U.S. Shale Gas in Context

Overview of U.S. Natural Gas production and trends

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By
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Discussion agenda

• About the U.S. Energy Information Administration
• Fundamentals of shale gas
• Natural gas production and electricity generation outlook
EIA mission: independent statistics and analysis

• EIA was created by the U.S. Congress in 1977

• EIA collects, analyzes, and disseminates **independent and impartial** energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment

• EIA is the nation's premier source of energy information and, by law, its data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government

• EIA does not propose or advocate any policy positions
EIA produces data series, analyses, and energy projections

- **Weekly, monthly, and annual data**
  - Displays U.S. and regional production, stocks, blender inputs, imports, and exports

- **Real-time analyses**
  - Digests important developments in Today in Energy, This Week in Petroleum, Issues & Trends, Country Analysis Briefs, Drilling Productivity Report

- **Short-Term Energy Outlook (STEO)**
  - Forecasts U.S. supplies, demands, imports, stocks, and prices of energy with a horizon of 12 to 24 months

- **Annual Energy Outlook (AEO)**
  - Presents 25- to 30-year projection and analysis of U.S. energy supply, demand, and prices

- **International Energy Outlook (IEO)**
  - Assesses international energy production and consumption
The U.S. has experienced a rapid increase in natural gas and oil production from shale and other tight resources.

Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through July 2015 and represent EIA’s official tight oil & shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).
Estimated U.S. shale gas production was 41.0 Bcf/d in June 2015 about 56% of total U.S. dry production (73.6 Bcf/d).

Sources: EIA Natural Gas Monthly data through December, STEO through June 2015 and Drilling Info.
Shale gas and tight oil plays
Tight oil characteristics vary considerably

• Prior to the “shale development breakthrough”
  – Drillers targeted either oil or natural gas formations
  – Production was relatively stable over a long period from each well
  – Simple rig count was sufficient to monitor and forecast production

• Drilling in tight formations
  – New applications of technology: Horizontal drilling and hydraulic fracturing
  – Pad drilling: Multiple wells per rig from one surface location
  – High initial production rates driven by better technology
  – Steep production declines
  – Formations yielding both oil and natural gas
  – Regional differences contrast rig and well productivity
  – Higher costs to drill and complete a well
Shale gas and tight oil trends: production by geography – the Drilling Productivity Report (DPR)

http://www.eia.gov/petroleum/drilling/
Seven key plays account for nearly all recent growth in U.S. oil and natural gas production

Source: EIA, Drilling Productivity Report, August 2015
DPR captures key elements of shale

Rig productivity underpins natural gas production gains

new-well gas production per rig
thousand cubic feet per day

Source: EIA, Drilling Productivity Report, July 2015
Contributing factors to U.S. Shale Gas / Tight Oil production

• Technical expertise and experience
• Extensive transportation capacity
• Price responsiveness of producers
• Regulatory stability & property rights
Natural gas & electricity generation outlook
An increasing amount of electric power generation comes from natural gas

electricity net generation
trillion kilowatthours

Source: EIA, Annual Energy Outlook 2015 Reference case
Low natural gas prices have made natural gas competitive with coal generation

Average U.S. costs for fossil fuels for generation $/MMBtu

Source: U.S. Energy Information Administration, Electricity Data Browser
In 2014, U.S. electricity generation was 67% fossil fuels, 20% nuclear, and 13% renewable.

**2014 Total net generation: 4,093 billion kWh**

- **Coal** 38.8%
- **Natural gas** 27.5%
- **Nuclear** 19.5%
- **Conventional hydroelectric** 6.3%
- **Other** 6.9%
- **Petroleum** 0.7%
- **Other gases** 0.3%

**2014 Non-hydro renewable net generation: 281 billion kWh**

- **Wind** 4.4%
- **Solar thermal and PV** 0.4%
- **Wood and wood-derived fuels** 1.1%
- **Geothermal** 0.4%
- **Other biomass** 0.5%

*Source: EIA, Monthly Energy Review*
Nearly half of power plant capacity additions in 2014 came from natural gas

U.S. power plant capacity additions in 2014
megawatts (MW)


Note: Data include facilities with a net summer capacity of 1 MW and above only.
Growth in natural gas electric power capacity is expected to continue.

May 2015 to April 2016
Total: 21,447 MW
Shale resources remain the dominant source of U.S. natural gas production growth.

U.S. dry natural gas production

<table>
<thead>
<tr>
<th>Year</th>
<th>Shale gas and tight oil plays</th>
<th>Tight gas</th>
<th>Coalbed methane</th>
<th>Other lower 48 onshore</th>
<th>Lower 48 offshore</th>
<th>Alaska</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>5 billion cubic feet per day</td>
<td>10 billion cubic feet per day</td>
<td>15 billion cubic feet per day</td>
<td>20 billion cubic feet per day</td>
<td>25 billion cubic feet per day</td>
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<td>2015</td>
<td>60 billion cubic feet per day</td>
<td>55 billion cubic feet per day</td>
<td>50 billion cubic feet per day</td>
<td>45 billion cubic feet per day</td>
<td>40 billion cubic feet per day</td>
<td>35 billion cubic feet per day</td>
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</table>

Source: EIA, Annual Energy Outlook 2015 Reference case
Natural gas consumption growth is driven by increased use in all sectors except residential.

U.S. dry gas consumption
trillion cubic feet

<table>
<thead>
<tr>
<th>Year</th>
<th>Residential</th>
<th>Commercial</th>
<th>Transportation**</th>
<th>Electric power</th>
<th>Industrial*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
</tr>
<tr>
<td>2013</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
</tr>
<tr>
<td>2020</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
</tr>
<tr>
<td>2025</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
</tr>
<tr>
<td>2030</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
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<tr>
<td>2035</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
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<td>2040</td>
<td>8.9</td>
<td>8.2</td>
<td>0.9</td>
<td>3.3</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Source: EIA, Annual Energy Outlook 2015 Reference case

*NIncludes combined heat-and-power and lease and plant fuel
**Includes pipeline fuel
Growth in manufacturing output and use of natural gas reflect high natural gas supply and low prices, particularly in the near term.

Source: EIA, Annual Energy Outlook 2015 Reference case
Coal regains some competitive advantage relative to natural gas over time on a national average basis.

Energy prices to the electric power sector (2013 dollars per Btu)

- **History**: Natural gas prices have fluctuated over time, with significant increases in the early 2000s and another rise in 2010. Coal prices have generally remained lower.
- **Projections**: The projections show continued growth in both natural gas and coal prices, with natural gas expected to remain higher than coal over the forecast period.

Competitive parity is indicated by the horizontal dashed line, where the ratio of natural gas price to steam coal price is equal to 1. The graph shows that this parity was not achieved during the historical period but is projected to occur in future years.

*Source: EIA, Annual Energy Outlook 2015*
Natural gas is projected to grow faster than other fuels in the AEO2015 Reference case.

Note: Includes generation from plants in both the electric power and end-use sectors.

Source: Projections: EIA, Annual Energy Outlook 2015; History: EIA, Annual Energy Review;
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

Monthly Energy Review | www.eia.gov/totalenergy/data/monthly

State Energy Portal | www.eia.gov/state

Drilling Productivity Report | www.eia.gov/petroleum/drilling
Supplemental Slides
North American natural gas prices are relatively low compared to prices in the rest of the world.

Global spot natural gas and crude oil prices with average monthly LNG prices in Japan
U.S. dollars per million British thermal unit

Source: U.S. Energy Information Administration based on Bloomberg data

Source: U.S. Energy Information Administration based on Bloomberg data
U.S. becomes a net exporter of natural gas in the near future

U.S. dry natural gas
trillion cubic feet per year

History

2013

Projections

billion cubic feet per day

Consumption

Production

Net exports

Source: EIA, Annual Energy Outlook 2015
Projected U.S. natural gas exports reflect the spread between domestic natural gas prices and world energy prices

U.S. natural gas imports and exports
trillion cubic feet

billion cubic feet per day

Source: EIA, Annual Energy Outlook 2015
Future domestic natural gas prices depend on both domestic resource availability and world energy prices

average Henry Hub spot prices for natural gas
2013 dollars per million Btu

Source: EIA, Annual Energy Outlook 2015
Increased production in the Northeast-Plus resulted in reduced net inflows to the region.

Northeast-Plus natural gas supply and demand balance

billion cubic feet per day

Source: Pipelines posting Information collected by Bentek Energy, LLC
Many natural gas pipeline projects are principally developing because of production growth in the Mid-Atlantic and Northeast.

Notes: Reversal projects are not on the map. ANR, Columbia Gulf Transmission, Iroquois Gas Pipeline, Rockies Express Pipeline, Tennessee Gas Pipeline, Texas Eastern Transmission, and Transcontinental Gas Pipeline are planning to reverse their flows.

Source: EIA, Natural Gas Pipeline Projects, July 2014
Pipeline capacity is expanding to move more Marcellus gas to the Northeast...

Source: U.S. Energy Information Administration
Note: Map is as of October 31, 2013 and only includes projects with at least 0.1 Bcf/d of additional takeaway capacity. Dashed lines indicate existing pipelines on which expansions are occurring. Solid lines indicate newly built pipeline connections.
...and West...

Westbound flows on Rockies Express

Full eastbound service from Mexico, Missouri to Charington, Ohio began in February 2006, with service to other points established in earlier months.

Full eastbound service from Cheyenne, Wyoming to Mexico, Missouri began in February 2008, with service to other points established in earlier months.


Source: ANR Pipeline Company

Legend
- Appalachian Basin
- Greater Green River Basin
- Rockies Express Pipeline
- ANR
- ANR East Pipeline Project
- TCPL
- Receipt Point
- Gas Plant
...and South.

Source: Williams Company