co. to acquire AGL Resources Inc.

As of Aug. 24, 2015.
Source: SNL Energy
Map credit: Alp Arasas
Nine US nuclear reactors have announced intent to retire. This could push natural gas demand up 1.35 Bcf per day

Table 2: Nuclear reactors with announced intent to retire

<table>
<thead>
<tr>
<th>Reactor</th>
<th>Size (MW)</th>
<th>Region</th>
<th>State</th>
<th>Owner</th>
<th>Age (yr)</th>
<th>Retirement date</th>
<th>Gas burn equivalent (Bcf/d)</th>
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<tr>
<td>Clinton</td>
<td>1,065</td>
<td>MISO</td>
<td>IL</td>
<td>Exelon</td>
<td>29</td>
<td>June 2017</td>
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<tr>
<td>Quad Cities</td>
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<td>PJM</td>
<td>IL</td>
<td>Exelon</td>
<td>44</td>
<td>June 2018</td>
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<td>Oyster Creek</td>
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<td>PJM</td>
<td>PA</td>
<td>Exelon</td>
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<td>2019</td>
<td>0.09</td>
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<td>Nine Mile Point 1</td>
<td>637</td>
<td>New York</td>
<td>NY</td>
<td>Exelon</td>
<td>47</td>
<td>March 2017</td>
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<td>Ginna</td>
<td>582</td>
<td>New York</td>
<td>NY</td>
<td>Exelon</td>
<td>46</td>
<td>2017</td>
<td>0.09</td>
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<tr>
<td>Fitzpatrick</td>
<td>847</td>
<td>New York</td>
<td>NY</td>
<td>Entergy</td>
<td>40</td>
<td>January 2017</td>
<td>0.13</td>
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<tr>
<td>Pilgrim</td>
<td>677</td>
<td>New England</td>
<td>MA</td>
<td>Entergy</td>
<td>44</td>
<td>June 2019</td>
<td>0.10</td>
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<tr>
<td>Diablo Canyon</td>
<td>2,240</td>
<td>California</td>
<td>CA</td>
<td>PG&amp;E</td>
<td>31</td>
<td>2024</td>
<td>0.34</td>
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<tr>
<td>Fort Calhoun</td>
<td>479</td>
<td>SPP</td>
<td>NE</td>
<td>Omaha Public Power District</td>
<td>43</td>
<td>December 2016</td>
<td>0.07</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>8,954</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.35</strong></td>
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</table>

Source: Bloomberg New Energy Finance Notes: Plants may have multiple reactors. Average reactor age shown. Gas burn assumes 7MMBtu/MWh.
Natural Gas Energy Policy Questions

• How will state energy plans treat nuclear? (eg. California vs. New York)
• Clean Power Plan – Will SCOTUS send EPA back to the drawing board?
• Will there be renewed interest in discussions about a carbon tax? Where does the natural gas industry stand?
What’s next for 2016 and 2017?
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