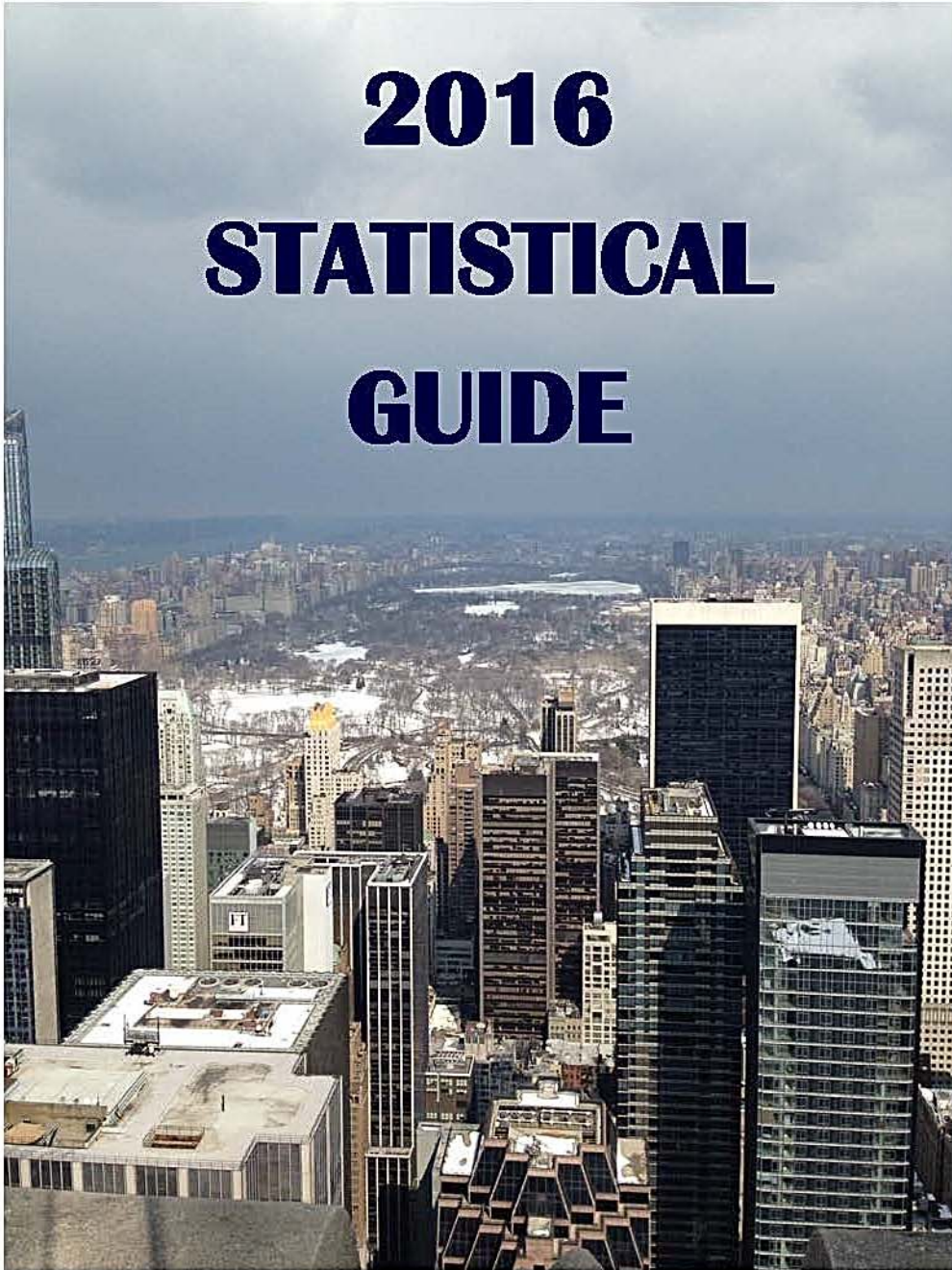


2016 STATISTICAL GUIDE



 **Northeast**
GAS ASSOCIATION

NORTHEAST GAS MARKET AT-A-GLANCE

	NEW ENGLAND	NEW YORK	NEW JERSEY	PENNSYLVANIA
<i>Gas Customers</i>	2.7 million	5 million	3 million	3 million
<i>Annual Consumption (2015)</i>	905 Bcf	1,326 Bcf	747 Bcf	1,069 Bcf
<i>Interstate Pipelines</i>	5	11	5	7
<i>Miles of transmission pipeline</i>	2,653	4,560	1,570	9,957
<i>Underground Storage</i>	-	246 Bcf	-	771 Bcf
<i>LNG import facilities</i>	3	-	-	-
<i>Gas production in-state, annual (2015)</i>	-	18 Bcf	-	4,704 Bcf
<i>Gas Efficiency Program Budgets (2015)</i>	\$253 million	\$196 million	\$83 million	\$13 million
<i>Primary energy consumption, leading fuels, % (2014)</i>	Natural Gas, 28% Oil, 42% Nuclear, 12% Coal, 2% Renewables, 12%	Natural Gas, 37% Oil, 35% Nuclear, 12% Coal, 2% Renewables, 11%	Natural Gas, 34% Oil, 41% Nuclear, 14% Coal, 1% Renewables, 4%	Natural Gas, 28% Oil, 26% Nuclear, 18% Coal, 23% Renewables, 5%
<i>Gas as a share of residential home heating fuels (2015)</i>	39%	58%	75%	51%
<i>Total population</i>	14.8 million	19.7 million	8.9 million	12.8 million
<i>Gross state domestic product (GDP, 2015; % of U.S)</i>	\$963 billion 5.3%	\$1,466 billion 8.1%	\$577 billion 3.2%	\$696 billion 3.9%

Sources: NGA, NYSEDA, NY DEC, NY PSC, NJ BPU, American Council for an Energy Efficient Economy, U.S. EIA, PHMSA, U.S. Census Bureau, U.S. BEA
Updated by NGA, November 2016

STATISTICAL GUIDE TO THE NORTHEAST U.S. NATURAL GAS INDUSTRY *2016*

*An annual review of statistics and trends
relating to the region's natural gas industry*



November 2016



The NGA *Statistical Guide* is intended as an introduction to the natural gas market in the Northeast U.S. region of New England, New Jersey, New York and Pennsylvania. Included are basic statistics on end-use markets, infrastructure, and natural gas issues and trends - from technology applications to environmental benefits.

Regional information is updated through calendar year 2015, where available. As much as possible the most recent data from other sources are presented.

NGA is grateful to its member companies for their cooperation and support in providing data and information for presentation in a regional tabulation.

Other particularly helpful sources of information are the U.S. Department of Energy/Energy Information Administration, the Federal Energy Regulatory Commission, Canada's National Energy Board, and the New York State Energy Research and Development Authority.

The Guide is prepared by Stephen Leahy of NGA. Please feel free to forward any suggestions, comments and revisions to:
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The Year in Review

2016

The Northeast Gas Association (NGA) is pleased to present this annual overview of market characteristics and recent developments in the Northeast region of the United States. This overview summarizes the key features of the natural gas system in New England, New York, New Jersey and Pennsylvania, and then discusses several current market issues (including new infrastructure, new technology R&D, supply and price trends, state policies to increase access to natural gas, and regional and national environmental and greenhouse gas implications).

MARKET BACKGROUND

Population and Economy

The Northeast region comprises the nine states of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The composite population is 56.2 million (17.5% of the U.S.). Total state domestic product for the region is \$3.7 trillion (20.5% of the U.S. total).

Regional Natural Gas Market

The nine-state region has 13.7 million natural gas customers (19% of the U.S. total of 73.5 million). Total annual gas sendout on the regional gas system is 4 trillion cubic feet (Tcf), or 16% of U.S. total consumption (measured in volumes delivered to consumers).

Primary Energy

Natural gas represents 28% of the primary energy consumption of the six New England states, 34% of New Jersey, 37% of New York, and 26% of Pennsylvania, compared to the national average of 28% (based on U.S. EIA data, 2014).

Gas Customers

New England has 2.7 million natural gas customers. Residential customers number 2.4 million; commercial and industrial customers number over 260,000.

New Jersey has close to 3 million natural gas customers. Residential customers number 2.7 million; commercial and industrial customers number about 250,000.

New York has 5 million natural gas customers. Residential customers number 4.5 million; commercial and industrial customers number about 400,000.

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Pennsylvania has 3 million natural gas customers. Residential customers number 2.7 million; commercial and industrial customers number about 250,000.

Natural gas is the leading home heating fuel in all four subregions. In New England, natural gas is the leading home heating fuel (38.7%), with oil a close second (36.5%). In New Jersey, it is the clear leader (75%), with oil at 9%. In New York, it has 58% of the heating market, with fuel oil second (23%). In Pennsylvania, it has 51% of the heating market, with electricity second (22%) and fuel oil third (17%).

Consumption/Sendout by Sector

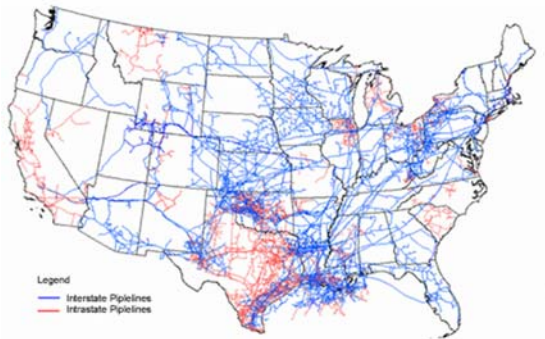
Total annual sendout in New England is 900 billion cubic feet (Bcf), in New Jersey about 750 Bcf, in New York about 1,320 Bcf, and in Pennsylvania about 1,070 Bcf (2015 EIA annual data).

In New England, gas consumption by end-use sector is 24% residential, 22% commercial, 12% industrial, and 42% power generation. In New Jersey it is 32% residential, 22% commercial, 7% industrial, and 39% power generation. In New York it is 34% residential, 23% commercial, 6% industrial, and 36% power generation. In Pennsylvania it is 22% residential, 14% commercial, 23% industrial, and 41% power generation.

The gas distribution company, or LDC, design day demand in New England is 4.5 Bcf per day, in New Jersey over 4 Bcf/d, and in Pennsylvania about 5 Bcf/d. Total gas system demand in New York State is about 7 Bcf/d. Winter is the peak season for Northeast demand. The increasing use of gas for power generation, however, has led to an increasing use in the summer months, although summer demand is still lower than winter demand.

Electric Generation Sector

Based on annual fuel mix and generator applications in the queue at ISO-NE, NYISO and PJM, natural gas remains one of the leading current - and projected - fuel sources for electric generation. In New England, natural gas represents 49%



The U.S. interstate natural gas pipeline system includes 302,000 miles of transmission pipeline, according to the U.S. PHMSA. The EIA map on the left illustrates the extensive system.

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The 9 Northeast states have close to 14 million gas customers, about 19% of the U.S. total.



of current regional electric capacity, in New Jersey about 56% (in-state generation), in New York 55%, and in Pennsylvania about 26%.

Regional Market: Gas Supply Sources

About 96% of the natural gas consumed in the U.S. is now produced domestically. The balance is imported from Canada, with a small share from imported liquefied natural gas (LNG).

Historically, the Northeast region relied on three main supply areas: Gulf Coast U.S., Canada, and

LNG. During the past 15 years, supply sources expanded to include Rockies/Midcontinent gas and eastern Canada. The most significant supply change is the development of the Marcellus Shale gas basin in Appalachia. In fact, Marcellus production has completely transformed the supply dynamic into the Northeast. Production there has grown from 2 Bcf/d in 2008 to over 18 Bcf/d in 2016.

As a result, the Northeast region’s imports from other U.S. supply basins, Canada, and LNG have declined as the new “local” production has emerged. Marcellus production is resulting in new delivery points and new pipeline infrastructure to bring this shale gas to market, as well as reducing prices for consumers.

Canada remains valuable to the region, but with new Marcellus supplies so near, the level of exports from Canada to the Northeast U.S. has fallen by two-thirds since 2007, from 2.8 Bcf/d to 0.9 Bcf/d.

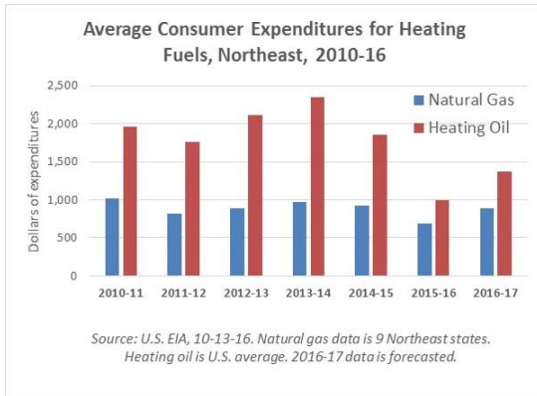
LNG imports into the U.S. were 91 Bcf in 2015, substantially lower than the high point of 771 Bcf in 2007. LNG imports still play a critical role in helping local gas utilities meet winter peak day requirements (e.g., LNG provides about 30% of New England’s utility peak day requirements).

The Distrigas facility outside Boston imported just under 50 Bcf in 2015, which represented 54% of total U.S. imports. (Notably, in the first nine months of 2016, Distrigas imported 59 Bcf, exceeding its 2015 annual volumes.) LNG inputs into the region are further enhanced via supplies from Canaport LNG in New Brunswick, Canada, which delivered another 23 Bcf in 2015.

Pipeline and LNG Deliverability into the Region

New England

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As illustrated in the chart, natural gas in the Northeast (shown in blue) has had a price advantage over heating oil for the last several years. While the price spread has narrowed, natural gas remains the heating fuel of choice: 85% of new single-family and multi-family homes built in the Northeast in 2015 ran on gas, according to the U.S. Census.

Chart source: U.S. Energy Information Administration, Oct. 2016

New England has 2,653 miles of gas transmission pipeline, according to the U.S. Department of Transportation/ Pipeline and Hazardous Materials Safety Administration (PHMSA).

The pipeline companies serving New England, interstate and intrastate, are: Algonquin Gas Transmission, Granite State Gas Transmission, Iroquois Gas Transmission System, Maritimes & Northeast Pipeline, Portland Natural Gas Transmission System, and Tennessee Gas Pipeline Co.

New England is the site of three import terminals for LNG. The onshore terminal is owned by ENGIE and operated by its subsidiary, Distrigas of Massachusetts Corp. (DOMAC). LNG is delivered by tanker to the Distrigas terminal where there is storage capacity of 3.4 Bcf. The terminal has pipeline interconnections as well as connections with a major gas utility and a major power plant. LNG is also transported to multiple LDCs’ satellite storage tanks from trucks that fuel at the DOMAC terminal. The terminal’s vaporization capability is 715 MMcf/d; it also has daily sendout by truck of another 100 MMcf/day.

The offshore Northeast Gateway facility (near Cape Ann, MA) can receive LNG cargoes and inject the revaporized gas into the HubLine pipeline system of Spectra Energy. This offshore facility owned by Excelerate Energy became fully operational in early 2008. It had several shipments in its early years but none from 2011 to 2014. After several years of inactivity it has brought some offshore gas into the market (2.6 Bcf in 2015 and 2.3 Bcf in 2016).

In 2010 the offshore Neptune LNG facility owned by ENGIE (also near Cape Ann, MA) was completed. Designed to inject an average of 400 million cubic feet per day into Spectra’s HubLine it has been inactive since its start-up, reflecting the changing market dynamics.

A fourth facility, Canaport LNG, is located just over the Maine border in Saint John, New Brunswick, Canada. Owned and operated by Repsol and Irving Oil, it became operational in June 2009. It can deliver up to 1 Bcf/d into the

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Photo: Spectra Energy

Brunswick Pipeline, which connects with the Maritimes & Northeast Pipeline, which then can transport the volumes into the New England market. Since its inception, it has delivered over 400 Bcf into the regional market.

New Jersey

New Jersey has 1,570 miles of gas transmission pipeline.

The interstate pipeline companies serving New Jersey are: Algonquin Gas Transmission, Columbia Gas Transmission, Tennessee Gas Pipeline Co., Texas Eastern Pipeline Co., and Transcontinental Gas Pipe Line Corp.

The LDCs utilize local LNG storage for peak day support.

New York

New York has 4,560 miles of gas transmission pipeline. The pipeline companies serving New York State are: Algonquin Gas Transmission, Columbia Gas Transmission, Dominion Transmission, Empire State Pipeline Co., Iroquois Gas Transmission System, Millennium Pipeline Company, National Fuel Gas Supply Co., North Country Pipeline, Stagecoach Gas Services, Tennessee Gas Pipeline Co., Texas Eastern Pipeline Co., and Transcontinental Gas Pipe Line Corp. New York also has gathering systems such as Laser Pipeline.

LNG is utilized by two local utilities in the New York City and Long Island areas. The LNG is received from the pipeline in vapor form and then liquefied. New York has no LNG import facility.

Pennsylvania

Pennsylvania has 9,957 miles of gas transmission pipeline. The pipeline companies serving the Commonwealth include: Columbia Gas Transmission, Dominion Transmission, National Fuel Gas Supply Co., Tennessee Gas Pipeline Co., Texas Eastern Pipeline Co., and Transcontinental Gas Pipe Line Corp. LNG is utilized by two LDCs, and produced by the affiliate of another utility for sale into the regional energy market.

Regional Production

The Northeast region, a major consumer of natural gas and a high-priced energy market, is an increasingly significant locus for natural gas production.

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The region traditionally had only limited natural gas production, in New York and Pennsylvania. (There is no gas resource production base in New Jersey or New England.) As mentioned, in recent years with the advent of hydraulic fracturing and the development of the Marcellus resource base, the Northeast has developed into a significant domestic natural gas production area.

Estimates are that the Marcellus area alone may hold as much as 500 Tcf of natural gas.

Marcellus production, centered in Pennsylvania and West Virginia, was over 18 Bcf/d in late 2016. It is anticipated that Northeast production could exceed 25 Bcf/d or more in coming years.

Interstate pipeline companies serving the Appalachian region continue to add interconnects from area producers. Several projects have been completed and others are in development to bring this gas to market. The primary permitting agency for interstate pipeline infrastructure is the Federal Energy Regulatory Commission (FERC). State environmental agencies among other entities are also involved in assessing siting issues at the state level.

Shale gas production encounters some challenges in terms of infrastructure development, land and water access, siting, and water treatment and disposal (water is one of the key ingredients in the hydraulic fracturing process used to dislodge the gas from the shale rock formations).

While there is a shale gas resource in New York, use of the hydraulic fracturing process is not permitted per state regulation announced in late 2014. New York State does allow conventional drilling production. Total annual state output was 18 Bcf in 2015. The state’s conventional production has been steadily declining since 2007.



Photo: PA PUC

There is some conventional production in eastern Canada.

Gas from offshore Nova Scotia in eastern Canada continues to be produced as part of the Sable Offshore Energy Project. Output however continues to decline and its future output is uncertain.

A gas production field in New Brunswick, the McCully field of Corridor Resources, began production in 2007, and provides some small amounts of gas for delivery into the Maritimes and Northeast Pipeline. There are estimates of considerable offshore natural gas reserves near Newfoundland and Labrador that conceivably could

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Another key supply point for the region is liquefied natural gas (LNG). The region has three operating import facilities, two in MA and one in New Brunswick, Canada. Nationally and regionally, LNG imports are down, as U.S. domestic production is on the increase. LNG remains especially important to New England for peak days. Photo: Distrigas/ENGIE



be developed. Potential shale resources exist in the other Eastern Canadian provinces but no shale development is occurring per provincial moratoria.

In 2016 Gaz Métro in Quebec expanded its liquefaction capability from 3 Bcf to over 9 Bcf.

Regional Storage

Storage is a critical part of the natural gas supply and delivery chain. The Northeast region has considerable underground storage, notably in Pennsylvania (8.4% of the U.S. total). Underground storage in New York represents 2.7% of the U.S. total. The geology of New Jersey and New England is not suitable for underground gas storage.

As noted, LNG is another important part of the Northeast storage portfolio. Total LNG storage capacity in New York is 3.2 Bcf, in New Jersey about 4 Bcf, in Pennsylvania 6.7 Bcf, and in New England 16 Bcf on the LDC system and another 3.4 Bcf at the DOMAC import terminal. In Saint John, the Canaport LNG facility has 9.9 Bcf of storage. As noted above, in 2016 Gaz Métro tripled the size of its liquefaction capability to 9 Bcf. The additional supply is meant to serve the road and marine transportation sector as well as parts of the province remote from the natural gas network. Some of the current supply is sold into the New England gas utility market, with delivery by truck.

Recent System Enhancements

In 2016 only a few system enhancements were placed into service. These included Spectra’s Algonquin Incremental Market (AIM) Project and its Salem Lateral. Vermont Gas System is completing its Addison Natural Gas Project to extend distribution service south to Middlebury.

The year was more notable for delays in projects scheduled to be in service in late 2016, from the proposed Constitution Pipeline to two smaller incremental

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projects designed to serve gas utility customers – Dominion’s New Market Project and Tennessee’s Connecticut Expansion. Although these projects received their federal certificates they encountered delays at the state environmental review level. Additional projects are in the regulatory process or in development for the Northeast market over the next several years.

Projected Market Growth

United States

The 2016 U.S. EIA Annual Energy Outlook forecasts 0.3% annual energy growth for the United States through 2040. EIA projects that natural gas will grow at a rate of 0.9% annually, coal at –1.4%, renewables at 2.8%, petroleum at 0.1%, and nuclear at 0%.

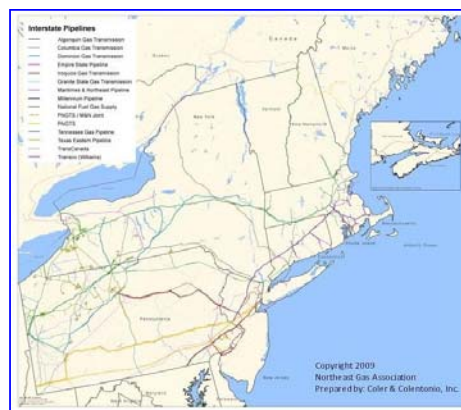
Regional Growth

The 2016 EIA Outlook projects a 0.2% annual growth rate for natural gas consumption in New England and a 0.8% annual rate in the Mid-Atlantic region through 2040. Total energy use in New England is projected to decline by 0.3% over the period, and remain flat at 0% in the Mid-Atlantic region.

Planned Infrastructure Enhancements

The Northeast region’s natural gas industry plans numerous infrastructure projects to meet growing market demand within the 2017-2020 timeframe. The region remains constrained at several points on its natural gas system, especially into New England and southern New York/Long Island. Two gas utilities in Massachusetts continue to have moratoria on adding new customers in certain parts of their systems due to inadequate pipeline capacity.

The interstate pipeline system in the Northeast accesses supplies from multiple sources. The pipelines also can access storage at different points along their systems, including local storage in Pennsylvania and New York. With prolific production underway in Appalachia, these pipeline operators are undertaking numerous projects to add facilities to bring these new supplies to local markets in the Northeast, changing traditional flow patterns.



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New supplies and infrastructure would help to ease these constraints, ameliorate the regional price disadvantage, further increase regional natural gas capacity, deliverability, flexibility and reliability, and provide economic and environmental benefits to the region.

NGA regularly posts updates on proposed projects at:
http://www.northeastgas.org/pipeline_expansion.php.

Challenges for new projects include siting, environmental concerns, and securing market position. Securing contract commitments in New England remains a challenging market issue, as the largest consuming sector, power generation, is constrained by the complex economic structure of its wholesale electricity market. Natural gas utilities on the other hand have committed to investing in proposed pipeline projects to meet system growth and reliability needs.

LNG is another supply option, for the market in general and for gas LDCs. UGI Corp. in Pennsylvania through its subsidiary, UGI LNG, has LNG storage, associated peak shaving services, and an LNG tanker truck-loading terminal, available for peak shaving service. As noted Gaz Métro is tripling its liquefaction capability in 2016. The “Access Northeast” project envisions the expansion of LNG capacity on the Eversource system in southeastern MA. National Grid is planning to add liquefaction at its Providence, RI facility; and South Jersey Gas just added liquefaction capability in 2016, obviating the need for trucked deliveries.

In fall 2016, the State of Maine solicited bids for proposals to provide additional LNG storage in the state. Among the benefits the State is seeking is that new LNG storage “provides the opportunity for access to lower cost natural gas at times of regional peak demand for natural gas or in the event of a disruption in upstream natural gas infrastructure; and...enhances electrical and natural gas reliability in the State.”

Another supply/delivery development has been the introduction of portable or mobile compressed natural gas (CNG) and LNG to bring natural gas to communities and businesses not located near a pipeline or distribution system. Some businesses and institutions, such as medical centers and colleges, have opted for natural gas delivered by truck; gas is transported via a trailer that then offloads the gas into the industrial or institutional facility.

New supply developments are transforming the traditional paths of supply sourcing into the region, creating a more diverse supply mix and a more robust delivery network.

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Natural gas and renewable energy are the leading growth fuels in the region, for sectors from power generation to alternate fuel transportation. Natural gas can help balance power system demand for variable sources like solar and wind. Shown here is a photo of an LNG tank on the South Jersey Gas system, along with a solar panel array.



MARKET ISSUES

Supply Outlook

In terms of U.S. natural gas supply, the outlook remains positive.

In April 2015, the Potential Gas Committee (PGC) at the Colorado School of Mines released its year-end 2014 biennial report, *Potential Supply of Natural Gas in the United States*. The updated assessment finds that the nation possesses a technically recoverable natural gas resource potential of 2,515 Tcf. This is the highest resource evaluation in the PGC’s 50-year history, exceeding by 131 Tcf the previous record-high assessment from year-end 2012. The future supply of domestic natural gas continues to grow due to the emergence and advancement of key technologies that unlock gas production from reservoirs such as shale formations.

In November 2015, EIA released its latest annual report on U.S. oil and gas reserves (the data is for 2014). EIA reported that total natural gas proved reserves increased 10% in 2014, reaching a new record of 388.8 Tcf. EIA reported that Pennsylvania had the most shale gas proved reserves in 2014, surpassing Texas for the first time, while West Virginia remained the third-largest shale gas reserves state. Marcellus Shale remains the largest shale play (ranked by proved reserves) in the U.S.

Canada has considerable natural gas reserves and remains an important energy partner, although its share of the U.S. natural gas market is expected to continue to decline over the long-term. As mentioned, the growth of U.S. supplies is leading to lower imports from Canada into the Northeast, while at the same time natural gas demand within Canada is expected to grow, leaving less for export. An indicator of the changing dynamic is that a few pipelines in the U.S. Northeast are now exporting supplies to Ontario – a reversal of historical supply patterns. In June 2016,

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Canada’s National Energy Board (NEB) observed in “*Canada’s Energy Future 2016*” that “net pipeline exports of natural gas from Canada could decline to essentially zero by 2040.”

The rise in domestic U.S. production is also having an impact on LNG imports. LNG imports into the U.S. are substantially lower than a decade ago, and the focus for several areas of the U.S. is shifting from *imports* to *exports*. Several LNG import facilities in the U.S. – on both coasts and especially in the Gulf - are working to add liquefaction facilities so that they can export LNG to the world market. As of September 2016, the U.S. had *exported* more LNG for the year (106 Bcf) than it had *imported* (64 Bcf). This divergence is anticipated to widen dramatically in coming years.

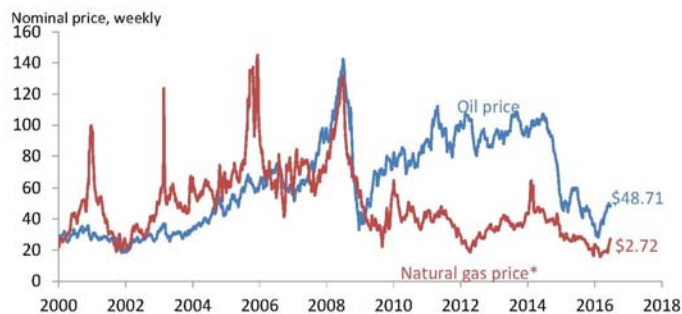
Nevertheless, with the Northeast delivery system still constrained at certain points, the regionally based LNG facilities are expected to continue to ease bottlenecks and increase supply and delivery options.

The Northeast states continue to be leaders in per capita energy efficiency.

Efficiency Initiatives

The Northeast region is a recognized leader in per capita energy efficiency. A 2016 report by the American Council for an Energy Efficient Economy (ACEEE) noted that \$1.4 billion was invested in natural gas efficiency programs nationwide in 2015 (the latest data). Nearly 40% of the national total (\$544 million) was invested in the nine Northeast states alone.

As ACEEE noted, efficiency opportunities exist in multiple sectors: “While the roots of natural gas efficiency programs lie within residential markets, there



The wide price differential between natural gas and oil has narrowed in the last two years. Natural gas however retains a price advantage - and the projection by U.S. EIA in its “2016 Annual Energy Outlook” is that natural gas spot prices will fall well below crude oil spot prices in coming decades in the U.S. Chart: Federal Reserve Bank of Dallas, 6-16

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New York City continues to make progress on its efforts to phase out the use of #4 and #6 oil in city buildings in favor of cleaner fuels such as natural gas as part of the “NYC Clean Heat Initiative.”

are now programs serving multiple types of natural gas customers - from homeowners to large industries...Programs may target specific technologies that use natural gas, such as furnaces, water heaters, boilers, and cooking equipment, or they may target the systems and facilities that are served by natural gas technologies. Improving the thermal envelope of buildings is one example of programs that address whole buildings."

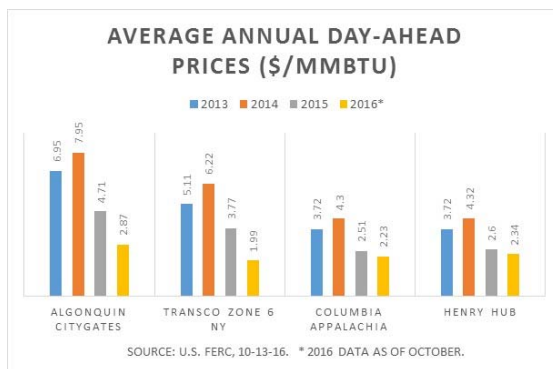
Price Trends

The key variables in natural gas price formation are demand growth, the condition of the national economy, production levels, storage levels, weather, and alternative fuel prices.

The natural gas price story in this new era of domestic production has been positive for both consumers and the entire U.S. economy. In July 2008, natural gas reached \$13.50/MMBtu and oil hovered close to \$150 a barrel. The average natural gas commodity price for 2015 was \$2.63/MMBtu.

Given the size of the domestic supply resource base, it is projected that the natural gas price bandwidth will stay relatively moderate. However, short-term volatility reflecting delivery constraints and weather will continue, especially in regional markets.

The lower commodity price offers economic opportunities for states in the re-



The Northeast region remains among the most constrained gas delivery areas in the U.S. This chart shows average annual day-ahead prices for several points. Algonquin serves as a proxy for New England, Transco for NY. The 2016 price shown in yellow is low for all points reflecting a generally low commodity price environment.

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gion. New Jersey’s 2015 State Energy Master Plan (EMP) noted that “Today, New Jersey’s natural gas prices are among the lowest in the country. Prices in our state were the 17th highest in the nation in 2011; today we rank 46th. This huge decrease was anticipated in the 2011 EMP and has been critical to successfully reducing the cost of electricity and improving the environmental performance of New Jersey’s electric generation.”

Likewise, New York State, in its 2015 Energy Plan, observed: “Projected prices reflect continued industry success in tapping the nation’s extensive shale gas resources. With its nearness to the Marcellus Shale basin, New York should participate in prices lower than those experienced from 2000 through 2010 and more similar to those of the last few years.”

Winter Challenges

The back-to-back winters of 2013-14 and 2014-15 brought colder than normal weather to the Northeast and set new records for both pipeline and gas utility sendout. The consistent cold weather, which tested regional energy delivery systems, resulted in significant energy price volatility.

FERC noted in its 2013-14 winter assessment that “during each of these cold events, customers who had firm transportation capacity on natural gas pipelines generally managed to secure natural gas deliveries.”

Since most gas generators in New England do not have firm transportation capacity arrangements, many are unable to obtain gas during high demand periods. ISO-New England’s “winter reliability program” utilizes oil through special contracts to offset the unavailability of the generators’ interruptible gas arrangements; LNG is also an option. ISO-NE’s program has been extended for another few winters in recognition of the projected constraints on the natural gas delivery system and the resultant impact on “non-firm” transportation customers such as many power generators.



Natural gas utility customers in the region are shielded in large part from the volatility of the spot market price thanks to gas utilities’ firm contract arrangements for pipeline capacity and their storage arrangements. Other market participants however, such as many power generators and industrial customers, do rely on non-firm capacity and thus are subject to spot market prices and interruptions in capacity delivery according to their contract terms.

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Air emissions from power generation in the region have declined substantially in the past decade thanks in great part to the use of cleaner-burning fuels such as natural gas.

Photo: Joseph Murphy

There is a further impact on regional electric prices. FERC notes that “as natural gas is the marginal fuel for most electricity energy markets, the price of natural gas plays a leading role in setting the price of electricity.”

The situation in the summer months is less challenging (although maintenance work can have impacts).

The addition of new infrastructure in the region, increasing supply availability, would help to mitigate the volatility of the Northeast energy market.

Gas and Electric Power Generation

Gas for electric generation is the leading gas consumption sector nationally and regionally. New technology, particularly combined-cycle technology (CCT), has made the natural gas power plant the energy system of choice for the last two decades. CCT’s advantages over other conventional fuel types include higher efficiency, lower heat rates, shorter construction lead times, and reduced air emissions.

Gas plants along with industrial-scale wind are the leading fuel types for new proposed power generation capacity in the generator queues in New Jersey (where gas represents 96% of proposed new generation), Pennsylvania (92%), New York (65%), and New England (53%). As the fossil fuel with the lowest carbon content, gas appears positioned as a stable power generation source for years to come. Natural gas also provides back-up potential for variable solar and wind power generation.

The regional power generation fleet, already highly reliant on natural gas, appears positioned to become more so in the near - to mid-term. In New Jersey in 2016 PSEG announced the retirement of its last two coal units, noting the competitive market pressure presented by low natural gas prices. In New England, a nuclear plant in Vermont and a coal/oil plant in Massachusetts retired in 2014, and a nuclear plant in Massachusetts announced it will retire in 2019.

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*Natural gas power plant
near Boston.*



Public policy in several states in the region is prioritizing non-fossil fuel units for future generation. As part of its “Reforming the Energy Vision (REV)” process New York State is seeking to transform its electric system with the primary goal of reducing carbon emissions in order to meet a newly-enacted Clean Energy Standard. This approach in 2016 led the state to implement steps to subsidize nuclear units located upstate that were slated for closure as a result of competitive power market pressures (an added benefit in the state’s view was the preservation of plant jobs in an area of the state seeing slower economic growth).

In Massachusetts, the governor in August 2016 signed an “energy diversity” bill to facilitate the import of up to 1,200 megawatts (MW) of “clean energy” from Canada and other areas, as well as up to 1,600 MWs of offshore wind.

These market interventions pose a challenge for non-fossil fuels as a generation option. Nevertheless natural gas, which serves as the backbone of the power system regionally, will likely do so for many years to come, as the region tries to come to terms with how best to balance environmental considerations, economics, and system reliability.

As the region continues to rely on natural gas for baseload generation, the lack of adequate pipeline infrastructure to meet power sector needs remains an unresolved issue - most notably in New England. As noted earlier, most power generators in New England do not contract for firm gas pipeline capacity and instead rely on “if and as available gas” non-firm capacity, or, in some cases, capacity held by third parties. Pipeline capacity is added to meet the needs of gas customers who desire and are willing to execute contracts for such firm service.

In December 2013, New England’s governors issued a joint statement expressing commitment to a regional initiative that called for the development of new natural gas pipeline infrastructure as well as electric transmission infrastructure and energy efficiency. This regional effort in support of new electric transmission investments to access clean energy remains underway. Connecticut, Massachusetts and Rhode Island are now reviewing bidders’ responses to a joint RFP process to solicit and support clean energy projects.

The natural gas pipeline initiative proceeded for more than a year through individual state processes after it was determined that a regional tariff concept was not feasible. Three states supported the concept of electric distribution utilities investing in gas pipeline capacity on behalf of electric utility customers as a way to achieve lower electric costs and higher power system reliability. The separate

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efforts in Massachusetts and New Hampshire, however, foundered in 2016 after both the Massachusetts Supreme Judicial Court and the New Hampshire Public Utilities Commission ruled that such a proposal would violate electric industry restructuring legislation. Thus, the coordinated states’ plan to facilitate new gas pipeline investment to meet electric sector needs appears stalled for at least the near term.

In April 2016, one of the major new pipeline projects planned for New England, Tennessee Gas Pipeline’s Northeast Energy Direct, was withdrawn. The developer had secured half of the planned capacity commitment, all from local gas utilities, but had not secured commitments from power generators. Access Northeast, a major project designed just for the power generation market, is still moving forward, but a new financing pathway will be needed as the necessary support from the electric sector has yet to be secured.

More than a decade after the January 2004 “cold snap” first exposed the regional power system’s reliance on interruptible natural gas deliveries, the New England gas-electric reliability challenge remains unresolved.

The president and CEO of ISO-NE observed in November 2016 that “New England is challenged to meet electricity demands with existing natural gas infrastructure, particularly during the winter. If the region cannot invest in new gas infrastructure or allow adequate use of dual-fuel capability, [ISO] will have to retain, and invest in sufficient non-gas resources to ensure reliability.” Mr. van Welie of ISO-NE went on to note that “renewable resources provide variable energy production and are typically not reliable capacity resources. To assure reliability, the region needs fast-responding, flexible capacity resources that are not constrained in their operation.”

New England had about 3,000 MWs of new gas generation planned as of fall 2016. The first of these new units is scheduled to come online in Salem, MA in summer 2017.

Industry Consolidation

At the national and continental level, 2016 witnessed a few major pipeline consolidations, with Canadian firms acquiring U.S. assets.

In July, TransCanada completed its acquisition of Columbia Pipeline Group. Columbia operates an approximate 24,000-kilometre (km) (15,000-mile) network of interstate natural gas pipelines extending from New York to the Gulf of Mexico, with a significant presence in the Appalachia production basin. Following the merger, TransCanada now operates a network of natural gas pipelines that extends more than 90,300 kilometres (56,100 miles), tapping into virtually all major gas

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supply basins in North America. It is the continent's leading provider of gas storage and related services with 664 billion cubic feet of storage capacity. TransCanada is also the developer and operator of one of North America's leading liquids pipeline systems that extends over 4,300 kilometres (2,700 miles), connecting growing continental oil supplies to key markets and refineries.

In September, Enbridge Inc. and Spectra Energy Corp announced that they have entered into a definitive merger agreement under which Enbridge and Spectra Energy will combine in a stock-for-stock merger transaction. The combination will create the largest energy infrastructure company in North America and one of the largest globally. The headquarters of the combined company will be in Calgary, Alberta. Houston, Texas will be the combined company's gas pipelines business unit center; Edmonton, Alberta will remain the business unit center for liquids pipelines, with gas distribution continuing to be based in Ontario. The merger is expected to close in the first part of 2017.

Natural Gas Vehicles

Natural gas vehicles (NGVs) remain a competitive alternative fuel option, especially for fleets, buses, and heavy-duty vehicles, including refuse trucks. On the environmental front, NGVs have other comparative advantages. The U.S. Department of Energy noted that “Commercially available medium - and heavy-duty natural gas engines have demonstrated over 90% reductions of carbon monoxide (CO) and particulate matter, and more than 50% reduction in nitrogen oxides (NOx) relative to commercial diesel engines.”

The market for heavy-duty vehicles remains strong, especially for both the bus and refuse truck sectors. Compressed natural gas (CNG) accommodates the widest vehicle types, from fleet vehicles to buses and garbage trucks. There is also interest in LNG as a fuel for heavy-duty trucks that travel defined routes and even for marine transportation (such as ferries).

New CNG fueling stations are being added throughout the region each year but the relatively limited availability of fueling stations remains a key market challenge.

New England has a few LNG fueling sites (in CT and MA), and some initiatives are underway in the U.S. and Canada for “LNG highways” to establish fueling stations to facilitate truck travel. New Jersey and Pennsylvania continue to experience CNG station development. New York State has seen an investment



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in CNG “virtual pipeline” facilities.

In January 2015 the NYS Department of Environmental Conservation released new regulations for LNG facilities in the state. DEC observed that “The adopted regulations enable permits to be granted to safely site, construct and operate new LNG facilities under requirements established in a DEC permit...Projections indicate that for the first five years, nearly all of the expected permit applications will be for facilities designed to supply fuel for longhaul tractor trailers and large capacity fleet trucks that use LNG as a substitute for diesel fuel. LNG offers a lower cost, cleaner fuel for truckers and an emissions benefit for the environment.”



State Policies to Increase Access to Natural Gas

The benefits of natural gas – lower price, lower emissions, domestic supply – are leading to higher levels of customer conversions and new customer development. Multiple states and municipalities are looking to natural gas to provide both greater energy choice and economic benefits to consumers and local economies, as well as to assist in complying with air and health quality standards.

In its state energy master plan (EMP) released in December 2015, New Jersey summarized some of the opportunities presented by natural gas. The report noted that “Expansion of the State’s gas distribution companies’ (GDCs) intrastate pipeline capacity and the capacity of the interstate pipelines serving the state provides an opportunity for the State to take advantage of relatively low priced and abundant nearby natural gas supplies. This will assist in meeting the increased and competing demands upon natural gas supply as fuel for residential and commercial heat and electric generation. Although New Jersey is generally well-supplied with natural gas pipeline capacity for heat and existing power generation, the state lacks adequate natural gas infrastructure to support new, gas-fired electrical generation, as well as substitution for other fuels in the residential and commercial sectors. Expanding the capacity for natural gas can increase economic development with lower costs for energy and enhance environmental quality through lower emissions.”

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Photo: National Grid

Utility System Expansions and Fuel Conversions

There are several operational and planned system expansions on local utility systems. In July 2015 for example, Enbridge St. Lawrence Gas Company completed its transmission line expansion in Franklin County in upstate New York. Vermont Gas continues its Addison Expansion Project with service anticipated to reach Middlebury later in 2016. Similarly, other utilities are looking to expand their distribution systems to serve areas lacking natural gas access. Some utilities in New England are looking as well to expand their LNG li-

quefaction capability.

Natural gas utilities in the region report steady levels of new customers and customer conversions from other fuels, and are seeking to grow their system capabilities to meet demand. In spring 2016, Con Edison reported that more than 5,000 large New York City buildings converted from oil to natural gas in the last four years—yielding price advantages, and helping to clear the air.

New England’s natural gas utilities set a new regional peak record on February 14, 2016 at 4 Bcf. In New York State, a new all-time peak was set on February 13, 2016 at 6.6 Bcf (exceeding the previous state peak set in February 2015 at 6.4 Bcf).

Since 2008, the number of homes heating with natural gas in the Northeast region has grown by over one million.

The Northeast states have added over 1 million new natural gas customers since 2008.

Infrastructure Siting Challenges and Regulatory Delays

Energy infrastructure has always encountered siting issues. Examples include wood plants, wind turbines, offshore wind farms, nuclear power units, electric transmission, and natural gas pipelines and compressor turbines.

Some natural gas pipelines in service today in the region experienced delays in development due to siting challenges before ultimately beginning operation.

In the last year or two however, the siting challenges for fossil fuel projects have reached a new level in the U.S. and North America. Recently, more organized opposition has emerged to various projects, focusing on the carbon content

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of fossil fuels and their contribution to greenhouse gas emissions. Some in the environmental community argue that fossil fuels should be “kept in the ground” and that any new infrastructure must be prevented, lest, once built, it remains in service for decades and restrains the use of renewables. Natural gas as a “bridge fuel” was for several years the fossil fuel preferred by many environmentalists since gas exhibits lower environmental impacts than coal and oil. Now, the rising use of natural gas is garnering increased attention from many groups which view gas as the last obstacle to the full implementation of clean energy.

Project delays and delays in the construction process ranging from legal challenges at every level of the proceeding to acts of civil disobedience on project work sites became more prevalent – and concerning - in 2016.

The regulatory process remains essentially unchanged but delays at the state level are increasing, particularly regarding the issuance of state water quality certificates. Natural gas pipeline projects to secure federal approval must demonstrate market need and financial viability, and their routes must meet environmental requirements. Contract commitments by future customers or shippers are essential to the process. Stakeholder and community outreach are also a required part of the process. Delays in the state environmental review process are concerning, adding costs and uncertainty.

The Northeast, a highly congested area, poses challenges for any energy development. There is demonstrated market demand for natural gas by customers in the region. Increasing stakeholder outreach and advocating project benefits are basic but fundamental steps that will only become more relevant in this new public environment.

Environmental Considerations

Environmental issues remain central to energy system use. Highlights of some environmental topics and the role of natural gas follows.

Reductions in air emissions from power generation

Because natural gas compares favorably to other fossil fuels regarding air emissions, it will likely remain a favored fuel for new power generation. MIT’s June 2011 study on gas concluded that using very efficient natural gas-powered plants to replace coal-fired plants was “the most cost-effective way of reducing CO₂ emissions in the power sector” over the next 25 to 30 years. Natural gas will also play “a central role in integrating more intermittent renewable sources - wind and solar - into the electricity system because they can easily be brought in and out of service as needed.”

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In May 2016 EIA reported that energy-related carbon dioxide (CO₂) emissions in the U.S. fell in 2015, and were over 10% lower than ten years ago. According to an issues brief by EIA, U.S. energy-related carbon dioxide emissions in 2015 were 12% below the 2005 levels, “mostly because of changes in the electric power sector.” EIA reported that: “Many of the changes in energy-related CO₂ emissions in recent history have occurred in the electric power sector because of the decreased use of coal and *the increased use of natural gas for electricity generation*...Overall, the fuel-use changes in the power sector have accounted for 68% of the total energy-related CO₂ reductions from 2005 to 2015.” [Note: boldface and italics added]



At the regional level, the air emissions trends remain favorable. NY ISO reported that from 2000 to 2015 emissions rates from the power sector saw a 42% decline in CO₂, a 79% decline in NO_x, and a 97% decline in SO₂. ISO-NE reported that “an increase in natural-gas-fired power generation and the implementation of emission controls on the region’s fossil-fuel-fired power plants have resulted in significant reductions in air emissions in New England.” For the period 2005-2014, SO₂ emissions in that region declined by 92%, NO_x emissions by 65%, and CO₂ by 35%. New Jersey reported that the CO₂ emission rate of fossil generation declined by 37% from 2011 to 2013.

Reductions of methane emissions in natural gas system operations

The natural gas industry is cognizant of its responsibility to reduce emissions from its system operations. Many of NGA’s distribution and transmission company members already participate in the EPA’s Natural Gas STAR Program and progress continues on this front. For 2014 in the U.S., Natural Gas STAR partners reported methane emissions reduction of 51 Bcf, providing “cross-cutting benefits” according to EPA. Reducing pipeline leaks is of paramount interest (see section on infrastructure replacement below).

Methane emissions related to the U.S. natural gas system were slightly higher in 2014 compared to 2013, but since 1990 methane emissions are down by 14.8%, according to the EPA’s April 2016 national GHG inventory report. The report noted that “The decrease in CH₄ emissions is largely due to a decrease in emissions from transmission, storage and distribution... The decrease in distribution emissions is largely attributed to increased use of plastic piping, which has lower emis-

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sions than other pipe materials, and station upgrades at metering and regulating (M&R) stations.”

For the distribution sector, the main emphasis has been on accelerating the replace-

ment of older, more “leak-prone” pipe. Early in 2015, a national study led by Washington State University reported that direct measurement analysis showed “decreasing methane emissions from natural gas local distribution systems in the United States.” Replacement of older pipe systems and improved leak surveys were among the reasons cited for the industry performance. An ICF study for the Commonwealth of Massachusetts in 2015 found that for the three geographic areas studied in the state, methane emissions fell within the range of 0.6 to 1.1% of all gas received. ICF noted that “the effectiveness of replacing cast iron and unprotected steel with plastic pipe to reduce emissions is clearly demonstrated in this study.” In December 2015, a report released by the Massachusetts Executive Office of Energy & Environmental Affairs indicated that methane emissions in the Commonwealth declined by over 60% from 1990 to 2012.

In 2016 EPA launched a new program called the Natural Gas STAR Methane Challenge Program. The initiative, says EPA, “provides a new mechanism through which U.S. oil and gas companies can make more specific and transparent commitments to reducing methane emissions. The Program provides a platform for partners to showcase their efforts to reduce methane emissions, improve air quality, and capture and monetize this valuable energy resource.” Several Northeast LDCs have joined the effort, including Avangrid, Con Edison Co. of NY, Eversource, National Grid, NiSource, Orange & Rockland Utilities, PSEG, South Jersey Gas, UGI, and Vermont Gas.



Shale gas development

The development of shale gas continues to merit analysis and technological improvements. MIT’s June 2011 study on natural gas noted that “the environmental impacts of shale development are challenging but manageable.” In a September 2012 paper for DOE’s “Clean Cities” Program, Argonne National Laboratory noted that even as improved science-based assessments of potential environmental impacts continue, “early results indicate that the risks can be managed and lowered through existing practices.”

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Industry and government regulatory agencies are working to address development in an environmentally safe manner. The natural gas production industry has been addressing the issue of disclosure regarding the additives used in hydraulic fracturing. The Ground Water Protection Council (GWPC) and the Interstate Oil and Gas Compact Commission (IOGCC), with funding support from DOE, unveiled <http://fracfocus.org>, a web-based national registry identifying the chemical additives used in the hydraulic fracturing process on a well-by-well basis. As of November 2016, the industry had registered 117,000 wells nationwide.

An October 2011 paper from the National Regulatory Research Institute (NRRI) stated that “Based on more than one million wells drilled with fracking, however, there is little evidence that fracking directly causes groundwater contamination...[R]eports show that these incidents resulted from surface spills, poor cementing jobs in wellbores, and other operational failures.”

The Pennsylvania Governor’s Marcellus Shale Advisory Commission reported that “The primary concerns regarding hydraulic fracturing relate to surface spills of fluids, well control and lost containment of production and flowback water on the surface.” Proper procedures and oversight are necessary at all stages of the process.

The Pennsylvania Department of Environmental Protection (DEP) in its *2015 Oil and Gas Annual Report* notes that “although the number of inspections has increased since 2008, the number of violations associated with unconventional and conventional wells has steadily decreased over the same time period. The record suggest that DEP’s compliance initiatives and outreach to operators are working as compliance rates are improving.”

Other issues, such as reducing the use of diesel fuel in the production process, enhancing “green completion” in the entire production cycle to reduce emission losses, and mitigating community impacts, continue to receive industry attention. The industry must be responsible for best practices at all times.

Pipeline Safety and Public Awareness

Pipeline safety is always a primary issue for the industry. Federal and state regulatory requirements are rigorous, and several recent regulations have been announced to enhance operations safety, from transmission and distribution integrity management to control room operations. While the rate of incidents is declining nationwide at both gas transmission and distribution levels, “high profile, high consequence” incidents, as termed by PHMSA, have occurred in recent years.



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Both industry and government regulators continue to prioritize worker and contractor training, including addressing the prevalence of “third party damage” (the leading cause of incidents); the importance of “call before you dig” programs; increasing public awareness of natural gas; encouraging individuals to call utility or emergency personnel if they smell gas in the home or street; and maintaining and enhancing the physical components of the delivery system using methods like “accelerated infrastructure replacement” to replace older pipe materials.

NGA and its member companies continue to work on important initiatives in the areas of public awareness, worker training, awareness of third party damage, integrity management implementation, and new technologies.

Accelerated Pipeline Replacement

An issue related to safe operations and environmental performance is the replacement of older pipeline system components (pipes constructed of bare steel or cast-iron) that are considered more “leak-prone”. The accelerated repair and replacement of more leak-prone natural gas distribution system components is thus an issue of growing interest. PHMSA continues to urge action on repairing older, potentially more leak-prone systems.

In general, due to its older systems, the Northeast states have higher levels of such distribution pipe components than the national average. The U.S. average for systems with bare steel and cast iron components is about 5%. The percentage is 32% in Rhode Island, 23% in Massachusetts, and 21% in New York. Rhode Island, which has the highest percentage of aged infrastructure in the region, has reduced its level of aged mains by one-third since 2009.

Replacing these older components is a priority, for safety reasons and to reduce system leaks and related emissions.

State regulatory agencies are working with utilities on programs to achieve pipe replacement in an economically appropriate manner.

Rhode Island and Massachusetts enacted legislation in recent years, and the New York State Public Service Commission announced in April 2015 that it was considering plans to accelerate utility replacement of “leak-prone” pipe in the state. In November 2015, the New Jersey Board of Public Utilities, as another example, approved a utility’s Gas System Modernization Program (GSMP) which will replace up to 400 miles of gas mains and related service lines over a three-year period.

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Renewable Natural Gas

Renewable Natural Gas (RNG), also known as bio-methane or biogas, is pipeline quality gas derived from biomass that is fully interchangeable with natural gas. The future natural gas network could also carry renewable gas from dairy farms, waste water treatment plants, landfills, and wood waste and food waste facilities.

In the Northeast, National Grid is an active proponent of incorporating biogas into the natural gas system. In a position paper a few years ago, National Grid observed that “the biggest driver of renewable gas is GHG reduction, but what makes renewable gas more compelling is that it also enhances diversity of supply while providing a solution for using local waste resources to produce renewable energy.”

Vermont Gas introduced a renewable gas program in 2016 that is utilizing biogas from local farms.

The U.S. Department of Energy notes that “like conventional natural gas, RNG can be used as a transportation fuel in the form of compressed natural gas (CNG) or liquefied natural gas (LNG). RNG qualifies as an advanced biofuel under the Renewable Fuel Standard.”

New Technology R&D

NGA has a significant R&D program operated by NYSEARCH.

NYSEARCH has been involved with innovative projects such as pipeline sensing and guided wave technology, and continues to utilize its own testbed facility (Johnson City, NY) for advanced demonstrations. Recent success stories include the development, testing and commercialization of the Remote Methane Leak Detector (RMLD), the EXPLORER II robotics program, and tests of drones for gas company facility inspection flights.

NGA also has had a program with the Gas Technology Institute (GTI) to help facilitate knowledge transfers regarding new technologies that can enhance operations, safety, efficiency, and analysis.

Technology is the bridge to our energy future; continued investment in natural gas technology is an avenue to progress.

Technology research & development continues to be essential to industry progress .

Photo: NYSEARCH



II.

REGIONAL ENERGY OVERVIEW

This section provides an introduction to the energy scene in the Northeast region.

Among the areas addressed are:

- *economic profile*
- *projected energy consumption by fuel type*
- *primary energy mix*
- *electric generation mix*
- *state energy consumption.*

NORTHEAST ECONOMIC PROFILE

STATE	POPULATION (2015)	HOUSEHOLDS (2015) [occupied housing units]	LABOR FORCE (Aug. 2016) [thousands]	GROSS DOMESTIC PRODUCT (GDP) (2015) [\$ billions]	GDP as % OF U.S. TOTAL (2015)	PER CAPITA PERSONAL INCOME (2015)
Connecticut	3,590,886	1,343,703	1,902	261	1.4	\$66,972
Maine	1,329,328	545,226	690	58	0.3	\$42,077
Massachusetts	6,794,422	2,559,951	3,611	476	2.7	\$61,032
New Hampshire	1,330,608	517,615	757	74	0.4	\$54,817
New Jersey	8,958,013	3,187,963	4,559	577	3.2	\$59,782
New York	19,795,791	7,233,694	9,552	1,466	8.1	\$57,705
Pennsylvania	12,802,503	4,956,037	6,426	696	3.9	\$49,180
Rhode Island	1,056,298	407,484	557	58	0.3	\$50,080
Vermont	626,042	254,865	346	31	0.2	\$47,864
U.S.	321,418,820	118,208,250	159,463	18,047	100	\$47,669

Sources: U.S. Bureau of the Census, U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics. GDP = current dollar.

TOTAL PRIMARY ENERGY CONSUMPTION

A comparison of primary energy consumption in the Northeast states indicates a strong role for petroleum, reflecting the inclusion of the transportation sector, a very small role for coal compared to the national average, a varying role for nuclear, a growing share for renewables, and a solid and growing share for natural gas.

Percentage by State per Fuel Type

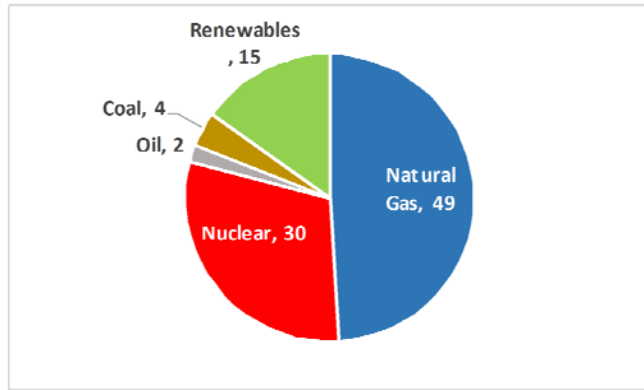
	Natural Gas	Oil	Nuclear	Renewables	Coal	Electric Flows
CT	32	41	22	5	1	
ME	15	46	-	38	-	
MA	30	38	4	6	2	19
NH	19	49	34	20	5	-27
NJ	34	41	14	4	1	
NY	37	35	12	11	2	2
PA	28	26	18	5	23	
RI	45	43	-	4	-	9
VT	8	57	38*	25	-	-17
US	28	36	8	10	18	

*Sources: U.S. Energy Information Administration (EIA), "State Energy Data Report 2014," released 2016. Electric flows shown for states where numbers make material difference. *Vermont nuclear number reflects Vermont Yankee nuclear plant which retired in December 2014.*

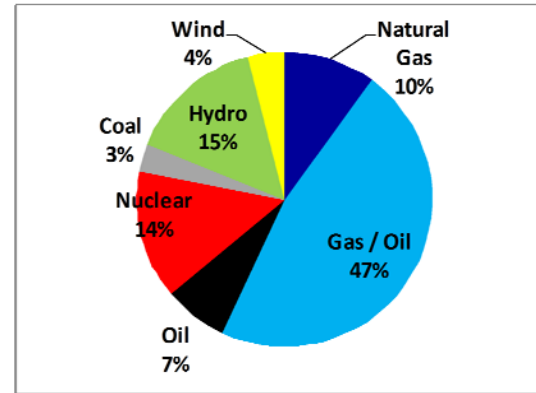
ELECTRIC GENERATION FUEL SOURCE

(% of total)

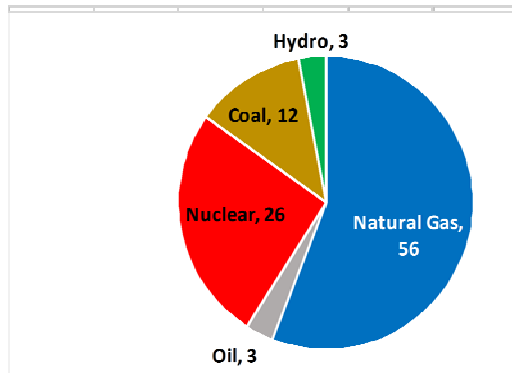
NEW ENGLAND



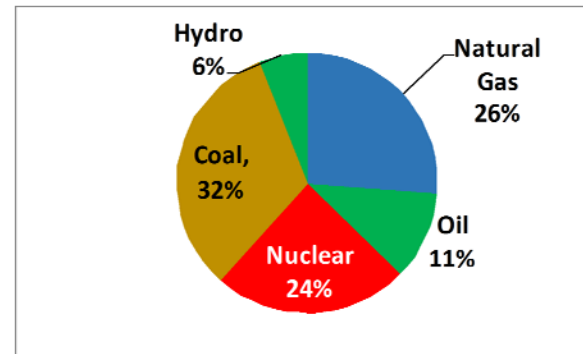
NEW YORK



NEW JERSEY



PENNSYLVANIA



Sources:
 ISO New England, 2015 sources of total electric energy production;
 NY ISO, 2016 "Power Trends";
 PJM, "2015 Regional Transmission Expansion Plan, State Reports," released 2016.

ENERGY CONSUMPTION BY MAJOR SOURCE

The Northeast states consume less energy per capita than the U.S. on average. Source: U.S. Energy Information Administration, "State Energy Data Report 2014," released 2016. Sum of fuel totals is not equal to total consumption due to other energy components not shown. Rank signifies level of state consumption compared to 50 U.S. states and District of Columbia. Electricity is that sold to end users. The data for fuels in TBtu is EIA's estimates for the year 2014.

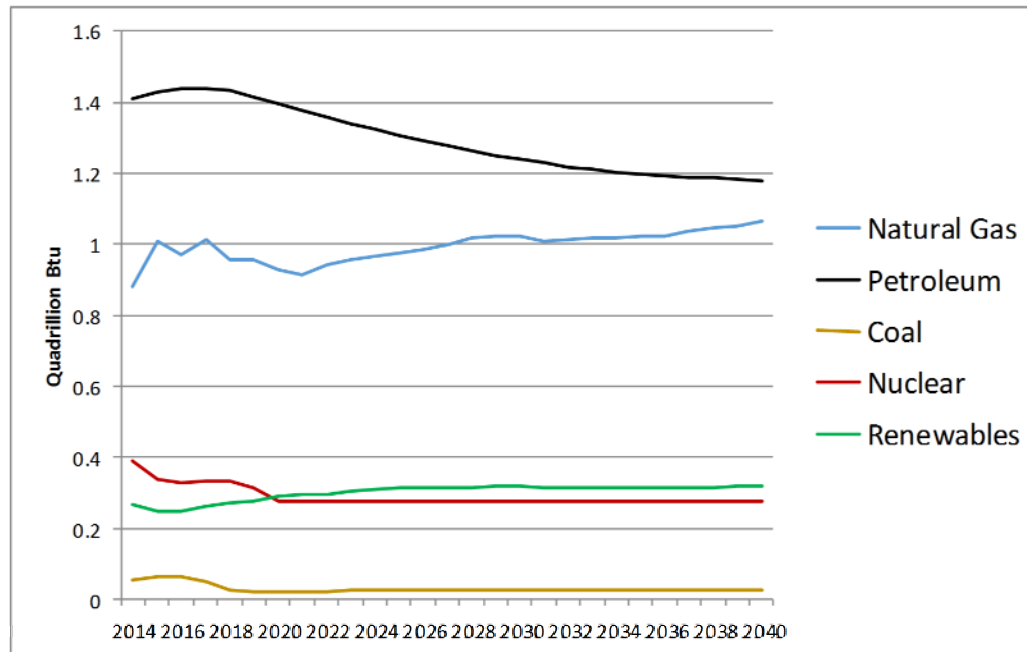
	Per Capita, 2014, Consumption		Natural Gas		Petroleum		Coal		Electricity	
	MMBtu	Rank	TBtu	Rank	TBtu	Rank	TBtu	Rank	TBtu	Rank
CT	208.6	46	240.6	34	322.2	33	9.1	46	102.2	37
ME	308.6	27	62.4	47	194.4	41	2.1	48	41.0	45
MA	212.8	44	433.2	17	571.2	20	29.9	41	185.8	26
NH	233.5	41	58.8	48	157.7	46	14.9	44	37.3	47
NJ	261.8	37	798.6	10	1,005.6	9	30.7	40	252.0	21
NY	189.5	51	1,386.6	4	1,342.0	5	64.7	36	502.8	5
PA	305.0	28	1,257.1	4	1,230.1	6	1,039.2	4	500.5	6
RI	193.8	50	91.7	44	90.7	49	-	50	26.1	49
VT	223.2	43	10.8	50	82.0	50	-	51	19.0	51
<i>Northeast</i>			4,339.8		4,995.9		1,190.6		1,666.7	
<i>U.S.</i>	308.5		27,513.2		36,110.3		17,996.6		12,845.2	

PROJECTED ENERGY CONSUMPTION GROWTH, NEW ENGLAND

U.S. EIA projects natural gas to grow at an annual rate of 0.2% in New England through 2040.

EIA projects growth trends for other leading energy sources as follows:

Renewables, 1.0%
 Coal, -3.7%
 Nuclear, -0.8%
 Oil, -0.8%.



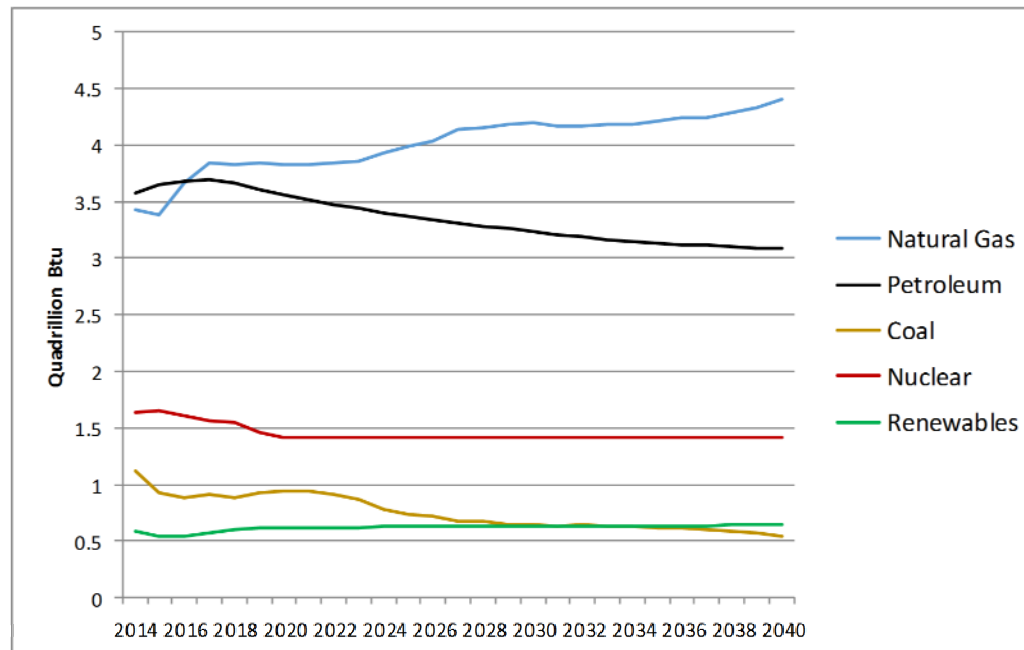
Source: U.S. Energy Information Administration, "2016 Annual Energy Outlook"

PROJECTED ENERGY CONSUMPTION GROWTH, MID-ATLANTIC

U.S. EIA projects natural gas to grow at an annual rate of 0.7% in the Mid-Atlantic region through 2040.

EIA projects growth trends for other leading energy sources as follows:

Renewables, 0.7%
Coal, -2.1%
Nuclear, -0.6%
Oil, -0.7%.



Source: U.S. Energy Information Administration, "2016 Annual Energy Outlook"

III.

SUPPLIES & INFRASTRUCTURE

This section provides an introduction to the natural gas delivery network in the Northeast.

Among the areas addressed are:

- *Description of pipeline systems*
- *Liquefied natural gas (LNG)*
- *Sources of regional gas supply*
- *Proposed infrastructure enhancements.*

Description of Pipelines/LNG Import Facilities Serving the Northeast Market

Algonquin Gas Transmission Company is a business unit of Spectra Energy. Its system incorporates approximately 1,129 miles of pipe. Its system commences in NJ, connecting with Texas Eastern, and extends through NY, CT, northern RI, and eastern and southeastern MA. Its capacity is 2.74 Bcf/d.

Columbia Gas Transmission, Inc. is a subsidiary of TransCanada and is headquartered in Richmond, VA. The company serves customers along its nearly 12,000-mile pipeline system in 10 Northeastern, Midwestern, and Mid-Atlantic states. It transports an average of 3 Bcf/day. It enters New York State through Pennsylvania and runs along the southern counties of New York bordering Pennsylvania; it also serves New Jersey. It has storage of 664 Bcf.

Con Ed Transmission (CET) invests in electric and gas transmission projects. The company was established in January 2016 after parent company Consolidated Edison, Inc. identified electric and gas transmission as two key areas of expertise and focus for the business. The company anticipates growth in the need for electric and gas transmission projects to meet the nation's changing energy priorities. CET falls under the oversight of the Federal Energy Regulatory Commission. CET operates Con Edison Gas Midstream, LLC, which invests in gas pipeline and storage businesses. CET is purchasing a 50-percent stake in a gas pipeline and storage business in Pennsylvania and New York, worth \$2 billion. CET is forming the joint venture with Crestwood Equity Partners. Known as Stagecoach Gas Services, the project provides a critical link between natural gas fields and the high demand for gas in the Northeast. CET purchased 50-percent equity interest in the Pennsylvania-Southern New York gas pipeline and storage business for about \$975 million, with an implied market value of almost \$2 billion.

Distrigas of Massachusetts Corporation (DOMAC), a subsidiary of ENGIE, owns and operates an LNG import terminal in Everett, Massachusetts. It interconnects with both the Tennessee and Algonquin systems. It began operation in 1971. Its vaporization sendout is approx. 715 MMcf/d, with another 100 MMcf/d by truck. Its storage is 3.4 Bcf. The facility has received over 1,100 cargoes, and served more than 350,000 truck loads.

Dominion Transmission, Inc., headquartered in Richmond, VA, is the interstate gas transmission subsidiary of Dominion Resources. Primarily a provider of gas transportation and storage services, Dominion Transmission, Inc. operates the world's largest underground natural gas storage system. Dominion Transmission, Inc. maintains 7,800 miles of pipeline in six states—Ohio, West Virginia, Pennsylvania, New York, Maryland and Virginia. The system enters New York State through Pennsylvania, and continues to points in western, central, and eastern New York, extending to the Albany area.

Granite State Gas Transmission, Inc. is a unit of Unitil. Granite State operates 86-miles of underground interstate pipeline extending from the MA-NH border through the New Hampshire coastal area to Portland, Maine, transporting gas from other pipeline companies. The NH portion began operation in 1956; in 1966 the line was extended to Maine.

Iroquois Gas Transmission System is a 416-mile interstate pipeline owned by a partnership of 4 U.S. and Canadian energy companies. It began operation in 1991. It transports natural gas from TransCanada PipeLine at the Ontario/NY border as well as Marcellus receipts, and travels through NY and CT to Long Island and into the New York City area. It has a physical receipt capability of 1.6 Bcf/d. It interconnects with TransCanada, Dominion, Tennessee and Algonquin.

Maritimes & Northeast Pipeline (M&NE) is a partnership of Spectra Energy, Emera and ExxonMobil. It transports gas from the Maritimes to markets in Atlantic Canada and New England. The total pipeline is 684 miles. U.S. capacity is 833 MMcf/d; its capacity in Canada is 555 MMcf/d.

Millennium Pipeline traverses New York's lower Hudson Valley and Southern Tier. It is comprised of 220 miles of 30 inch diameter steel pipeline and is capable of transporting up to 850,000 dekatherms per day of natural gas. It is owned by subsidiaries of TransCanada/ Columbia Pipeline Group, National Grid and DTE Energy. It began commercial operations in December 2008.

National Fuel Gas Supply Corporation provides interstate natural gas transmission and storage for affiliated and nonaffiliated companies through an integrated gas pipeline system of 2,300 miles that extends from southwestern Pennsylvania to the New York-Canadian border at the Niagara River. It also owns and operates 31 underground natural gas storage areas.

North Country Pipeline is an intrastate pipeline of approximately 22 miles that runs from the Canadian border in northeastern New York near Champlain to the Plattsburgh area, with natural gas imported from the TransCanada system. It has a capacity of about 100 DTH/day.

Portland Natural Gas Transmission (PNGTS) is sponsored by an international consortium of energy companies - TransCanada PipeLines and Gaz Métro. It transports western Canadian gas to New England from an interconnection with TransCanada PipeLines (through the TQM extension). On the U.S. side, it involves approximately 300 miles of pipeline including 50 miles of variously sized laterals, extending through northern NH to southern Maine and interconnecting with Maritimes & Northeast through the Joint Facilities. Its current capacity is 210 Dth/d. It interconnects with the Maritimes & Northeast Pipeline at Westbrook, Maine; from there, the Joint Facilities line extends to Dracut, MA.

Repsol operates the Canaport LNG facility located in Saint John, New Brunswick, Canada; its project partner is Irving Oil. The facility received its first shipment in June 2009. The physical infrastructure consists of three storage tanks with total capacity of 9.9 Bcf. The terminal has a maximum sendout capacity of 1.2 Bcf/day. Regasified LNG from the terminal

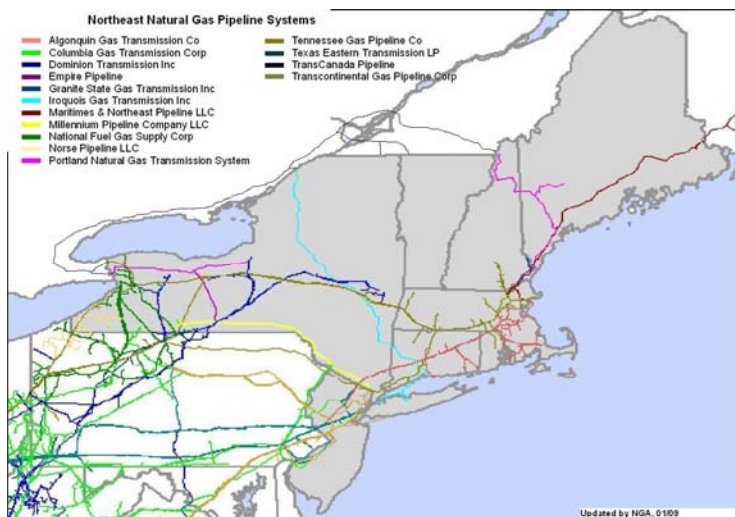
flows through the Brunswick Pipeline, a 90 mile pipeline connecting the terminal to the Maritimes & Northeast Pipeline at the Maine border. Since its start-up, it has delivered about 350 Bcf to the market.

Tennessee Gas Pipeline Company is a business unit of Kinder Morgan. The Tennessee Gas Pipeline has 11,800 miles of pipeline. Tennessee’s system enters New England at two points: western Mass. near West Pittsfield and southern Connecticut near Greenwich. It enters New York at several points – from southwestern Pennsylvania, central Pennsylvania, an interconnect at Niagara, and through New Jersey into the New York City area and on to Connecticut. It has 92 Bcf of storage, and a capacity of ~9 Bcf/d.

Texas Eastern Transmission Company is a business unit of Spectra Energy. Its system incorporates approximately 9,096 miles of pipe, from the U.S. Gulf Coast to New Jersey. Its peak capacity is 10.46 Bcf/d, with storage of 74 Bcf.

TransCanada PipeLine has a network of approximately 56,000 miles of pipeline which tap into virtually all major gas supply basins in North America. It interconnects with several systems serving the Northeast. It has more than 664 Bcf of working gas storage capacity. It acquired the Columbia Pipeline Group in the U.S. in 2016.

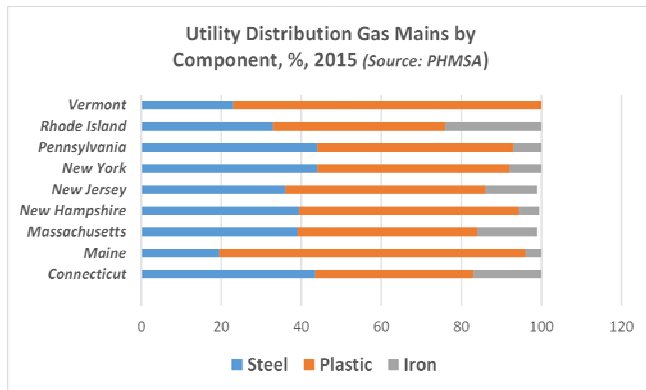
Transcontinental (Transco) is a subsidiary of Williams Company. The Transco pipeline comprises a 10,200-mile pipeline system, extending from South Texas to New York City. The peak system design capacity is 10.9 billion cubic feet per day. In the Northeast, it provides gas service to New York City, New Jersey and the Mid-Atlantic region. It has 197 Bcf of seasonal storage.



UTILITY MILES OF PIPELINE AND MAIN, NORTHEAST

The miles of pipeline and distribution mains form a basic indicator of access to the gas market. The Northeast has continued to increase both its transmission and distribution systems; planned infrastructure enhancements and LDC system growth will produce increases to these numbers in coming years.

The chart below shows percentage of pipeline mains by material by state as of 2015. Plastic pipe is in the 40-50 percentile range for most states in the region, but is the dominant method for new distribution pipe, and now represents 55% of all U.S. miles of main.



STATE / U.S.	DISTRIBUTION MAIN MILES	TRANSMISSION MILES
<i>Connecticut</i>	7,984	591
<i>Maine</i>	1,171	510
<i>Massachusetts</i>	21,576	1,131
<i>New Hampshire</i>	1,920	251
<i>New Jersey</i>	34,792	1,570
<i>New York</i>	48,684	4,560
<i>Pennsylvania</i>	47,954	9,957
<i>Rhode Island</i>	3,210	96
<i>Vermont</i>	789	74
U.S. total	1,276,913	301,203

Source: PHMSA, U.S. Department of Transportation, 2015 data

NORTHEAST PIPELINE PROJECTS IN PROCESS

2016 saw limited infrastructure projects placed in service in the region, with several projects delayed due to regulatory review issues at the state level. Several other projects are in the regulatory and development process for the period 2017-2019 and are summarized below. This list changes with market conditions—please visit NGA’s web site during the year for updated listings.

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
New Market Project	Dominion Pipeline	Planned for customers in upstate NY (National Grid). Will include the addition of 2 new compressor stations along DTI’s existing transmission pipeline; and increased compression at an existing station. Capacity of 84 MMcf/d.	2017	Filed with FERC, June 2014. FERC issued environmental assessment, October 2015. Approved by FERC, 4-16. Awaiting NY state permit.
Garden State Expansion Project	Williams/Transco	The project has been designed to provide up to 180,000 dekatherms per day of natural gas service in two phases to a new delivery point with New Jersey Natural Gas in Burlington County, N.J. The project will include the installation of a new compressor station, meter and regulating station on land located in Burlington County, N.J. It will also require modifications and the addition of compression at an existing compressor station. No expansion of the pipeline is required.	2017 (2 phases)	Filed with FERC, Feb. 2015. Approved by FERC, 4-16.
Northern Access	National Fuel Gas Supply & Empire Pipeline	Capacity of 350,000 Dth/day on Empire, 497,000 on NFGSC. Deliveries to Chippawa, with new interconnect at TGP 200 Line. 99 miles of 24” pipeline and 2 compressor stations.	2017	FERC issues environmental assessment, 7-16.

This table is based on publicly-available information as of Nov. 2016; project details may change.

NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
Connecticut Expansion	Tennessee Gas Pipeline / Kinder Morgan	Capacity of 72,100 Dth/d. Pipeline looping on TGP 200 and 300 lines. Market is CT natural gas utilities.	2017	Open Season held July 2013. Filed with FERC, 7-14. FERC issued environmental assessment, 10-15. Approved by FERC, 3-16. Working to secure final state permits.
Susquehanna West	Tennessee Gas Pipeline/ Kinder Morgan	Incremental supply to existing interconnect with National Fuel. Capacity of 145,000 Dth/d. 8.2 miles of 36" pipeline loop.	Nov. 2017	Received environmental assessment from FERC, 3-16. Approved by FERC, 9-16.
Atlantic Bridge	Spectra Energy	Incremental expansion on Algonquin and Maritimes & Northeast, to serve New England and Canadian Maritimes. Proposed capacity of ~133,000 Dth/d.	2017	Announced, Feb. 2014. Open season held, Feb.- March, 2014. In pre-filing with FERC, Feb. 2015. Filed with FERC, Oct. 2015. Received environmental assessment from FERC, 5-16.
Valley Lateral Project	Millennium Pipeline	The Valley Lateral Project will connect Millennium's gas mainline to CPV's energy center in Wawayanda, NY, and provide access to natural gas for its new 650 MW combined-cycle electric power generating facility. Capacity of 130,000 Dth/d.	2017	Filed with FERC, Nov. 2015. Received environmental assessment from FERC, 5-16. Approved by FERC, 11-16.
Continent to Coast (C2C) Expansion	PNGTS	C2C will access natural gas supplies from key North American natural gas basins via Trans-Canada Pipeline. Atlantic Canada markets can then transport on PNGTS to an interconnect with Maritimes and Northeast Pipeline at Westbrook, ME. Shippers interested in moving natural gas further south into New England can transport on PNGTS to interconnects with other pipelines.	Nov. 2017	Open season, April 1 to June 28, 2013. Open season re-convened, Dec. 2013 – Jan. 2014. Relaunch of open season, Jan. – Feb. 2015. Project is confirmed to proceed.

This table is based on publicly-available information as of Nov. 2016; project details may change.

NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
New York Bay Expansion	Transco / Williams	The New York Bay Expansion Project would provide National Grid with an additional 115,000 dekatherms of natural gas per day in time for the 2017/2018 winter heating season. The project will include the installation of additional horsepower at three existing Transco compressor facilities, in addition to upgrading Transco's existing Lower New York Bay lateral and replacing 0.2 miles of 42-inch pipe in Middlesex County, N.J. The project will also include modifications to existing Transco meter & regulator stations in Middlesex County, N.J., and Richmond County, N.Y.	2017	Filed with FERC, July 2015. Approved by FERC, 7-16.
South-to-North ("SoNo") Project	Iroquois Gas Transmission	Reverse flow on Iroquois offering physical transport to U.S./Canada border. The SoNo project would transport up to 650,000 Dth/day from Iroquois' existing interconnects with Dominion Transmission in Canajoharie, NY and Algonquin Gas Transmission in Brookfield, CT, as well as the proposed Constitution Pipeline in Wright, NY.	2018	Open season held, Dec. 2013 – Jan. 2014. Relaunch of open season, Jan. – Feb. 2015.
PennEast Project	AGL Resources, NJR Pipeline Company, South Jersey Industries, UGI Energy Services, Spectra Energy and PSE&G Power LLC	100-mile pipeline intended to bring lower cost natural gas produced in the Marcellus Shale region to homes and businesses in Pennsylvania and New Jersey. Designed to provide natural gas service to the equivalent of 4.7 million homes, up to 1 Bcf per day. PennEast is investing nearly \$1 billion to build the pipeline with the costs split among the four entities. Construction of the pipeline could begin in 2017 pending regulatory approvals.	2018	Announced Aug. 2014. Open season held August 2014. In FERC pre-filing process, Oct. 2014. Filed with FERC, Sept. 2015. FERC issued draft EIS, 7-16.

This table is based on publicly-available information as of Nov. 2016; project details may change.

NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
Eastern System Upgrade	Millennium Pipeline	Proposal to upgrade and expand the eastern end of the system. It includes an estimated 7.8 miles of mostly 30" looped pipeline, upgrades to existing Hancock compressor station, new compression capabilities at a facility in Sullivan County, and upgrades to existing Ramapo meter and regulator station in Rockland Co.	Fall 2018	Entered pre-filing process with FERC, 2-16. Filed with FERC, 7-16.
Constitution Pipeline	Cabot/Williams	Approx. 124-mile Constitution Pipeline is designed to extend from Susquehanna County, PA, to the Iroquois Gas Transmission and Tennessee Gas Pipeline systems in Schoharie County, N.Y. Proposed capacity of 650 MMcf/d. Cabot and Southwestern are shippers.	2018	Announced spring 2012. Filed with FERC, 6-13. FERC issued final EIS, 10-14. Authorized by FERC, 12-2-14. NY DEC denies water quality permit, 4-22-16; company affirms plans to continue with project, 4-25-16. FERC grants 2-year extension, 7-16.
Wright Interconnect Project (WIP)	Iroquois Gas Transmission	WIP will enable delivery of up to 650,000 Dth/d of natural gas from the terminus of the proposed Constitution Pipeline in Schoharie County, NY into both Iroquois and the Tennessee Gas Pipeline under a 15 year capacity lease agreement with Constitution.	2018	Announced 1-13. Filed with FERC, 6-13. FERC issued final EIS, 10-14. Authorized by FERC, 12-2-14. FERC grants 2-year extension, 8-16.
Empire North Expansion	Empire Pipeline	The proposed project size is 300,000-338,000 Dth/d. Transportation paths: Jackson/Corning to Chippawa/Hopewell. Open Season concluded Nov. 2015. 3 new compressor stations.	2018 or later	Open season concluded, Nov. 2015.

This table is based on publicly-available information as of Nov. 2016; project details may change.

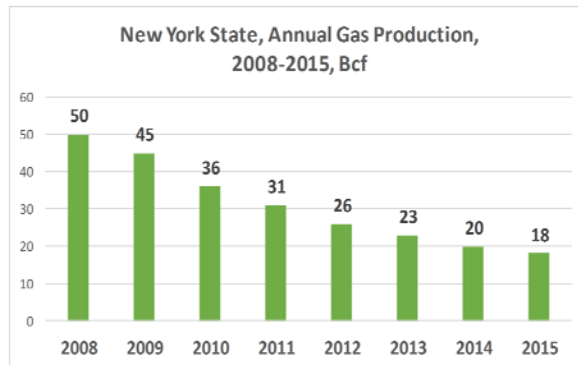
NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
Northeast Supply Enhancement	Williams / Transco	The project would add natural gas pipeline infrastructure in PA, NJ and NY. It is designed to provide customers access to an additional 400 million cubic feet of natural gas per day (enough natural gas to serve the daily needs of about 2.3 million homes). The Northeast Supply Enhancement project will provide service to National Grid.	2019	In FERC pre-filing, May 2016.
Access Northeast	Spectra Energy, Ever-source Energy, National Grid	The gas pipeline expansion project will enhance the Algonquin and Maritimes pipeline systems and market area storage assets in New England to deliver up to one billion cubic feet of natural gas per day for electric generation markets. Alliance with Iroquois Gas Transmission announced, 12-14. Can provide as much as 0.9 Bcf/d to power plants.	2019	Announced 9-14. Solicitation of interest held, fall 2014. Open season held first half of 2015. In FERC pre-filing. MA Supreme Court ruled in Aug. 2016 that electric utilities could not invest in pipeline capacity. Project developers reaffirmed commitment to project, 8-16.



This table is based on publicly-available information as of Nov. 2016; project details may change.

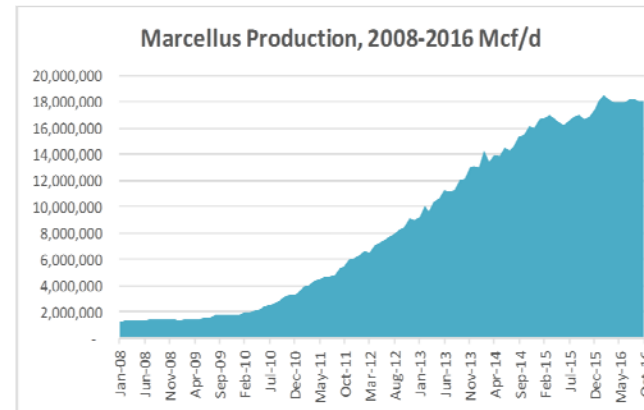
NATURAL GAS PRODUCTION IN NORTHEAST U.S.



Source: NY State Dept. of Environmental Conservation/ Office of Oil & Gas

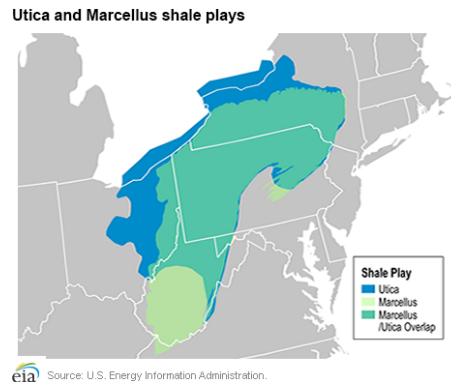
The New York State Department of Environmental Conservation / Division of Mineral Resources reports that gas production in the state in 2015 was 17.8 billion cubic feet (Bcf), down from 20.5 Bcf in 2014. Annual production is less than half what it was in 2008. The 2015 production was driven by wells in the Trenton-Black River formation in the Finger Lakes region, as well as in the Medina formation. The production is from conventional gas wells; the hydraulic fracturing drilling process is not permitted in the state.

Natural gas production in the Northeast continues steady and rapid growth, as illustrated in the chart below with data from the U.S. Energy Information Administration (EIA). Marcellus production as of fall 2016 is about 18 Bcf per day. U.S. EIA observed in November 2013: “This [production] trend has reduced the cost and increased the supply of natural gas in the Northeast. This additional supply has encouraged greater use of natural gas in the Northeast...and has also reduced net inflows of natural gas into the region from other regions such as the Gulf of Mexico, the Midwest and Eastern Canada.” Pennsylvania’s annual natural gas production has grown from 0.3 Tcf in 2010 to 4.6 Tcf in 2015.



Source: U.S. Energy Information Administration

SHALE GAS DEVELOPMENT IN THE NORTHEAST / MIDWEST



Map: U.S. EIA

Significant shale gas basins have emerged in the Northeast region in recent years: the Marcellus Shale and Utica Shale in the Appalachian basin. The Marcellus Shale runs through several mid-Atlantic states, including West Virginia, Pennsylvania and New York. Shale gas now represents over 50% of U.S. dry natural gas production—up from 5% in 2007.

Estimates are that the Marcellus basin alone may hold as much as 500 trillion cubic feet (Tcf) of natural gas.

Current Marcellus production is centered in Pennsylvania and West Virginia. Production there has reached 18 billion cubic feet per day, and is expected to grow further in coming years. In its 2013 assessment of U.S. proved natural gas reserves, EIA reported that “Pennsylvania and West Virginia account for 70% of the increase in natural gas proved reserves.” Pennsylvania is now the 2nd largest producing state of natural gas, behind only Texas.

The Utica Shale, centered principally in Ohio, is both an oil and natural gas play. Natural gas production has grown from 0.1 Bcf/d in December 2012 to over 3.5 Bcf/d in June 2016, according to U.S. EIA.

New technology in the form of horizontal drilling has enabled producers in recent years to access the shale gas in a technically and economically feasible manner.

Already, as outlined in preceding pages, the interstate pipelines in the Northeast are working to increase their interconnections to bring these new supplies to market.

Shale gas production is not permitted in New York State.

INCREASING GAS POTENTIAL IN THE U.S.

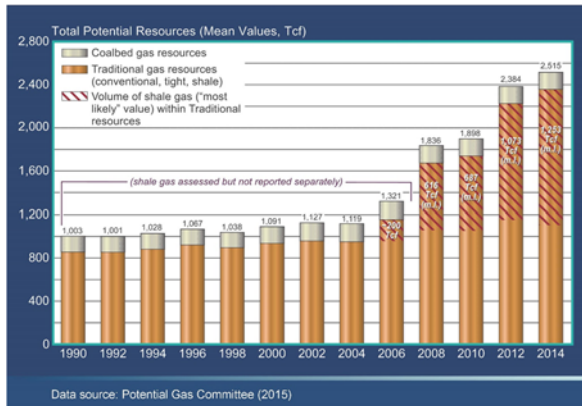
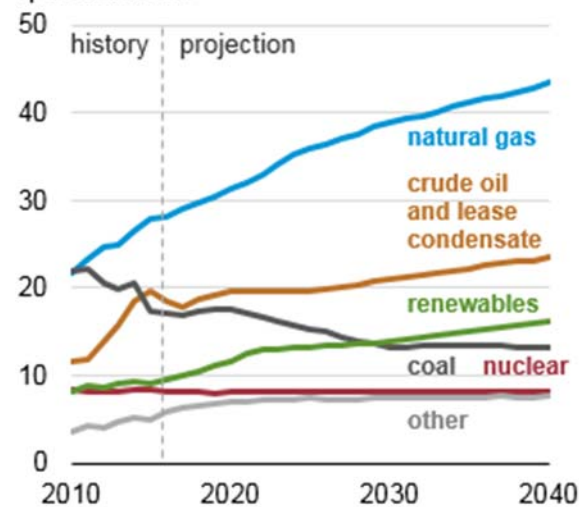


Chart: Potential Gas Committee, 4-15

Every 2 years, the Potential Gas Committee (PGC) of the Colorado School of Mines releases a long-term assessment of U.S. potential natural gas supply. Its 2014 assessment, released in April 2015, and illustrated in the PGC chart above, shows an increase in total estimated potential supplies from the previous study, due in large part to shale (shown in the red stripe). According to this latest assessment, the U.S. possesses a total technically recoverable resource base of 2,515 trillion cubic feet (Tcf). The 2014 assessment is “the highest resource evaluation in the Committee’s 50-year history.”

U.S. NATURAL GAS PRODUCTION PROJECTIONS

U.S. energy production (2010-40)
quadrillion Btu



This chart from U.S. EIA previews projected production outlook for U.S. energy sources through 2040. Natural gas is projected to be the leading fuel for domestic energy production. Chart: U.S. EIA, 5-16

LNG SERVING NEW ENGLAND MARKET

Import facilities:

Distrigas terminal, Everett, MA (part of ENGIE). Began operation in 1971.

- Storage of 3.4 billion cubic feet.
- On a sustainable basis, the vaporization capacity is approximately 715 million cubic feet per day.
 - Additional sendout capability of 100 MMBtu/d in liquid via truck.

Canaport facility, Saint John, NB, Canada. Began operation in 2009.

- Operated by Repsol in partnership with Irving Oil.
- Sendout capability of 1 Bcf/d in vapor via Brunswick Pipeline into Maritimes & Northeast.
 - Three storage tanks of 3.3 Bcf each, or ~10 Bcf total.

Northeast Gateway facility, offshore Cape Ann, MA. Began operation in 2008.

- Operated by Excelerate Energy.
- Sendout capability of 0.4 to 0.8 Bcf/d in vapor via underwater HubLine.

Neptune facility, offshore Gloucester, MA (part of ENGIE). Completed in 2010.

- Connects to underwater pipeline, HubLine, via 13.4 miles of offshore pipe. Not currently operating.

LDC satellite tanks/peak-shaving units:

- 43 tanks in 28 communities in 5 states (CT, ME, MA, NH, RI).
 - LDCs' total LNG storage capacity is 16 Bcf.
 - LDCs' vaporization capacity is 1.4 Bcf/day.
- Liquefaction is available at 5 LDC-owned facilities - total liquefaction capability is 43,500 MMBtu/day.

LNG IN NEW JERSEY

- Storage capacity of approximately 3.7 Bcf.
- LDC tanks in 6 communities, owned by 4 LDCs, as well as one pipeline-owned facility.

LNG IN NEW YORK

LDC-owned peak-shaving plants:

- New York City area and Long Island, on Con Edison and National Grid systems.
 - Storage capacity of approximately 3.2 Bcf.
 - LNG obtained via liquefaction of pipeline gas.
- Vaporization capacity is approximately 0.56 Bcf/day.
 - Liquefaction capacity is 19,850 MMBtu/day.

LNG IN PENNSYLVANIA

- Two utilities, PECO Energy and PGW, utilize LNG peakshaving with storage capacity of approximately 5.45 Bcf.
 - UGI LNG has storage capacity of 1.25 Bcf, for sale into Mid-Atlantic market.

NORTHEAST NATURAL GAS STORAGE

Storage is essential to the natural gas supply and delivery system. The principal storage system in the U.S. is underground storage, in salt caverns, aquifers, and depleted oil and gas fields. There are 415 such facilities in the U.S., with demonstrated peak working gas capacity of about 4.8 Tcf.

For the Northeast, there are two main types of storage: underground, and liquefied natural gas (LNG).

Pennsylvania has considerable underground gas storage, 49 facilities totaling 771 Bcf, which represents 8.4% of total U.S. capacity.

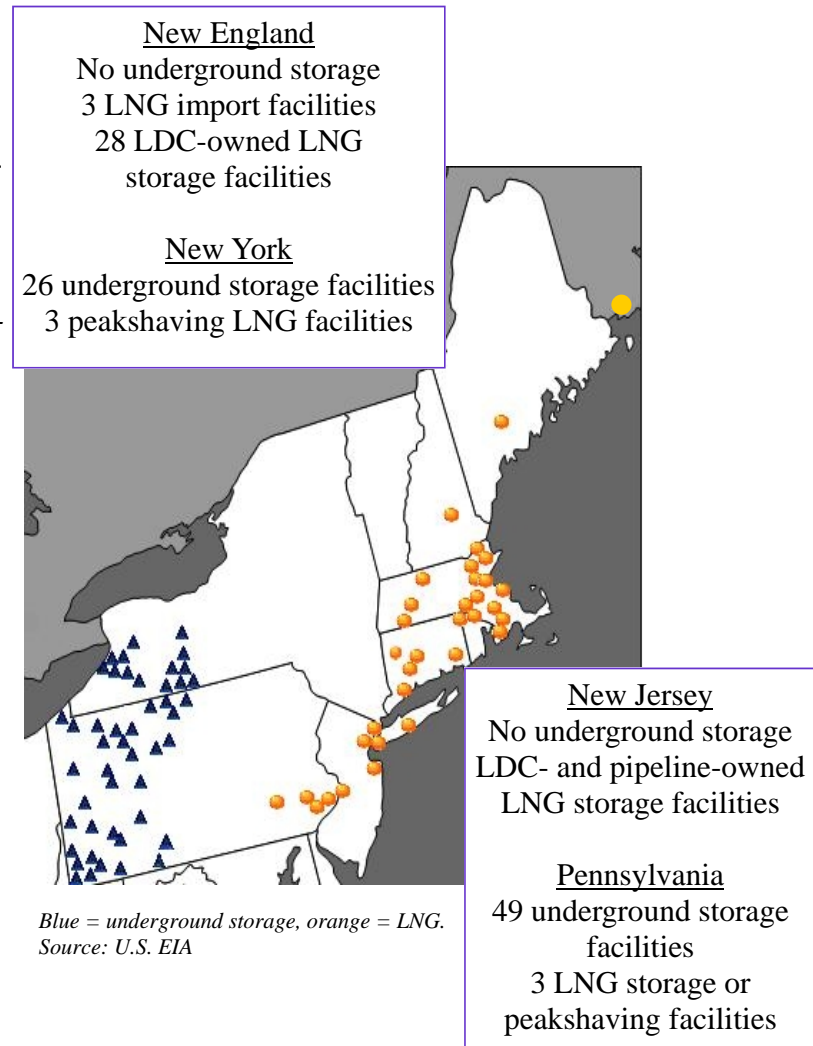
New York has 26 underground storage facilities with 246 Bcf of working gas capacity. New York's underground storage represents 2.7% of the U.S. total.

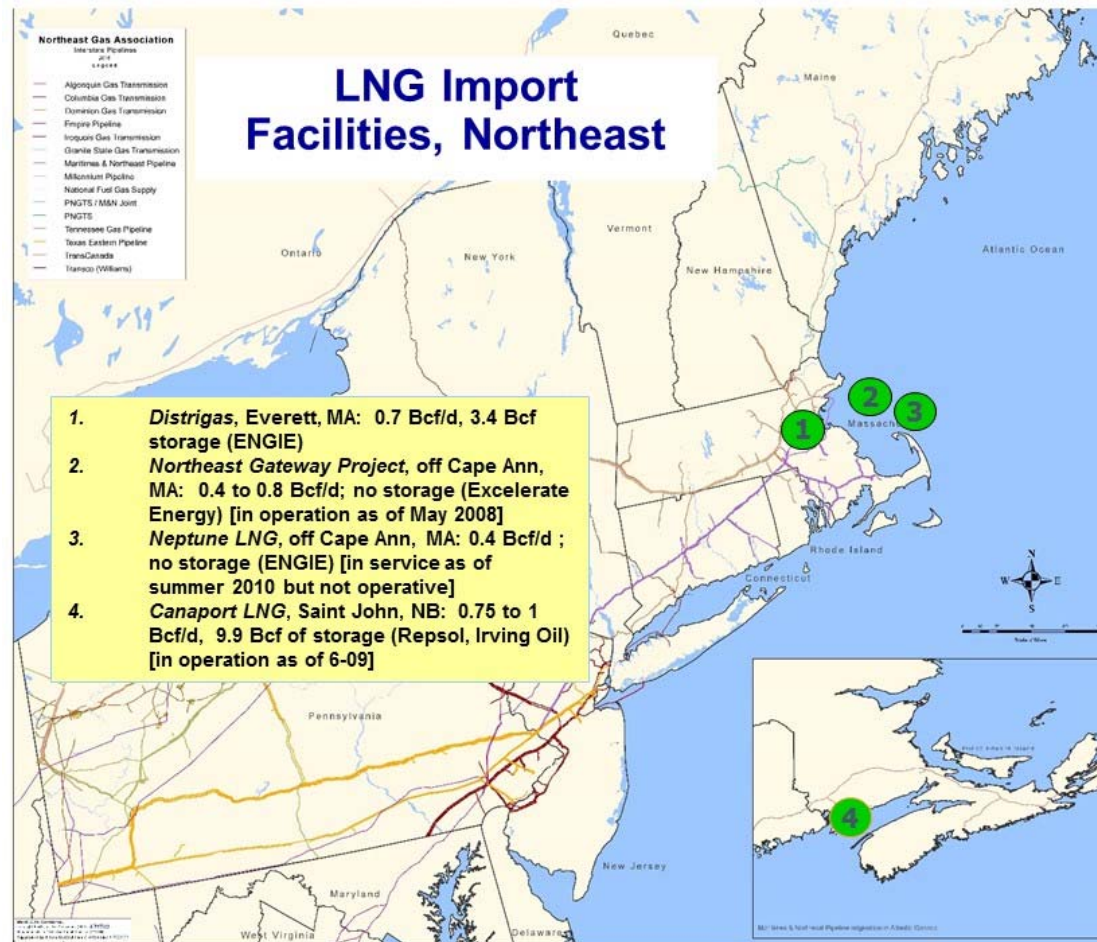
There is no underground storage in New England or New Jersey, as the map indicates, because of the unsuitability of the region's geology.

New England and New Jersey do utilize LNG. There are two LNG import facilities currently operating in the greater Boston area. There is also a facility in New Brunswick, Canada, close to the U.S. border in Maine.

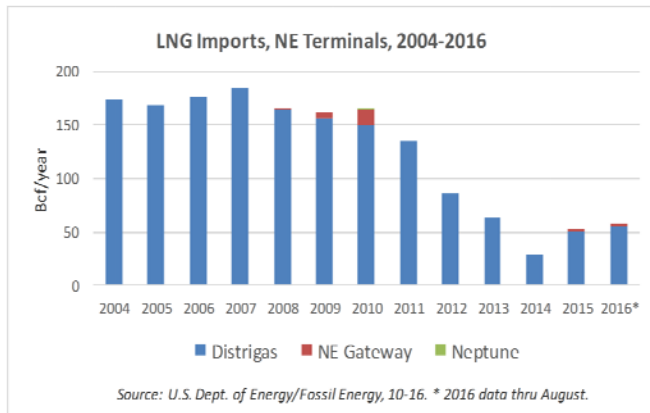
In addition, the LDCs operate above-ground LNG storage tanks for peak-shaving.

As noted in previous pages, gas utilities in several Northeastern states (CT, ME, MA, NH, NJ, NY, PA, RI) utilize LNG for peakshaving and system support.





LNG ANNUAL VOLUMES IMPORTED INTO NEW ENGLAND TERMINALS



LNG imports into New England facilities were 52 Bcf in 2015, compared to 29 in 2014. Distrigas of MA imported 49.7 Bcf in 2015, or 55% of all U.S. ship imports in 2015. An offshore LNG facility - Northeast Gateway - had its first cargoes in several years in early 2015 and 2016, helping to meet winter demand by providing another roughly 2.5 Bcf to the market in both 2015 and 2016.

Source: U.S. Department of Energy, Office of Fossil Energy, Office of Natural Gas & Petroleum Import Activities.

Liquefied natural gas (LNG) is an important component of the region’s gas supply, especially for peak winter needs. Distrigas of Massachusetts Corp. (DOMAC), a subsidiary of ENGIE, owns and operates a land-based facility at Everett, MA. There is also one operating facility located offshore near Gloucester, MA owned by Exceleerate Energy.

Repsol’s Canaport LNG facility in nearby Brunswick, Canada has supplied over 400 Bcf to the market since it began operation in mid-2009. It provided about 23 Bcf to the regional market in 2015.

The chart below from Repsol shows the changing levels of various supply inputs from/into the Maritimes Canada for the period of Nov. 2010 through February 2016. Canaport is shown in red.

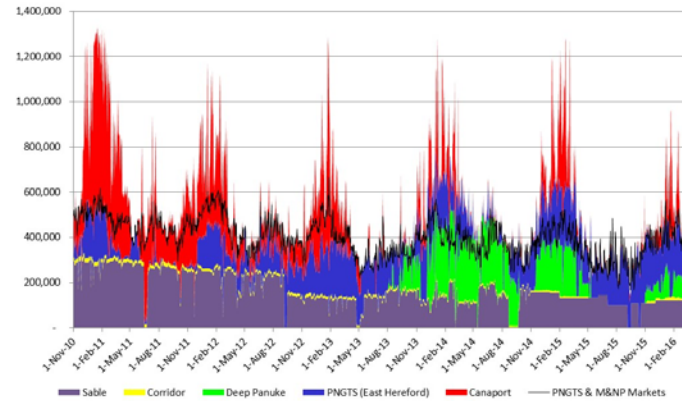
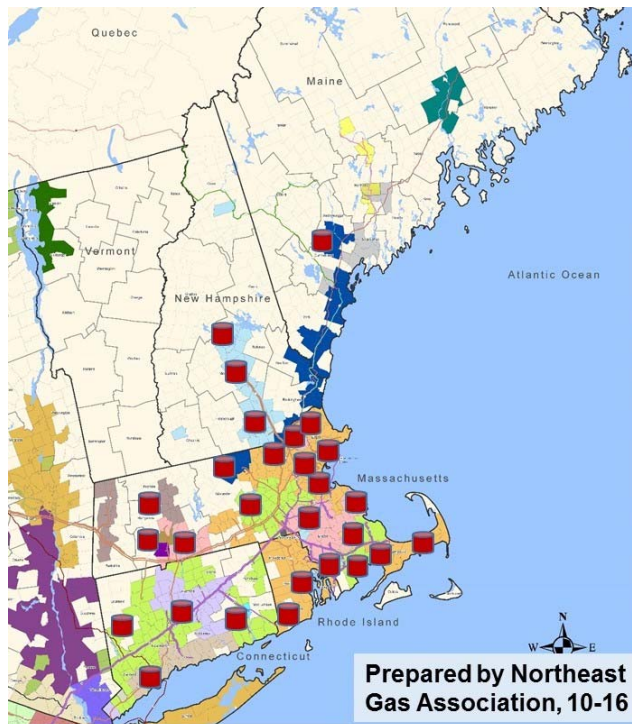


Chart: Repsol, based on Repsol and Ventyx. Gas volumes in Dth.

LNG STORAGE HELD BY NEW ENGLAND GAS UTILITIES



Map prepared by NGA. Red tanks indicate LNG satellite tanks owned and operated by gas LDCs. Locations approximate.

Liquefied natural gas (LNG) is a key form of in-region storage for natural gas utilities in the Northeast—but particularly so in New England. For some of the larger utilities, LNG can represent 35 to 40% of peak day supply.

LNG on the gas utility system provides not only peak day supply but also pressure support at key points on the systems.

The map shows the location of LNG tanks in the New England region. LNG is stored by utilities in 28 communities in 5 New England states.

There are proposals in several New England utilities to either increase LNG storage capacity or to add liquefaction.

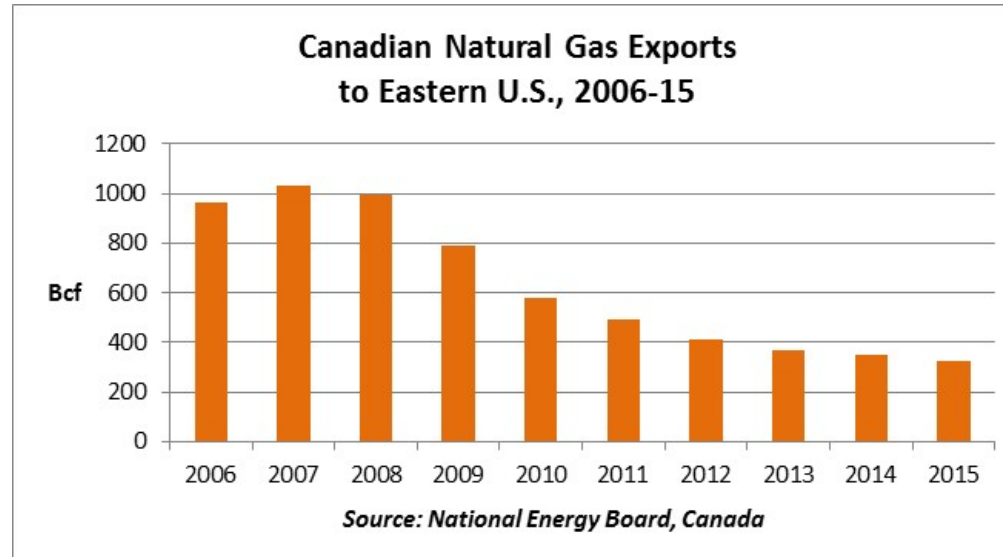
PROPANE / LP AIR: STORAGE CAPACITY AT NEW ENGLAND GAS LDCs

Year	Number of Communities with Facilities	Number of Tanks	Storage Capacity in Gallons
1998	46	346	16,053,819
2016	13	94	4,233,732

As natural gas pipeline capacity and LNG storage have increased in the region, propane storage at the natural gas utility level has declined. Propane/air was often used to supplement gas pipeline capacity for several utilities in the Northeast, particularly in New England.

The rise of natural gas production in the Appalachian region meanwhile is creating opportunities for considerable propane development in the region.

CANADIAN GAS EXPORTS TO THE NORTHEAST U.S.



Canadian imports have long been a major source of U.S. - and Northeast - natural gas supply. The Northeast has drawn supplies from Alberta, offshore Nova Scotia and New Brunswick. Increasingly however the supply dynamic is changing, as U.S. domestic production rises, reducing the need for imports. As indicated in the chart on the left, Eastern U.S. imports have declined considerably over the last few years. Canadian gas exports to the northeast U.S. are down by over 60% since 2007. (Overall, U.S. EIA reports that natural gas exports into the U.S. in 2015 reached their lowest level in thirty years .)

IV.

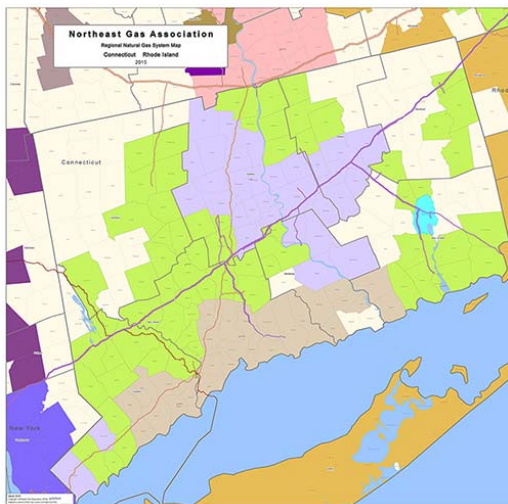
NATURAL GAS TRENDS IN THE NORTHEAST

This section provides an introduction to the natural gas industry in the Northeast.

Among the areas addressed are:

- *Gas consumption by sector*
- *Price trends*
- *Growth areas*
- *Gas & power generation.*

CONNECTICUT



Natural Gas Utilities in Connecticut

There are 4 natural gas utilities:

Connecticut Natural Gas

(purple area on map)

Eversource (Yankee Gas Services Co.)

(lime-green area on map)

Norwich Public Utilities

(aqua area on map)

The Southern Connecticut Gas Co.

(light brown area on map)

Natural Gas Utility Customers:

There are approximately 640,000 natural gas customers in the state.

Natural Gas Use in Connecticut

Primary energy: 32%

Electric generation capacity: 35%

% of households with gas as main heating fuel: 35%

Annual consumption: 248 billion cubic feet (Bcf) of natural gas.

Natural Gas Pipelines Serving Connecticut

- **Algonquin Gas Transmission**, a subsidiary of Spectra Energy.
- **Iroquois Gas Transmission.**
- **Tennessee Gas Pipeline Company**, a subsidiary of Kinder Morgan.

LNG Storage in Connecticut

There are utility liquefied natural gas (LNG) storage facilities in four communities.

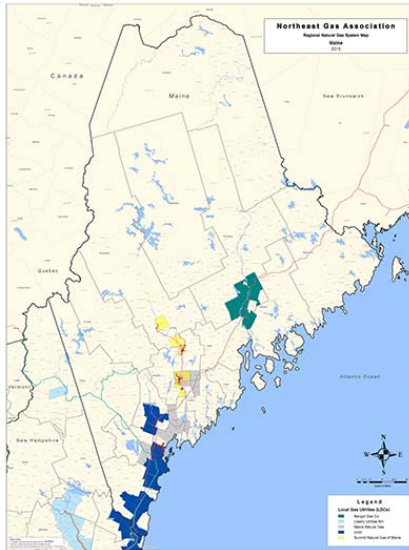
Underground Storage

None.

Natural Gas Production

None.

MAINE



Natural Gas Utilities in Maine

There are 4 natural gas utilities:

Bangor Gas

(green area on map)

Maine Natural Gas

(grey area on map)

Summit Natural Gas

(yellow area on map)

Unitil

(blue area on map)

Natural Gas Use in Maine

Primary energy: 15%

Electric generation capacity: 37%

% of households with gas as main heating fuel: 7%

Annual consumption: 51 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are approximately 43,000 natural gas customers in the state.

Natural Gas Pipelines Serving Maine

4 natural gas pipelines transport gas:

- ***Portland Natural Gas Transmission (PNGTS).*** It is owned by TransCanada PipeLines and Gaz Métro.
- ***Maritimes & Northeast Pipeline.*** It is owned by Emera, Spectra Energy and Exxon Mobil.
- ***Joint Facilities of PNGTS and Maritimes & Northeast Pipeline.***
- ***Granite State Gas Transmission.*** It is owned by Unitil.

LNG Storage in Maine

There is a utility liquefied natural gas (LNG) storage facility in 1 community.

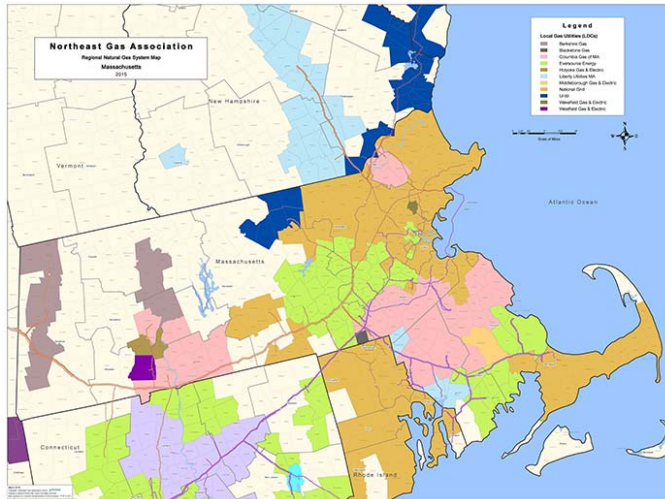
Underground Storage

None.

Natural Gas Production

None.

MASSACHUSETTS



Natural Gas Pipelines Serving Massachusetts

- **Algonquin Gas Transmission**, a subsidiary of Spectra Energy.
- **Tennessee Gas Pipeline Company**, a subsidiary of Kinder Morgan.
- **Joint Facilities of PNGTS and Maritimes & Northeast.**

LNG Import Facilities

There are two in operation —one onshore, one offshore.

- **Distrigas of Massachusetts**, a subsidiary of ENGIE
- **Northeast Gateway**, a subsidiary of Excelebrate Energy

LNG Storage in Massachusetts

There are utility liquefied natural gas (LNG) storage facilities in 18 communities.

Underground Storage

None.

Natural Gas Production

None.

Natural Gas Use in Massachusetts

Primary energy: 30%

Electric generation capacity: 47%

% of households with gas as main heating fuel: 51%

Annual consumption: 434 billion cubic feet (Bcf) of natural gas.

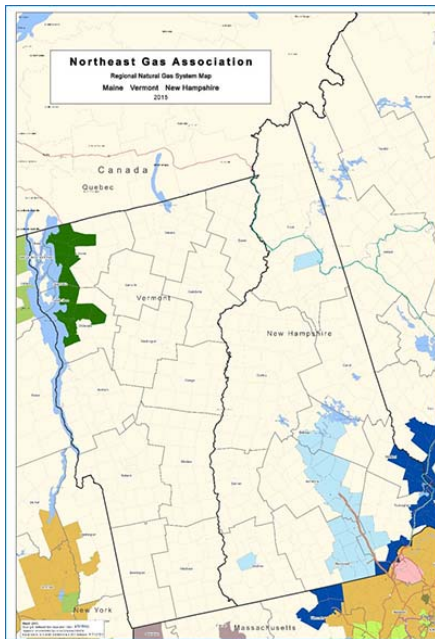
Local Gas Utilities:

There are eleven natural gas utilities in the state.

Natural Gas Utility Customers:

There are approximately 1.6 million natural gas customers in the state.

NEW HAMPSHIRE



Natural Gas Utilities in New Hampshire

There are 2 natural gas utilities:

Liberty Utilities

(light blue area on map)

Unitil Corp.

(dark blue area on map)

Natural Gas Use in New Hampshire

Primary energy: 19%

Electric generation capacity: 22%

% of households with gas as main heating fuel: 20%

Annual consumption: 69 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers :

There are approximately 121,000 natural gas customers in the state.

Natural Gas Pipelines Serving New Hampshire

4 natural gas pipelines transport gas:

- ***Portland Natural Gas Transmission (PNGTS).*** It is owned by TransCanada PipeLines and Gaz Métro.
- ***Tennessee Gas Pipeline Company,*** a subsidiary of Kinder Morgan.
- ***Joint Facilities of PNGTS and Maritimes & Northeast Pipeline.***
- ***Granite State Gas Transmission.*** It is owned by Unitil.

LNG Storage in New Hampshire

There are utility liquefied natural gas (LNG) storage facilities in 3 communities.

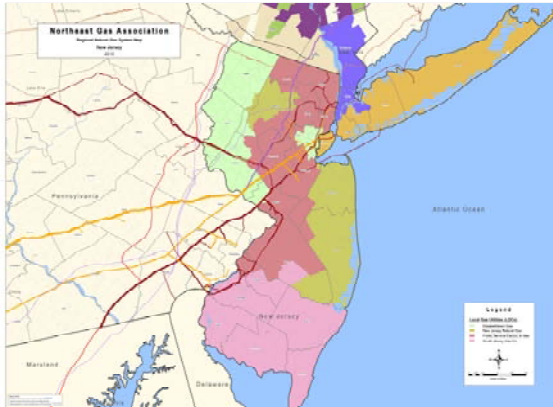
Underground Storage

None.

Natural Gas Production

None.

NEW JERSEY



Natural Gas Utilities in New Jersey

There are 4 natural gas utilities:

Elizabethtown Gas

(pale green area on map)

New Jersey Natural Gas

(lime green area on map)

PSE&G

(light red area on map)

South Jersey Gas

(light purple area on map)

Natural Gas Use in New Jersey

Primary energy: 34%

Electric generation capacity: 58%

% of households with gas as main heating fuel: 75%

Annual consumption: 747 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are approximately 3 million natural gas customers in the state.

Natural Gas Pipelines Serving New Jersey

- ***Algonquin Gas Transmission and Texas Eastern Transmission,*** subsidiaries of Spectra Energy.
- ***Columbia Transmission,*** a subsidiary of TransCanada.
- ***Dominion Transmission***
- ***Tennessee Gas Pipeline Company,*** a subsidiary of Kinder Morgan.
- ***Transcontinental Pipeline,*** a subsidiary of Williams.

LNG Storage in New Jersey

There are utility liquefied natural gas (LNG) storage facilities in several communities.

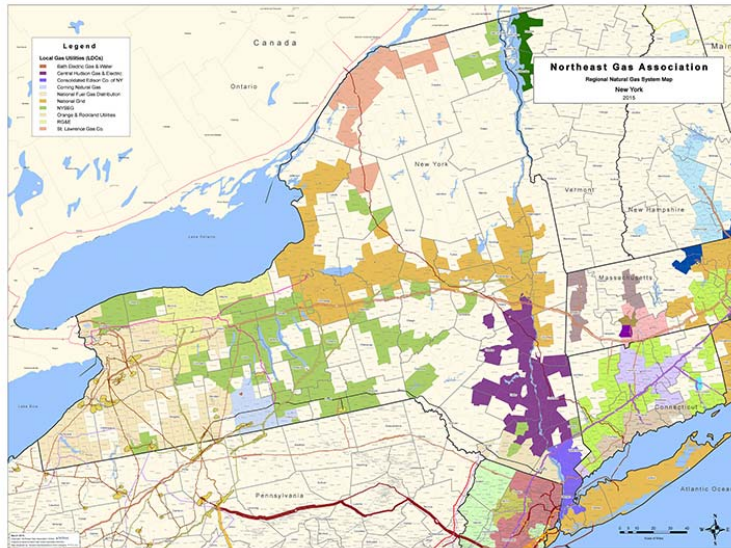
Underground Storage

None.

Natural Gas Production

None.

NEW YORK



Natural Gas Use in New York

Primary energy: 37%

Electric generation capacity: 57% gas, and/or gas/oil.

% of households with gas as main heating fuel: 58%

Annual consumption: 1,326 billion cubic feet (Bcf) of natural gas.

Local Gas Utilities:

There are ten natural gas utilities in the state.

Natural Gas Utility Customers:

There are 5 million natural gas customers in the state.

Natural Gas Production

In 2015, production was 18 Bcf.

Natural Gas Pipelines Serving NY

- **Algonquin Gas Transmission and Texas Eastern**
- **Columbia Transmission**
- **Dominion**
- **Empire Pipeline**
- **Iroquois Gas Transmission**
- **Millennium Pipeline**
- **National Fuel Gas Supply**
- **North County Pipeline**
- **Stagecoach Gas Pipeline & Storage**
- **Tennessee Gas Pipeline Company**
- **Transcontinental Pipeline.**

LNG Storage in New York

There are utility liquefied natural gas (LNG) storage facilities in three communities.

Underground Storage

Approximately 246 Bcf.

PENNSYLVANIA



Natural Gas Use in PA

Primary energy: 28%

Electric generation capacity: 28% gas

% of households with gas as main heating fuel: 51%

Annual consumption: 1,069 billion cubic feet (Bcf) of natural gas.

Local Gas Utilities:

There are eleven natural gas utilities in the state.

Natural Gas Utility Customers:

There are approximately 3 million natural gas customers in the state.

Natural Gas Production

In 2015, production was 4.7 Tcf.

Natural Gas Pipelines Serving PA

- **Columbia Transmission**
- **Dominion Transmission**
- **Equitrans**
- **National Fuel Gas Supply**
- **Tennessee Gas Pipeline Company**
- **Texas Eastern Transmission**
- **Transcontinental Pipeline.**

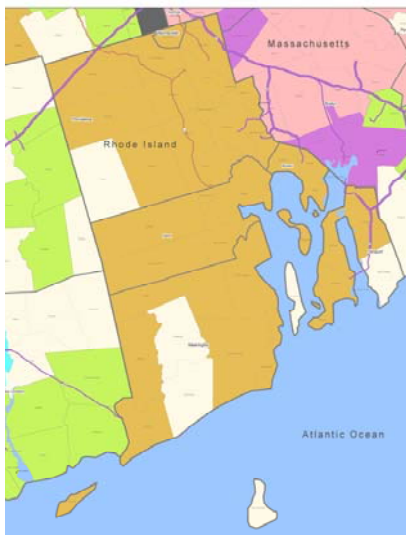
LNG Storage

There are four liquefied natural gas (LNG) facilities.

Underground Storage

Approximately 771 Bcf.

RHODE ISLAND



Natural Gas Utility in Rhode Island

There is 1 natural gas utility:

National Grid

(tan area on map)

Natural Gas Use in Rhode Island

Primary energy: 45%

Electric generation capacity: 96%

% of households with gas as main heating fuel: 53%

Annual consumption: 91 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are approximately 260,000 natural gas customers in the state.

Natural Gas Pipelines Serving Rhode Island

2 natural gas pipelines transport gas:

- ***Algonquin Gas Transmission***, a subsidiary of Spectra Energy.
- ***Tennessee Gas Pipeline***, a subsidiary of Kinder Morgan.

LNG Storage in Rhode Island

There are utility liquefied natural gas (LNG) storage facilities in 2 communities.

Underground Storage

None.

Natural Gas Production

None.

VERMONT



Natural Gas Utility Customers :

There are approximately 50,000 natural gas customers in the state.

Natural Gas Pipeline Supplying Vermont

1 natural gas pipeline transports gas to the VT border:

- ***TransCanada Pipelines.***

LNG Utility Storage in Vermont

None.

Underground Storage

None.

Natural Gas Production

None.

Natural Gas Utility in Vermont

There is 1 natural gas utility:

Vermont Gas Systems

(dark green area on map)

Natural Gas Use in Vermont

Primary energy: 8%

Electric generation capacity: 0%

% of households with gas as main heating fuel: 18%

Annual consumption: 12 billion cubic feet (Bcf) of natural gas.

NORTHEAST STATES' ANNUAL NATURAL GAS CONSUMPTION BY SECTOR, 2015 (Bcf)

STATE	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	ELECTRIC POWER	TOTAL*
CT	51	52	26	119	248
ME	3	10	21	17	51
MA	127	105	46	156	434
NH	8	10	8	43	69
NJ	237	163	55	291	747
NY	452	311	83	476	1,326
PA	236	152	241	439	1,069
RI	20	12	8	50	91
VT	4	6	2	—	12

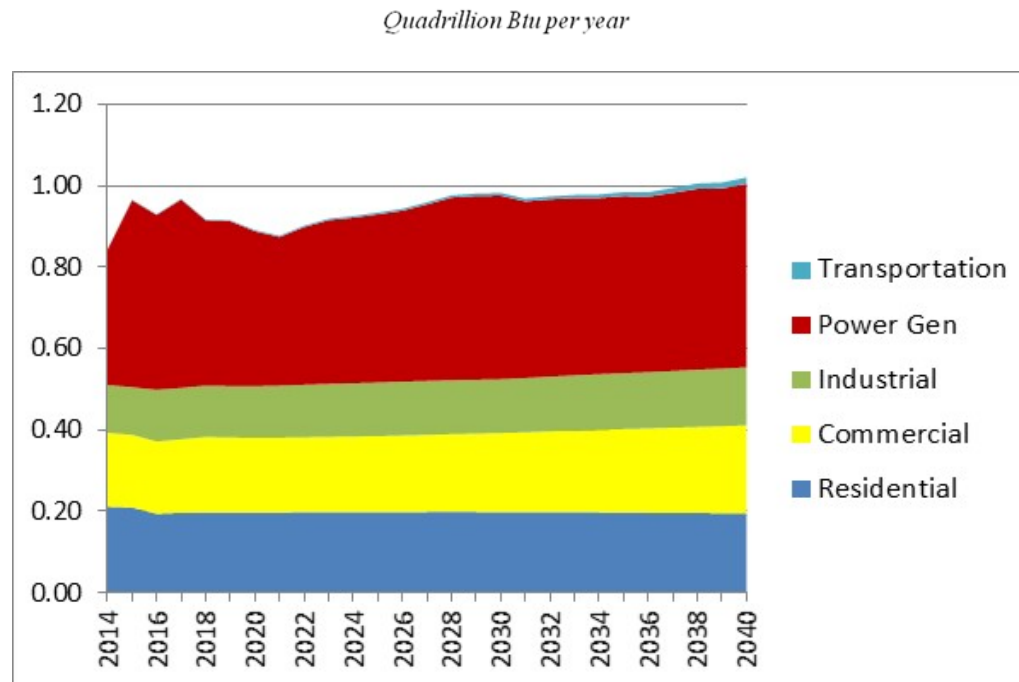
*Source: U.S. Energy Information Administration, "Natural Gas Annual 2015," released September 2016. Numbers are rounded off. Delivered energy consumption. * Vehicle fuel consumption not shown, which slightly increases total number for some states.*

PROJECTED NATURAL GAS MARKET GROWTH, NEW ENGLAND

U.S. EIA projects natural gas to grow at an annual rate of 0.2% in New England through 2040.

Projected sectoral growth rates:

Residential: -0.3%
Commercial: 0.8%
Industrial: 0.8%
Power Gen: -0.1%
Transportation (CNG & LNG): 0.003%



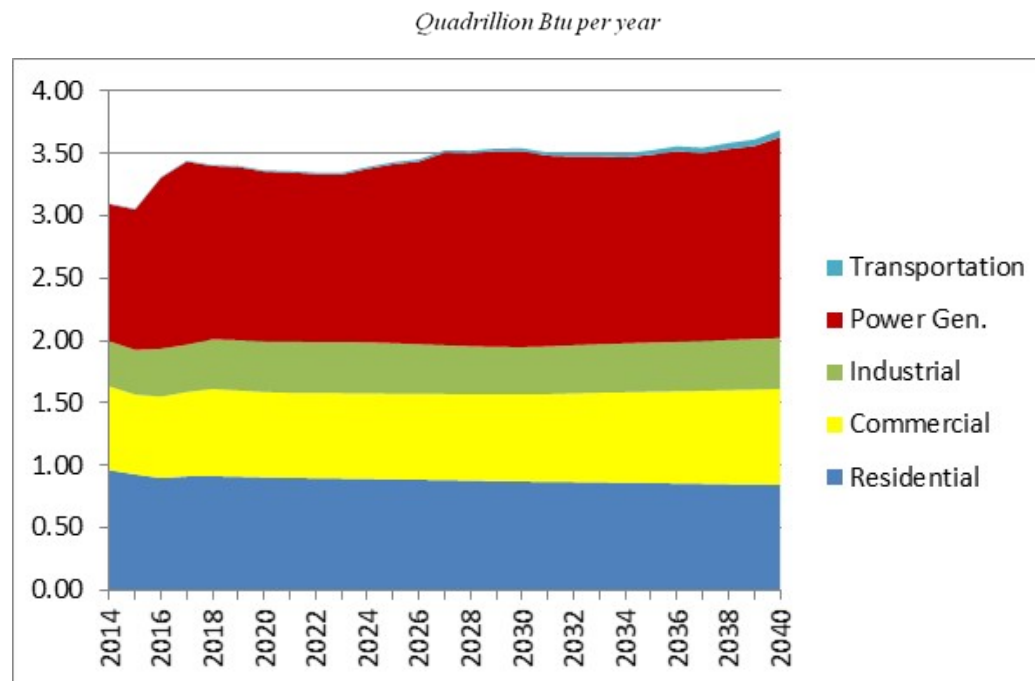
Source: U.S. Energy Information Administration, "2016 Annual Energy Outlook"

PROJECTED NATURAL GAS MARKET GROWTH, MID-ATLANTIC

U.S. EIA projects natural gas to grow at an annual rate of 0.7% in the Mid-Atlantic region (NJ, NJ, PA) through 2040.

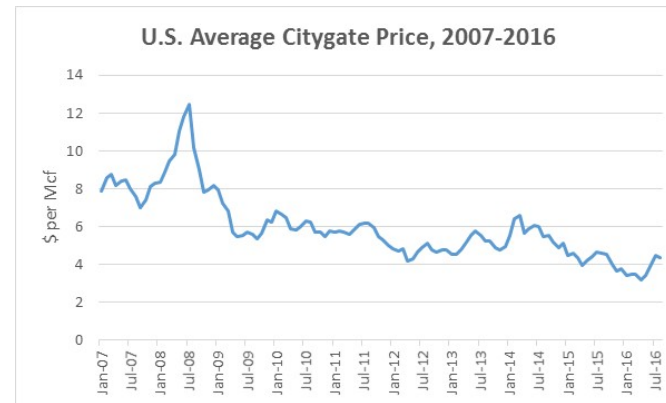
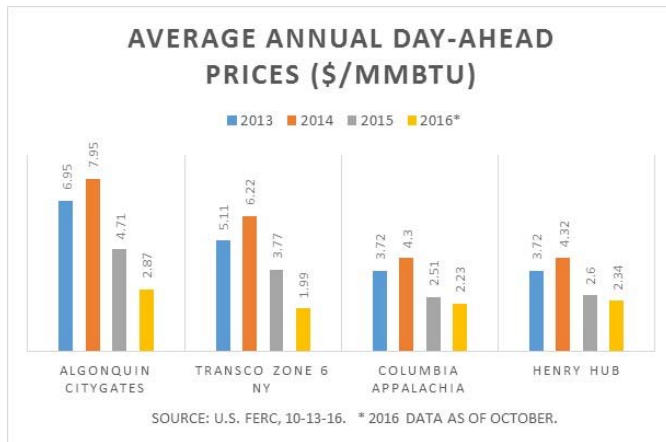
Projected sectoral growth rates:

Residential: -0.4%
Commercial: 0.7%
Industrial: 0.5%
Power Gen: 1.4%
Transportation (CNG & LNG): 0.015%



Source: U.S. Energy Information Administration, "2016 Annual Energy Outlook"

NATURAL GAS PRICE TRENDS



Source: U.S. Energy Information Administration

U.S. natural gas prices in 2016 have continued on a steady path. Commodity prices in 2016 have been relatively low, at around \$2.50/MMBtu for the Henry Hub annual average. U.S. EIA projects the 2017 Henry Hub price to be in the range of \$3.12. The Northeast market remains higher-priced than the national average, particularly in New England, reflecting infrastructure constraints. The entire Northeast region experienced considerable spot price volatility in the “polar vortex” winter of 2013-14, and again in the winter of 2014-15, although the heights were less extreme. Additional pipeline capacity into the region would help to alleviate constraints and reduce the regional price volatility.

The region's proximity to abundant shale gas resources remains however a positive factor. As the New York State Energy Planning Board observed in its June 2015 “New York State Energy Plan”: “Projected prices reflect continued industry success in tapping the nation's extensive shale gas resources. With its nearness to the Marcellus Shale basin, New York should participate in prices lower than those experienced from 2000 through 2010 and more similar to those of the last few years.”

RESIDENTIAL HEATING FUELS

Natural gas continues to make inroads in the residential heating market in the region. This table illustrates the leading house heating fuels, by percentage, for the years 1990, 2000 and 2015.

For the 9 state region, natural gas in 2015 represented 54% of home heating, compared to 23% for heating oil and 15% for electricity.

According to the most recent data, natural gas represented 58% of the home heating market in New York state, and three-fourths of the home heating market in New Jersey. In Pennsylvania, gas heats 51% of homes.

In New England, gas's share is 38.7%. Heating oil is second at 36.5%. Electricity is 13.4%.

Source: U.S. Census Bureau, "Profile of Selected Housing Characteristics." Data is 2015, 1-year estimates.

STATE	2015 %	2000 %	1990 %
Connecticut	Gas, 35 Oil, 42 Elec., 16	Gas, 29 Oil, 52.4 Elec., 14.6	Gas, 26.3 Oil, 54.4 Elec., 15.1
Maine	Gas, 7 Oil, 62 Wood, 13	Gas, 3.5 Oil, 80.2 Elec., 4.4	Gas, 1.8 Oil, 69.5 Elec., 11.7
Massachusetts	Gas, 51 Oil, 27 Elec., 16	Gas, 43.9 Oil, 39.4 Elec., 12.4	Gas, 38 Oil, 44 Elec., 13.5
New Hampshire	Gas, 20 Oil, 45 Propane, 15	Gas, 18.4 Oil, 58.1 Elec., 7.6	Gas, 15.2 Oil, 55.8 Elec., 12.4
New Jersey	Gas, 75 Oil, 9 Elec., 12	Gas, 66.8 Oil, 19.4 Elec., 10.3	Gas, 57.5 Oil, 29.2 Elec., 10
New York	Gas, 58 Oil, 23 Elec., 11	Gas, 51.7 Oil, 33.1 Elec., 8.7	Gas, 45.7 Oil, 39.6 Elec., 8.5
Pennsylvania	Gas, 51 Oil, 22 Elec., 17	Gas, 51 Oil, 25.5 Elec., 16.5	Gas, 49.5 Oil, 27.9 Elec., 14.8
Rhode Island	Gas, 53 Oil, 30 Elec., 11	Gas, 46.3 Oil, 42.1 Elec., 7.6	Gas, 40.7 Oil, 47 Elec., 7.9
Vermont	Gas, 18 Oil, 43 Wood, 17 Propane, 16%	Gas, 12.1 Oil, 58.6 Elec., 4.7 Wood, 9.4	Gas, 8 Oil, 54.3 Elec., 9.1

CHANGES IN NORTHEAST HOME HEATING CUSTOMER BASE, 2008-16

*Number of households by primary space heating fuel,
Northeast states (in thousands)*



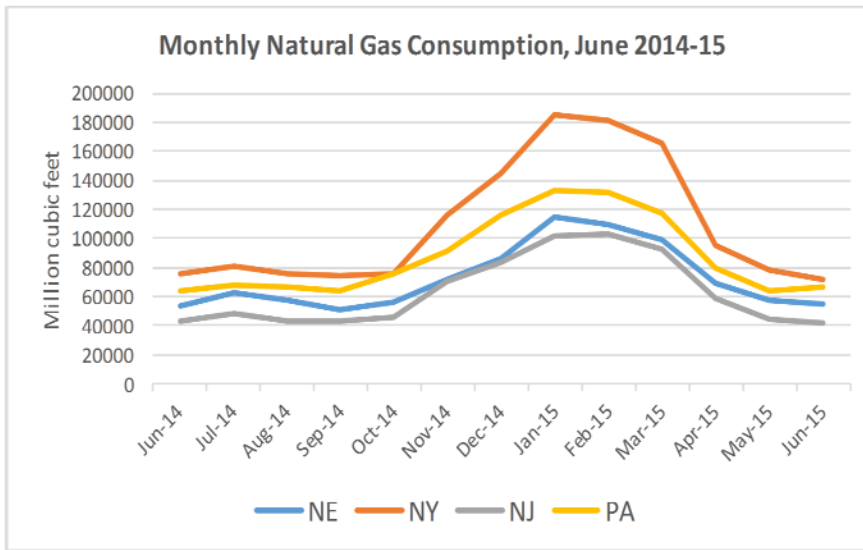
	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Natural Gas	10,889	10,992	11,118	11,236	11,345	11,481	11,630	11,728	11,959
Heating Oil	6,260	6,016	5,858	5,701	5,458	5,222	5,060	4,867	4,827
Propane	713	733	744	761	813	844	840	848	878
Electricity	2,563	2,645	2,776	2,894	3,011	3,027	3,068	3,161	3,307
Wood	474	501	512	548	582	579	582	598	536

U.S. EIA data indicates that the number of natural gas households in the Northeast U.S. has increased by 1 million since 2008.

In the same period, heating oil lost 1.4 million households, electricity gained 700,000, and propane gained 60,000.

Source: U.S. EIA, October 2016

NEW ENGLAND / NEW JERSEY / NEW YORK / PENNSYLVANIA MONTHLY LOAD CURVE



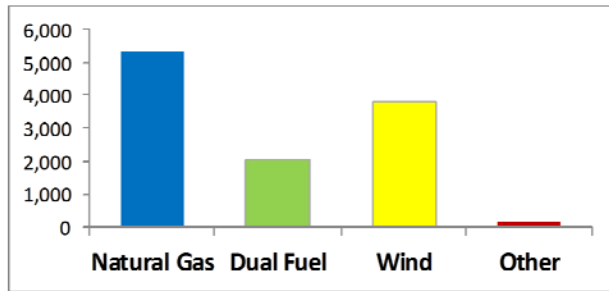
This graph displays the monthly variations in gas consumption in New England, New Jersey, New York and Pennsylvania for the illustrative period of June 2014 through June 2015. As can be seen, all four regions are winter-peaking systems. January 2015 represents the highest monthly consumption period for most of the states.

Even with milder weather last winter (2015-16), many of the region's utilities set new peaks during mid-February 2016, reflecting new customer additions.

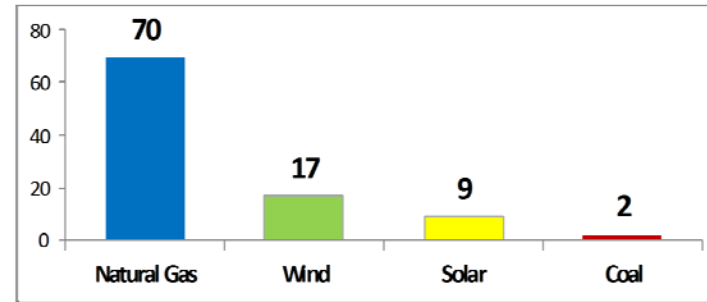
Source: U.S. Energy Information Administration, "Natural Gas Monthly"

PROJECTED NATURAL GAS ADDITIONS IN REGIONAL ELECTRIC GENERATION SECTOR

PROPOSED GENERATOR ADDITIONS, NEW YORK, Megawatts (Source: NY ISO, "Power Trends 2016")

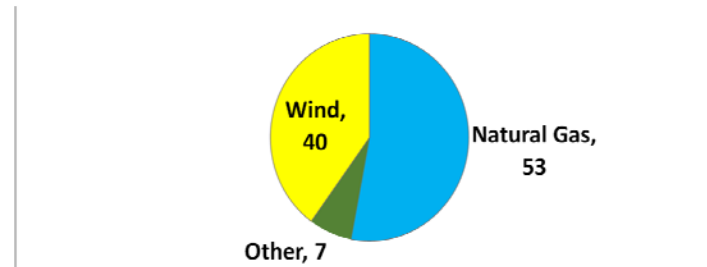


PROPOSED GENERATOR ADDITIONS, PJM, Percentage (Source: PJM Generator Queue, as of Aug. 2016)



Natural gas has been an increasingly significant fuel in the Northeast electric power system. The region's electric grid operators, as shown in these graphics, report that natural gas remains the leading choice for proposed new power plants. Renewable energy, imported hydro from Canada, and efficiency (not portrayed) are the other leading projected future power sources at this time.

PROPOSED GENERATOR ADDITIONS, NEW ENGLAND, Percentage of nameplate capacity (Source: ISO-NE Generator Queue, as of 9-16)



V.

TECHNOLOGY & ENVIRONMENTAL ISSUES

New technologies and environmental issues have been key drivers in shaping the regional gas market in recent years.

Among the areas addressed are:

- *Natural gas vehicles*
- *Power generation technologies*
- *Efficiency investments*
- *Environmental issues*
- *RD&D advances.*

NATURAL GAS VEHICLES

Natural gas fueled vehicles (also known as NGVs) have shown steady growth in recent years nationally and regionally. These vehicles provide environmental benefits, reliability, cost-effectiveness, and are sourced from domestic supplies. Natural gas fuels 23% of all transit buses in the U.S., and over 60% of new refuse truck orders are natural gas fueled.

The availability of public fueling stations remains a challenge. According to the U.S. Department of Energy's Alternative Fuels Data Center, Pennsylvania has 43 public compressed natural gas (CNG) stations, New York State has 39, New Jersey has 13, and New England has 26. Nationally, there are 955 CNG fueling stations. Efforts are underway to increase the number of publicly available stations. Pennsylvania legislation established a few years ago a “Natural Gas Energy Development Program” to award grants to promote the use of domestic natural gas as a vehicle fuel in Pennsylvania.

The private sector is at the same time establishing its own network for private fleets, from delivery vans to trucks. Companies with specific daily travel routes are finding it makes sense to use CNG or LNG, depending on weight and distance. There are public LNG fueling stations available in Connecticut, Massachusetts and Pennsylvania. In Canada, there is also a “blue road” of LNG fueling stations linking Quebec and Ontario trucking routes.

There is growing interest in “renewable natural gas” as an input to the transportation fuel stream. Potential sources of organics used to create renewable natural gas include food waste, agriculture waste, wastewater and landfill gas.



Photo: South Jersey Gas Company

CNG AND LNG FOR OFF-SYSTEM SUPPLY

Areas not currently served by pipeline (or distribution) infrastructure are looking at ways to gain access to the fuel—and increasingly opting for portable delivery systems, often referred to as a “virtual pipeline.”

In this process, CNG or LNG can be delivered via truck to serve institutional or industrial sites. The gas is transported via a trailer that also can serve to offload the gas into the facility.

This application is proving especially popular in areas of New England, New York and Eastern Canada where natural gas pipeline infrastructure has yet to reach. The new fuel system can potentially be set up in a matter of several months.

The natural gas can be sourced from the local gas distribution utility, or via the interstate transmission company.

Customers include paper mills, medical facilities, and farm/food processing.

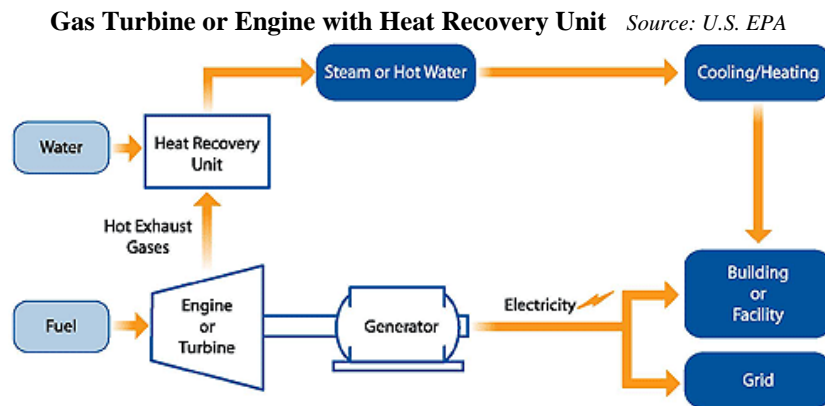


Shown in the photo is a CNG fueling station in Pembroke, NH that opened in the summer of 2014. The station is owned and operated by Clean Energy. The station operates as a CNG refueling stations for vehicles, but also supplies CNG by truck—the white trucks in the photo are examples.

CHP & FUEL CELLS

Natural gas is a key fuel input for energy systems that represent new technologies with opportunities for reduced air emissions, higher system efficiency, and greater reliability.

Combined heat and power (CHP), also known as cogeneration, is the simultaneous production of electricity and heat from a single fuel source – such as natural gas. **Natural gas fuels 70% of existing CHP capacity in the U.S.** Total generating capacity in the U.S. from CHP in 2014 was 83 gigawatts, representing about 8% of total capacity. The U.S. EPA notes that “gas turbines produce a high quality (high temperature) thermal output suitable for most combined heat and power applications...There is a significant amount of gas turbine based CHP capacity operating in the United States located at industrial and institutional facilities. Much of this capacity is concentrated in large combined-cycle CHP systems that maximize power production for sale to the grid. However, a significant number of simple-cycle gas turbine based CHP systems are in operation at a variety of applications including oil recovery, chemicals, paper production, food processing, and universities.” CHP is environmentally beneficial. EPA reports that “because of their relatively high efficiency and reliance on natural gas as the primary fuel, gas turbines emit substantially less carbon dioxide (CO₂) per kilowatt-hour (kWh) generated than any other fossil technology in general commercial use.”



Fuel Cells use “hydrogen as the fuel in an electrochemical process, similar to what occurs in a battery, that generates electricity” (EPA). The primary fuel source for the fuel cell is hydrogen, which can be obtained from natural gas and other fuels containing hydrocarbons. Fuel cells provide great advancements in efficiency and lower emissions. The National Academy of Science noted in an Oct. 2009 report that, looking ahead, “natural gas-powered fuel cells could become mainstream and generate significant amounts of electricity.”

NYSEARCH



NGA's NYSEARCH is recognized as one of the leading gas industry research and development organizations in the U.S., with pioneering programs that have received national and international recognition. NYSEARCH has recorded significant RD&D achievements - monitoring technology developments, identifying common needs, performing market research, evaluating potential technical solutions, and conducting product development.

Recent success stories include the development, testing and commercialization of the Remote Methane Leak Detector (RMLD), the EXPLORER II robotics program, and testing of drone systems for gas company facility inspection flights.

For further information, visit the NYSEARCH web site at www.nysearch.org.

RENEWABLE NATURAL GAS

Renewable Natural Gas (RNG), also known as bio-methane or biogas, is pipeline quality gas derived from biomass that is fully interchangeable with natural gas. The future natural gas network could include renewable gas from dairy farms, waste water treatment plants, landfills, wood waste and food waste plants.

The U.S. Department of Energy notes that like conventional natural gas, RNG can be used as a transportation fuel in the form of compressed natural gas (CNG) or liquefied natural gas (LNG). RNG qualifies as an advanced biofuel under the Renewable Fuel Standard."

The Gas Technology Institute (GTI) notes that Bio-methane and liquid biofuels provide an opportunity to supply affordable, clean, domestically-sourced energy to U.S. and global energy customers. These renewable energy sources can help companies comply with renewable portfolio standard (RPS) requirements, low carbon fuel standards, and other policy-driven efforts intended to promote the use of renewable and sustainable energy resources for power generation, transportation, and other end use market applications."

In a position paper a few years ago, National Grid observed that "the biggest driver of renewable gas is GHG reduction, but what makes renewable gas more compelling is that it also enhances diversity of supply while providing a solution for using local waste resources to produce renewable energy."



FOSSIL FUEL AIR EMISSIONS COMPARISONS

Natural gas technologies for electric generation provide substantial clean air benefits over other fuel systems. The combustion turbine and combined-cycle technologies remain among the most highly-favored generating technology in the nation and region; while the fuel cell technology holds great promise for future development. And the results for the environment have been positive. A key factor in this improving environmental performance is the rising use of natural gas and the fall in coal's share of total generation. In 2016, the electric grid operator in New York reported that carbon emissions in that region have declined by 42% since 2000, and that SO₂ emissions are down by 97% and NO_x by 79%. The use of natural gas generation technology is a key driver in this improving power sector trend.

Comparison of Air Pollution from Fossil Fuels

(average emission rates measured in pounds for air pollutants produced per megawatt hour of electricity generated, U.S.)

	SO ²	NO _x	CO ₂
Natural Gas	0.1	1.7	1,135
Oil	12	4	1,672
Coal	13	6	2,249

Source: U.S. EPA

Comparing Oil and Natural Gas Emissions

		Pounds per MMBtu	
		Oil	Natural Gas
SO ₂	✓ Higher with Oil	0.203	0.001
NO _x	✓ Higher with Oil	0.129	0.092
CO	✓ Higher with Gas	0.036	0.039
Particulates	✓ Higher with Oil	.003	.002
TOC's	✓ Higher with Oil	0.18	0.11
Organics	✓ Higher with Oil	Multiple Sources	Multiple Sources
Metals	✓ Higher with Oil	Multiple Sources	Multiple Sources

Source: GTI, "Oil and Gas Options in the Northeast: Creating the Scientific Basis for Comparing Fuel Differences," July 2003

ADDRESSING CARBON EMISSIONS

Natural gas is a contributor to greenhouse gas emissions, but is the cleanest of all fossil fuels, and as a result natural gas is included as part of the solution to the climate change challenge. At the same time, utility companies are implementing efficiency programs to reduce usage and emissions. Furthermore, natural gas companies are striving to reduce their emissions of methane, which is a greenhouse gas. Companies at all levels of the natural gas production and transmission chain are working to reduce pipeline leaks, fugitive emissions, and impacts from venting. Methane emissions from natural gas distribution systems and landfills in Massachusetts for example declined by over 60% between 1990 and 2012.

One highly successful program has been the “Natural Gas STAR” program of the U.S. EPA. The program invites voluntary participation from industry segments to reduce methane emissions. Over 1,200 billion cubic feet (Bcf) of methane emissions have been reduced by participating companies in the last ten years. A number of LDCs from the Northeast participate in this program.

EPA reports that “reducing methane emissions can result in environmental, economic, and operational benefits.”

Source: U.S. EIA, 11-16

State Energy-Related CO2 Emissions (million metric tons carbon dioxide)

State	1990	2014	Percentage Change
CT	41	35	-14.2%
ME	19	17	-13.1%
MA	84	64	-23.8%
NH	15	15	2.0%
NJ	110	114	3.0%
NY	209	170	-18.8%
PA	265	245	-7.4%
RI	9	11	19.1%
VT	6	6	7.3%
US	5,028	5,405	7.5%

ACCELERATING REPLACEMENT OF OLDER PIPE MATERIALS

**Miles of Distribution Main Considered
“Replacement Candidates” by Type**

State	Bare Steel	Cast / Wrought Iron	Percentage of Total Main %
CT	156	1,349	18.9%
ME	1	45	3.9%
MA	1,566	3,315	22.7%
NH	16	113	6.8%
NJ	1,333	4,586	17%
NY	6,138	3,960	20.7%
PA	7,208	2,901	21.1%
RI	266	769	32.3%
VT	--	--	0.0%

2015 data, released 2016 by PHMSA.

*Accelerated repair and replacement of more “leak-prone” natural gas distribution system components is an issue receiving growing attention. The Pipeline and Hazardous Materials Safety Administration (PHMSA) of the U.S. Department of Transportation is urging action on repairing older pipe systems, which are considered more vulnerable to potential leaks. Accelerating repair and replacement would meet safety, environmental and efficiency goals. In July 2013, NARUC, the national state regulatory association, adopted a resolution encouraging “regulators and industry to consider sensible programs aimed at **replacing the most vulnerable pipelines as quickly as possible along with the adoption of rate recovery mechanisms** that reflect the financial realities of the particular utility in question.” Utilities in the Northeast are working to accelerate this replacement process, in concert with efforts to reduce emissions and extend the systems to meet market demand. As one example, in June 2014 the Massachusetts Legislature unanimously enacted legislation addressing “natural gas leaks” and facilitating utility accelerated replacement.*

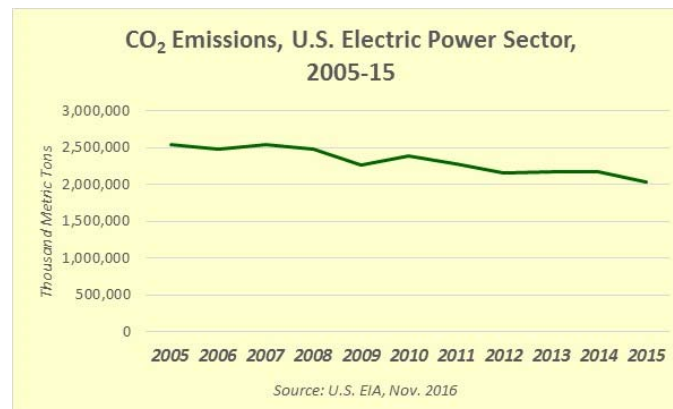
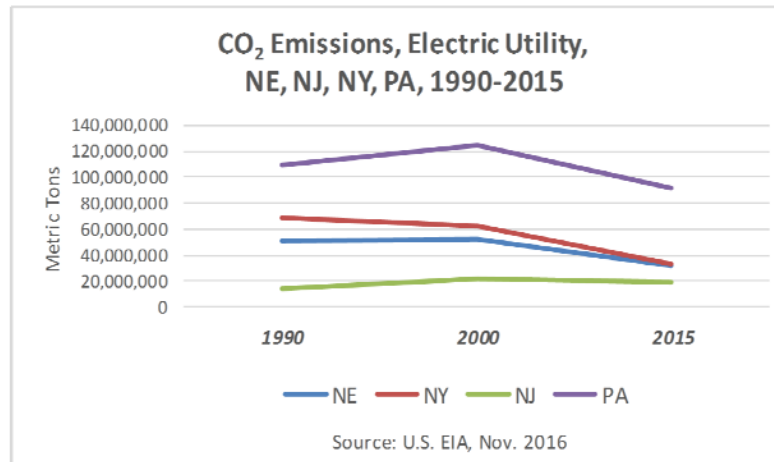
ACHIEVING EMISSIONS REDUCTIONS IN THE POWER SECTOR

The electric utility sector in the Northeast has achieved major reductions in several air emission areas in recent years—in part thanks to new, more efficient power sources, from natural gas to renewables.

In New York State, from 2000 to 2015, NY ISO reports that emissions rates from the power sector dropped by 42% for CO₂, 79% for NO_x, and 97% for SO₂.

ISO-NE reports that from 2001 to 2014, total emissions from power plants in New England dropped by 94% for sulfur dioxide (SO₂), 66% for nitrogen oxides (NO_x), and 26% for CO₂.

U.S. power sector carbon emissions have fallen by 10% over the last decade, with the substitution of natural gas for coal a key driver.



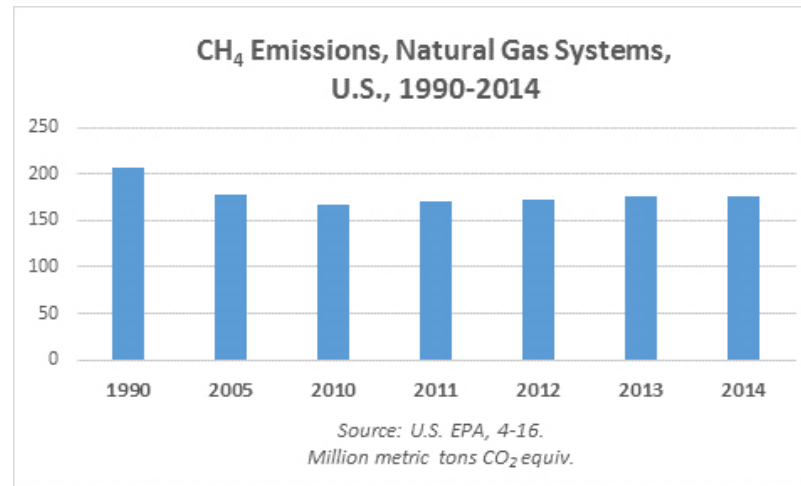
REDUCING METHANE EMISSIONS IN NATURAL GAS SYSTEMS

Natural gas systems are a leading contributor to CH₄ or methane emissions in the U.S., along with agriculture, landfills and coal mining. But methane emissions from natural gas have been trending lower overall in the last decade.

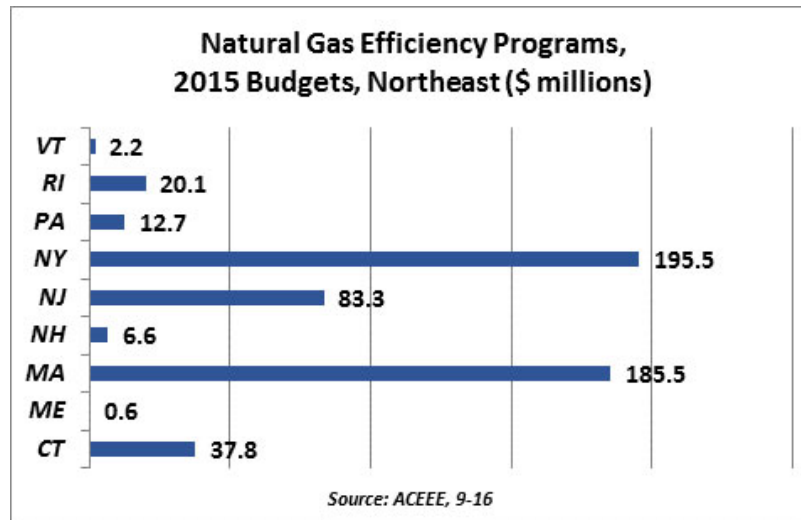
CH₄ emissions from natural gas systems declined by 15% from 1990 to 2014, according to the U.S. EPA's 2014 Greenhouse Gas Inventory, released in April 2016.

The decline is due to the following, notes EPA: “The decrease in CH₄ emissions is largely due to the decrease in emissions from transmission, storage, and distribution...The decrease in distribution emissions is largely attributed to increased use of plastic piping, which has lower emissions than other pipe materials, and station upgrades at metering and regulating (M&R) stations. and their replacement with plastic pipelines.” [EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014, page ES-14]

Reducing methane emissions further through infrastructure replacement, new technology applications, and best practices at all stages of the production and delivery process, is an industry priority.



NATURAL GAS EFFICIENCY



Source: ACEEE, “2016 State Energy Efficiency Scorecard”, released September 2016

Natural gas efficiency programs are a central part of the evolving national and regional natural gas supply/demand portfolio. Efficiency remains a resource of immense opportunity. The Northeast states already are national leaders in their per capita energy efficiency, and the utilities in the region, electric and gas, have been active for years in efficiency programs.

The 2016 annual ACEEE Scorecard for Energy Efficiency, which looks at both electric and natural gas programs, found that five Northeast states were in the top 10 in the U.S.: MA, RI, VT, CT, and NY.

In 2015, \$1.4 billion was invested in natural gas efficiency programs nationwide, according to the ACEEE. Of that, over one-third of the national total (\$544 million, or 39%) was invested in the nine Northeast states (CT, ME, MA, NH, NJ, NY, PA, RI and VT). These program investments - and energy savings - will grow even further in coming years.

**NGA's MEMBER LOCAL
DISTRIBUTION COMPANIES**
(as of November 2016)

Bangor Gas Company
21 Main Street
Bangor, ME 04402
(207) 941-9595
www.bangorgas.com

Bath Electric, Gas & Water System
7-11 South Avenue
Bath, NY 14810
(607) 776-3072

The Berkshire Gas Company
115 Cheshire Road, P.O. Box 138
Pittsfield, MA 01202
(413) 442-1511
www.berkshiregas.com

Blackstone Gas Company
61 Main Street, P.O. Box 162
Blackstone, MA 01504
(508) 883-9516
www.blackstonegas.com

Central Hudson Gas & Electric Corp.
284 South Avenue
Poughkeepsie, NY 12601
(845) 452-2000
www.cenhud.com

Columbia Gas of Massachusetts
4 Technology Drive, Suite 250
Westborough, MA 01581
(508) 836-7000
www.columbiagasma.com

Columbia Gas of Pennsylvania
121 Champion Way, Suite 100
Canonsburg, PA 15317
www.columbiagaspa.com

Connecticut Natural Gas Corp.
77 Hartland Street, 4th floor
East Hartford, CT 06108
(860) 727-3000
www.cngcorp.com

Consolidated Edison Co. of NY, Inc.
4 Irving Place
New York, NY 10003
(212) 460-4600
www.coned.com

Corning Natural Gas Corp.
330 West William Street
Corning, NY 14830
(607) 936-3755
www.corninggas.com

Enbridge St. Lawrence Gas Company
33 Stearns Street
Massena, NY 13662
(315) 769-3516
www.stlawrencegas.com

NGA's LDC MEMBERS *(as of 11-16)*

Eversource Energy
One NSTAR Way
Westwood, MA 02090
(800) 592-2000

107 Selden Street
Berlin, CT 06037
(800) 286-5000
www.eversource.com

Fillmore Gas Company, Inc.
10577 New York 19
Fillmore, NY 14735
(585) 567-2272

Hamilton Municipal Gas
3 East Broad Street, PO Box 119
Hamilton, NY 13346-0119
(315) 824-1111
www.hamilton-ny.gov

Holyoke Gas & Electric Dept.
99 Suffolk Street
Holyoke, MA 01040
(413) 536-9300
www.hged.com

Liberty Utilities MA
PO Box 911
Fall River, MA 02722
(508) 324-7811
<http://www.libertyutilities.com/ma/>

Liberty Utilities NH
15 Buttrick Road
Londonderry, NH 03053
(800) 833-4200
www.libertyutilities.com/east/gas

Maine Natural Gas
PO Box 99
Brunswick, ME 04011
(207) 729-0420
www.mainenaturalgas.com

Middleborough Gas & Electric Dept.
32 South Main Street
Middleborough, MA 02346
(508) 947-1371
www.mgandonline.com

**National Fuel Gas Distribution Co.
(NY)**
6363 Main Street
Williamsville, NY 14221
(716) 857-7000
www.natfuel.com

**National Fuel Gas Distribution Co.
(PA)**
1100 State Street
Erie, PA 16512
(814) 871-8200
www.natfuel.com

NGA's LDC MEMBERS *(as of 11-16)*

National Grid

One MetroTech Center
Brooklyn, NY 11201
(718) 403-2000
www.nationalgrid.com

40 Sylvan Road
Waltham, MA 02451
(781) 466-5000
www.nationalgrid.com

New Jersey Natural Gas Co.

1415 Wyckoff Road
Wall, NJ 07719
(732) 938-7977
www.njng.com

New York State Electric & Gas

4500 Vestal Parkway East
Binghamton, NY 13902
(607) 762-7200
www.nyseg.com

Norwich Public Utilities

173 North Main Street
Norwich, CT 06360
(860) 887-2555
www.norwichpublicutilities.com

Orange & Rockland Utilities, Inc.

One Blue Hill Plaza
Pearl River, NY 10965
(914) 352-6000
www.oru.com

PECO Energy

2301 Market Street
Philadelphia, PA 19103
(800) 841-4141
www.peco.com

Philadelphia Gas Works (PGW)

800 W. Montgomery Avenue
Philadelphia, PA 19122
(215) 235-1000
www.pgworks.com

Public Service Electric & Gas Co.

80 Park Plaza
Newark, NJ 07101
(973) 430-7000
www.pseg.com

Rochester Gas & Electric Corp.

89 East Avenue
Rochester, NY 14649
(585) 546-2700
www.rge.com

NGA's LDC MEMBERS *(as of 11-16)*

The Southern Connecticut Gas Co.

855 Main Street, P.O. Box 1540
Bridgeport, CT 06604
(203) 382-8111
www.soconngas.com

South Jersey Gas

One South Jersey Plaza
Folsom, New Jersey 08037
(609) 561-9000
www.southjerseygas.com

Summit Natural Gas of Maine

442 Civic Center Drive, Suite 100
Augusta, ME 04330
(207) 621-8000
www.summitnaturalgasmaine.com

UGI Utilities, Inc.

2525 N. 12th Street, Suite 360
Reading, PA 19612
(610) 337-1000
www.ugi.com

Unitil

6 Liberty Lane West
Hampton, NH 03842
(888) 886-4845
www.unitil.com

Valley Energy, Inc.

523 S. Keystone Avenue
Sayre, PA 18840
(570) 888-9664
www.valley-energy.com

Vermont Gas Systems, Inc.

P.O. Box 467
S. Burlington, VT 05402
(802) 863-4511
www.vermontgas.com

**Wakefield Municipal Gas & Light
Department**

9 Albion Street, P.O. Box 190
Wakefield, MA 01880
(781) 246-6363
www.wmgld.com

Westfield Gas & Elect. Light Dept.

100 Elm Street
Westfield, MA 01085
(413) 572-0100
www.wgeld.org

TRANSMISSION COMPANIES AND LNG MEMBERS *(as of 11-16)*

Algonquin Gas Transmission Company

890 Winter Street, Suite 300
Waltham, Massachusetts 02451
(617) 254-4050
www.spectraenergy.com

Con Edison Transmission

4 Irving Place
New York, NY 10003
(212) 460-6417
www.conedtransmission.com/

Distrigas of Massachusetts Corp.

20 City Square, 3rd Floor
Charlestown, Massachusetts 02129
(617) 886-8300
www.engie-na.com/business/natural-gas-lng/

Granite State Gas Transmission, Inc.

1075 Forest Avenue
Portland, Maine 04104
(207) 797-8002
www.unitil.com

Iroquois Gas Transmission System

One Corporate Drive, Suite 600
Shelton, Connecticut 06484
(203) 925-7200
www.iroquois.com

Maritimes & Northeast Pipeline

890 Winter Street, Suite 300
Waltham, Massachusetts 02451
(617) 254-4050
www.mnp-usa.com

Millennium Pipeline

One Blue Hill Plaza, 7th floor
Pearl River, NY 10965
(800).572-7515
www.millenniumpipeline.com

North Country Gas Pipeline Corp.

99 Weed Street, PO Box 2985
Plattsburgh, New York 12901
(518) 563-1072

Portland Natural Gas Transmission System (PNGTS)

One Harbour Place, Suite 375
Portsmouth, NH 03801
(603) 559-5500
www.pngts.com

Repsol Energy North America

2001 Timberloch Place, Suite 3000
The Woodlands, Texas 77380
(281) 297-1128
www.repsolenergy.com

Talisman Energy USA

337 Daniel Zenker Drive
Horseheads, NY 14845
(607) 562-4000
www.talisman-energy.com

Tennessee Gas Pipeline Company

1001 Louisiana
Houston, TX 77002
(713) 420-2600
www.kindermorgan.com

VII. ABOUT NGA

The Northeast Gas Association (NGA) is a regional trade association that focuses on education and training, operations, planning, technology research and development, and increasing public awareness of natural gas in the Northeast U.S.

NGA represents natural gas distribution companies, transmission companies, liquefied natural gas importers, and manufacturers and suppliers to the industry. These member companies provide natural gas to approximately 13 million customers in nine states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont).

Mission Statement

The Northeast Gas Association's mission is to promote and enhance the safe, reliable, efficient, and environmentally responsible delivery of natural gas to customers in the region, and to advocate for the industry from production to delivery.

Its web site is www.northeastgas.org/

For further information, contact NGA at:

Northeast Gas Association
75 Second Avenue, Suite 510
Needham, Massachusetts 02494-2859
Tel. 781-455-6800
Fax 781-455-6828

Its NYSEARCH office is located at:

20 Waterview Boulevard, 4th floor
Parsippany, NJ 07054
Tel. 973-265-1900
www.nysearch.org

DATA SOURCES

The data sources used in the Guide are referenced on each page. NGA is grateful to the many agencies and individuals from a variety of sectors who provided information and guidance in the preparation of this report.

Documents of particular interest include the following:

New York State Energy Research and Development Authority (NYSERDA)
(www.nyserda.org)

- “Patterns and Trends - New York State Energy Profiles: 1999-2013”

Pennsylvania Public Utility Commission

- “Pennsylvania Gas Outlook Report 2015”

U.S. Department of Energy, Office of Fossil Energy, Office of Natural Gas & Petroleum Import and Export Activities

- “Natural Gas Imports and Exports”

U.S. Energy Information Administration (www.eia.gov)

- “Annual Energy Outlook 2016”

- “Natural Gas Annual 2015”

- “Natural Gas Monthly”

- “State Energy Data Report”

National Energy Board of Canada

- “Statistics: Natural Gas Exports and Imports”

NGA will continue during the year to provide up-to-date summaries of regional gas industry developments, and will make that information available on its web site at:
www.northeastgas.org.



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