Outlook for Natural Gas

for National Conference of State Legislatures (NCSL)
Hydraulic fracturing webinar

John Staub, Team Lead for Exploration and Production Analysis
December 19, 2012
What is the state of energy?

Explore EIA’s new state energy portal!
www.eia.gov/state
States pages include EIA datasets and analysis on all fuels and energy infrastructure included in EIA data collection.

**Pennsylvania**
State Profile and Energy Estimates

**Rankings: Natural Gas Marketed Production, 2010**
(million cu ft)

<table>
<thead>
<tr>
<th>Rank</th>
<th>State</th>
<th>Natural Gas Marketed Production (million cu ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Texas</td>
<td>6,715,294</td>
</tr>
<tr>
<td>2</td>
<td>Wyoming</td>
<td>2,305,525</td>
</tr>
<tr>
<td>3</td>
<td>Louisiana</td>
<td>2,219,099</td>
</tr>
<tr>
<td>4</td>
<td>Oklahoma</td>
<td>1,827,329</td>
</tr>
<tr>
<td>5</td>
<td>Colorado</td>
<td>1,676,319</td>
</tr>
<tr>
<td>6</td>
<td>New Mexico</td>
<td>1,292,105</td>
</tr>
<tr>
<td>7</td>
<td>Arkansas</td>
<td>928,838</td>
</tr>
<tr>
<td>8</td>
<td>Pennsylvania</td>
<td>572,902</td>
</tr>
<tr>
<td>9</td>
<td>Utah</td>
<td>432,045</td>
</tr>
<tr>
<td>10</td>
<td>Alaska</td>
<td>374,226</td>
</tr>
<tr>
<td>11</td>
<td>Kansas</td>
<td>374,720</td>
</tr>
<tr>
<td>12</td>
<td>California</td>
<td>283,441</td>
</tr>
</tbody>
</table>

**Additional State Rankings**

**Consumption**

<table>
<thead>
<tr>
<th>Rank</th>
<th>State</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

**Production**

<table>
<thead>
<tr>
<th>Rank</th>
<th>State</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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EIA updates state level data sets with mapping features and energy infrastructure datasets

Interactive map links to state level energy data

Profile Overview

- Pennsylvania was the fourth largest coal-producing state in the Nation in 2011, and the only state producing anthracite coal, which has a higher heat value than other kinds of coal. Annual production of coal was more than double in Pennsylvania in 2011, according to EIA.

John Staub
NCSL webinar, December 19, 2012
Multiple layers of user selected options are available such as shale gas plays, power plants, pipelines, and transmission lines.
Henry Hub Natural Gas Price
dollars per million btu

- 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 December 6, 2012. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Source: Short-Term Energy Outlook, December 2012
U.S. Natural Gas Prices
dollars per thousand cubic feet

Source: Short-Term Energy Outlook, December 2012
U.S. Natural Gas Production and Imports

billion cubic feet per day (bcf/d)  annual change (bcf/d)

Federal Gulf of Mexico production (right axis)  U.S. non-Gulf of Mexico production (right axis)
U.S. net imports (right axis)  Total marketed production (left axis)
Marketed production forecast (left axis)

Source: Short-Term Energy Outlook, December 2012
Natural gas prices increase over the outlook

Henry Hub Spot Price
2011 dollars per million Btu

Source: EIA, Annual Energy Outlook 2013 Early Release
Coal regains some competitive advantage relative to natural gas over time on a national average basis.

Energy prices to the electric power sector

- **Ratio of Natural Gas Price to Steam Coal Price**: The ratio of natural gas price to steam coal price is shown on a graph, indicating competitive parity.

- **Energy Prices to the Electric Power Sector**
  - **History**: The historical prices from 1990 to 2011 are shown.
  - **2011**: The year 2011 is marked to show the competitive parity.
  - **Projections**: Projections from 2011 to 2040 are shown, indicating the future trend of energy prices.

Source: EIA, Annual Energy Outlook 2013 Early Release
Currently, U.S. shale gas production comprises about 35% of total U.S. dry production.

Shale gas production (dry)
- billion cubic feet per day
- trillion cubic feet per year

Sources: LCI Energy Insight gross withdrawal estimates as of November 2012 that are converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.
Domestic production grows rapidly over projection period, particularly natural gas and renewables, and liquids in the near term.

U.S. energy production (quadrillion Btu)

- **History**
- **2011**
- **Projections**

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural gas</th>
<th>Renewables</th>
<th>Crude oil and natural gas plant liquids</th>
<th>Coal</th>
<th>Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>60%</td>
<td>20%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>1990</td>
<td>65%</td>
<td>25%</td>
<td>10%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>2000</td>
<td>70%</td>
<td>30%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>2010</td>
<td>80%</td>
<td>40%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>2020</td>
<td>90%</td>
<td>50%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>2030</td>
<td>100%</td>
<td>60%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>2040</td>
<td>110%</td>
<td>70%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Shares of total U.S. production

- **2011**
- **2020**
- **2030**
- **2040**

- Natural gas: 35%
- Renewables: 14%
- Crude oil and natural gas plant liquids: 24%
- Coal: 17%
- Nuclear: 10%

Source: EIA, Annual Energy Outlook 2013 Early Release

John Staub
NCSL webinar, December 19, 2012
U.S. energy use grows slowly over the projection reflecting improving energy efficiency and a slow and extended economic recovery.

U.S. primary energy consumption (quadrillion Btu)

Source: EIA, Annual Energy Outlook 2013 Early Release

John Staub
NCSL webinar, December 19, 2012
Domestic natural gas production grows faster than consumption and the U.S. becomes a net exporter of natural gas around 2020

U.S. dry gas
trillion cubic feet

Source: EIA, Annual Energy Outlook 2013 Early Release

John Staub
NCSL webinar, December 19, 2012
Total natural gas exports nearly quadruple by 2040 in the AEO2013 Reference case

U.S. natural gas exports
trillion cubic feet

Source: EIA, Annual Energy Outlook 2013 Early Release

John Staub
NCSL webinar, December 19, 2012
Shale gas production leads growth in production through 2040

U.S. dry natural gas production
trillion cubic feet

Source: EIA, Annual Energy Outlook 2013 Early Release
Natural gas consumption is quite dispersed with electric power, industrial, and transportation use driving future demand growth.

U.S. dry gas consumption
trillion cubic feet

<table>
<thead>
<tr>
<th>Year</th>
<th>History</th>
<th>Projections</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>19%</td>
<td>32%</td>
</tr>
<tr>
<td>2011</td>
<td>13%</td>
<td>33%</td>
</tr>
<tr>
<td>2020</td>
<td>3%</td>
<td>33%</td>
</tr>
<tr>
<td>2025</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>2030</td>
<td>12%</td>
<td>6%</td>
</tr>
<tr>
<td>2035</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>2040</td>
<td>14%</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Includes combined heat-and-power and lease and plant fuel.
**Includes pipeline fuel.

Source: EIA, Annual Energy Outlook 2013 Early Release

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There are three main drivers of natural gas production:

- Economics
- Geology
- Technology
Three drivers impact resource estimation metrics differently

- **Theory**
  - Gas in Place (GIP)

- **Experiment**
  - Technically Recoverable Resources (TRR)

- **Practice**
  - Economically Recoverable Resources (e.g. proved reserves)

Geology

Technology

Economics

Well-level data, incl. estimated ultimate recovery (EUR)
Technically recoverable natural gas resources continue long-term rise

U.S. dry gas resources

Source: EIA, Annual Energy Outlook 2013 Early Release

*Alaska resource estimates prior to AEO2009 reflect resources from the North Slope that were not included in previously published documentation.
Steep decline curves for shale gas plays make the market more responsive to price

Source: EIA, Annual Energy Outlook 2012

John Staub
NCSL webinar, December 19, 2012
Estimated ultimate recovery (EUR) calculated from historical individual natural gas well data shows most wells are concentrated around mean. Fort Worth Basin – natural gas

<table>
<thead>
<tr>
<th>Number of wells</th>
<th>Average EUR</th>
<th>25th percentile</th>
<th>Mean</th>
<th>Median</th>
<th>75th percentile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>4016</td>
<td>1.3869</td>
<td>0.9999</td>
<td>1.641</td>
<td>1.687</td>
<td>0.098</td>
<td>3.000</td>
</tr>
</tbody>
</table>

Source: EIA analysis, EUR = total projected production over 30 year life of wells
For more information


Annual Energy Outlook | www.eia.gov/forecasts/aeo

Short-Term Energy Outlook | www.eia.gov/forecasts/steo

International Energy Outlook | www.eia.gov/forecasts/ieo

Today In Energy | www.eia.gov/todayinenergy

Natural Gas Weekly Update | http://www.eia.gov/naturalgas/weekly/

States data | http://www.eia.gov/beta/state/

Shale gas | http://www.eia.gov/energy_in_brief/article/about_shale_gas.cfm
Supplemental slides
Over time the electricity mix gradually shifts to lower-carbon options, led by growth in natural gas and renewable generation.

U.S. electricity net generation

Source: EIA, Annual Energy Outlook 2013 Early Release
Natural gas and renewables account for the vast majority of capacity additions from 2012 to 2040

U.S. cumulative capacity additions

Source: EIA, Annual Energy Outlook 2013 Early Release
Natural gas, wind and other renewables account for the vast majority of capacity additions from 2011 to 2040

**2011 capacity**

- Natural gas: 413 (39%)
- Coal: 315 (30%)
- Nuclear: 101 (10%)
- Hydropower*: 101 (10%)
- Other renewables: 15 (1%)
- Wind: 45 (4%)

Total: 1,055 gigawatts

**Capacity additions 2012 to 2040**

- Natural gas: 215 (64%)
- Wind: 42 (13%)
- End-use coal: 58 (17%)
- Nuclear: 11 (3%)
- Coal: 8 (2%)
- Other renewables: 58 (17%)
- End-use coal: 1 (0.4%)
- Other: 0.4 (0.1%)

Total: 339 gigawatts

* Includes pumped storage