

2019

STATISTICAL GUIDE

NORTHEAST NATURAL GAS MARKET AT-A-GLANCE

	NEW ENGLAND	NEW YORK	NEW JERSEY	PENNSYLVANIA
Gas Customers	2.8 million	5 million	3 million	3 million
Annual Consumption (2018)	908 Bcf	1,323 Bcf	764 Bcf	1,189 Bcf
Interstate Pipelines	5	11	5	7
Miles of transmission pipeline	2,704	4,583	1,566	10,365
Underground Storage	-	246 Bcf	-	763 Bcf
LNG operating import facilities	2	-	-	-
Gas production in-state, annual (2018)	-	11.8 Bcf	-	6,123 Bcf
Gas Efficiency Program Budgets (2018)	\$331.7 million	\$141.7 million	\$90.1 million	\$8.8 million
Primary energy consumption, leading fuels, % (2017)	Natural Gas, 29% Oil, 43% Nuclear, 10% Coal, <1% Renewables, 13%	Natural Gas, 35% Oil, 35% Nuclear, 12% Coal, <1% Renewables, 13%	Natural Gas, 34% Oil, 43% Nuclear, 17% Coal, <1% Renewables, 4%	Natural Gas, 32% Oil, 27% Nuclear, 20% Coal, 15% Renewables, 5%
Gas as a share of residential home heating fuels (2018)	39.9%	60%	75%	51%
Total population	14.8 million	19.5 million	9 million	12.8 million
Gross state domestic product (GDP, 2018; % of U.S)	\$1,102 billion 5.3%	\$1,701 billion 8.2%	\$640 billion 3.0%	\$803 billion 3.8%

Sources: NGA, American Council for an Energy Efficient Economy, U.S. EIA, PHMSA, U.S. Census Bureau, U.S. BEA. Updated by NGA, October 2019

STATISTICAL GUIDE TO THE NORTHEAST U.S. NATURAL GAS INDUSTRY *2019*

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



November 2019



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 topics.

Regional information is updated through calendar year 2018, 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, and Canada's Energy Regulator.

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The Year in Review

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 Jersey, New York, and Pennsylvania, and then reviews several current market issues (including infrastructure developments and restrictions, new technology R&D, supply and price trends, and regional and national environmental topics).

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 56.1 million (17.1% of the U.S.). Total state domestic product for the region is \$4.2 trillion (20% of the U.S. total).

Regional Natural Gas Market

The nine-state region has 13.8 million natural gas customers (18.4% of the U.S. total of 74 million). Total annual gas sendout on the regional gas system is 4.1 trillion cubic feet (Tcf), or 15% of U.S. total consumption (measured in volumes delivered to consumers).

Primary Energy

Natural gas represents 29% of the primary energy consumption of the six New England states, 34% of New Jersey, 35% of New York, and 32% of Pennsylvania, compared to the national average of 29% (based on U.S. EIA data, 2017).

Gas Customers

New England has 2.8 million natural gas customers. Residential customers total 2.5 million; commercial and industrial customers number over 280,000.



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New Jersey has 3 million natural gas customers. Residential customers total 2.8 million; commercial and industrial customers number about 250,000.

New York has 5 million natural gas customers. Residential customers total 4.5 million; commercial and industrial customers number about 410,000.

Pennsylvania has 3 million natural gas customers. Residential customers number 2.8 million; commercial and industrial customers number 245,000.

Natural gas remains the leading home heating fuel: in New England it is 39.9%, followed by fuel oil (35%); in New Jersey, 75%, followed by electricity (13%); in New York, 60%, followed by fuel oil (20%); and in Pennsylvania, 51%, followed by electricity (24%), and fuel oil (16%).

Consumption/Sendout by Sector

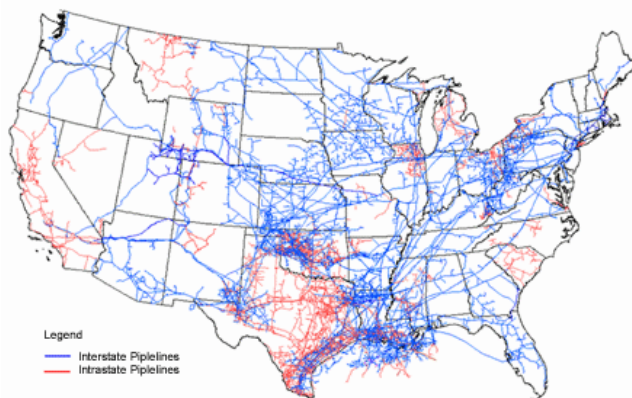
Total annual sendout in New England is 900 billion cubic feet (Bcf), in New Jersey about 760 Bcf, in New York about 1,320 Bcf, and in Pennsylvania about 1,110 Bcf (2018 EIA annual data).

In New England, gas consumption by end-use sector is 24% residential, 24% commercial, 13% industrial, and 40% power generation. In New Jersey, it is 32% residential, 22% commercial, 8% industrial, and 37% power generation. In New York, it is 37% residential, 25% commercial, 6% industrial, and 31% power generation. In Pennsylvania, it is 21% residential, 11% commercial, 19% industrial, and 45% power generation.

In New England, the gas distribution company, or LDC, design day demand is 4.8 Bcf per day, in New Jersey over 4 Bcf/d, and in Pennsylvania 5 Bcf/d. In New York State, gas system peak demand is 7.8 Bcf/d. While winter is still the peak season for demand, the increasing use of gas for power generation has led to higher demand in summer months.

Electric Generation Sector

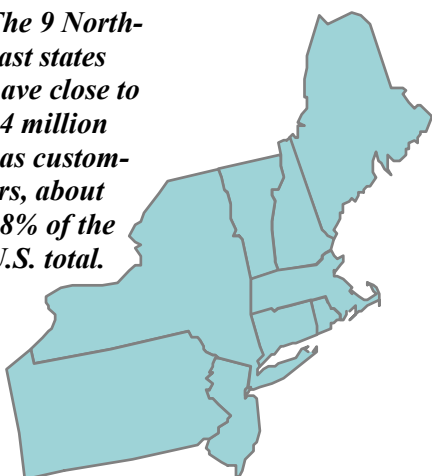
Based on annual fuel mix and generator applications in the queues at ISO-NE, NYISO, and PJM, natural gas remains one of the leading current and projected



The U.S. interstate natural gas pipeline system includes 300,000 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 18% of the U.S. total.



fuel sources for electricity generation. In New England, natural gas represents 49% of current regional electric capacity, in New Jersey, about 66% (in-state generation), in New York, over 50%, and in Pennsylvania, 34%.

Regional Market: Gas Supply Sources

Domestic resources account for 90% of the natural gas consumed in the U.S. The balance is imported from Canada, and a small share is imported in the form of liquefied natural gas (LNG).

Net imports as a percentage of total natural gas consumption in the U.S. totaled 8% in 2011, but dropped to about 2.5% in 2016. “The U.S. became a net natural gas exporter on an annual basis in 2017 for the first time in almost 60 years,” according to the EIA.

Historically, the Northeast has relied on three supply areas: Gulf Coast U.S., Canada, and imported LNG. Throughout the last two decades, supply areas expanded to include Rockies/Midcontinent gas and eastern Canada. For the Northeast, the most significant supply change is the development of the Marcellus and Utica Shale gas basins in Appalachia and Ohio. Marcellus/Utica production is resulting in new delivery points and new pipeline infrastructure. Appalachian production reached 32 Bcf/d in mid-2019. Exports from Canada to the Northeast have fallen from 2.8 Bcf/d in 2007 to 0.8 Bcf/d in 2018, because of Marcellus and Utica shale gas availability.

LNG imports into the U.S. were 72 Bcf in 2018, substantially lower than the high point of 771 Bcf a decade earlier. The Everett LNG facility outside Boston imported 56 Bcf in 2018, which represented nearly 80% of total U.S. imports.

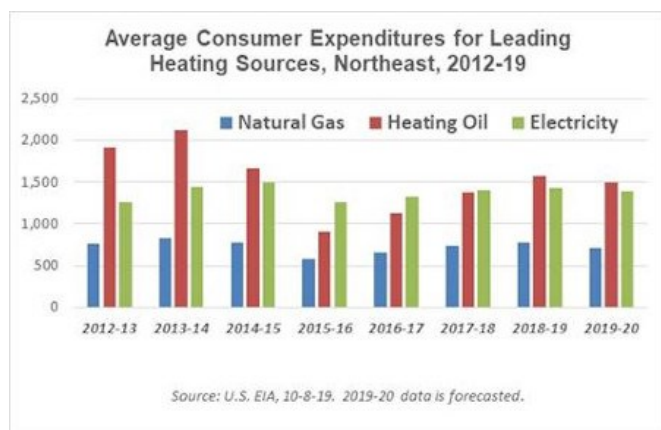
LNG imports play a critical role in helping gas utilities in the Northeast region meet winter peak day requirements; for example, LNG provides about 27% of New England utilities’ peak day requirements. Canaport in New Brunswick, Canada delivered 21 Bcf to the Northeast in 2018. (The offshore Northeast Gateway terminal delivered no volumes in 2018 but did import 5 Bcf in early 2019.)

Pipeline and LNG Deliverability

New England

New England has 2,704 miles of gas transmission pipeline, according to the U.S. Department of Transportation / Pipeline and Hazardous Materials Safety Administration (PHMSA).

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As illustrated in the chart, natural gas in the Northeast (shown in blue) maintains a price advantage over heating oil and electricity for heating fuel costs. Natural gas remains the heating fuel of choice: over 90% of new single-family homes built in the Northeast in 2018 ran on natural gas, according to the U.S. Census.

Chart source: U.S. Energy Information

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, two of which are operational. The onshore terminal in Everett, outside of Boston, is owned by Exelon (Constellation). LNG is delivered by tanker to the terminal which has 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 Everett facility. The terminal's vaporization capability is 715 MMcf/d; it also has daily sendout by truck of another 100 MMcf/d.

The offshore Northeast Gateway facility (near Cape Ann, MA) is owned by Excelerate Energy. It can receive LNG cargoes and inject the revaporized gas into Enbridge's HubLine pipeline system. After several years of inactivity it brought 2.6 Bcf in 2015 and 2.3 Bcf in 2016, but none in 2017 or 2018. In early 2019, the facility brought in just under 5 Bcf to meet cold weather demand.

The offshore Neptune LNG facility owned by ENGIE (also near Cape Ann, MA) was completed in 2010. It has been inactive since its start-up, and is presently offline.

Canaport LNG (located across the Maine border in Saint John, New Brunswick) is owned and operated by Repsol and Irving Oil. It can deliver up to 1 Bcf/d into the Brunswick Pipeline, which connects with the Maritimes & Northeast Pipeline, which then can transport the volumes into New England. Since its inception, it has delivered over 400 Bcf into the regional market. Canada's National Energy Board noted in March 2017 that "Canaport is a peak demand serving facility with deliveries increasing during the winter months in response to cold temperatures."

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New Jersey

New Jersey has 1,566 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 4,583 miles of gas transmission pipeline. The pipeline companies serving New York State are: Algonquin Gas Transmission, Columbia Gas Transmission, Dominion Energy 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 10,365 miles of gas transmission pipeline. The pipeline companies serving Pennsylvania are: Columbia Gas Transmission, Dominion Energy 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 a center of U.S. natural gas production.

Historically, the region had only limited natural gas production in New York and Pennsylvania. (There is no gas resource production base in New Jersey or New England.) With the advancement of hydraulic fracturing and the develop-

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ment of the Marcellus resource base, the Northeast has become a significant area of natural gas production.

Appalachian production, centered in Pennsylvania, Ohio, and West Virginia, reached 32 Bcf/d in mid-2019. Pennsylvania’s annual production exceeded 6 Tcf in 2018; it is the second-largest state producer of natural gas in the U.S.

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.



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 11.8 Bcf in 2018. The state’s conventional production has steadily declined since 2007, when annual production totaled 55 Bcf.

There is some limited conventional production in eastern Canada.

Gas from offshore Nova Scotia was produced for two decades from the Sable Offshore Energy Project, but production ceased at the end of 2018. In February 2019, Canada’s NEB noted: “The Maritimes will transform from being an exporter of natural gas to being an importer of natural gas from the U.S.”

A gas production field in New Brunswick, the McCully field of Corridor Resources, which began production in 2007, provides small amounts of gas for delivery into the Maritimes & Northeast Pipeline.

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 (8.2% of the U.S. total). Underground storage in New York is about 2.6% of the U.S. total. The geology of New Jersey and New England is not suitable for underground gas storage.

LNG is an important part of the 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 Everett import terminal. The Canaport LNG facility has 9.9 Bcf of storage. LNG is also produced and supplied by companies in Québec and Pennsylvania.

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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. This photo is of an LNG tanker delivery to Everett during a snowstorm in March 2019.

Photo source: Everett LNG



Recent System Enhancements

2019 witnessed the advancement of several interstate pipeline projects:

Millennium: “Eastern System Upgrade”

Transco: “Rivervale South to North”

PNGTS: “Portland XPress” [phase 2]

PNGTS: “Westbrook” [phase 1]

Enbridge: “Lambertville East.”

Several other projects experienced permitting delays (refer to the section on Infrastructure Siting Challenges and Regulatory Delays).

Planned Infrastructure Enhancements

The Northeast region’s natural gas industry plans several infrastructure projects in the near-term to meet growing market demand. The natural gas system remains constrained at several points on its natural gas system, especially into New England and southern New York/Long Island. Several gas utilities in the region have implemented moratoria on new customer connections, citing supply and delivery limitations

New supplies and infrastructure, however, would ease constraints, mitigate regional price disadvantages, and increase regional natural gas capacity, deliverability, flexibility, and reliability. NGA 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. Contract commitments in New England remain a vexing market issue, as the largest consuming sector, power generation, is constrained by

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the complex economic structure of its wholesale electricity market. Local natural gas utilities have tried to invest in incremental pipeline projects to meet system expansion 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. En-ergir (Gaz Métro LNG) in Québec increased its liquefaction capability in 2016. South Jersey Gas added liquefaction capability in 2016. National Grid received federal regulatory approval in 2018 to add liquefaction at its Providence, RI facility. Philadelphia Gas Works (PGW) received city approval in 2019 to advance its proposed LNG project with Passyunk Energy Center, LLC (PEC) to facilitate the marketing and sale of LNG to regional customers. A further project is the Northeast Energy Center (NEC), proposed as a FERC-regulated LNG liquefaction, storage, and vaporization project to be located in central MA and connected to the Tennessee Gas Pipeline. The project sponsor is Liberty Energy Trust of Pennsylvania.

Portable or mobile compressed natural gas (CNG), another supply/delivery development, is designed to bring natural gas to communities and businesses not located near a pipeline or distribution system. Some large commercial and industrial facilities, such as medical centers and colleges, have opted for “portable” or “mobile” natural gas delivered by truck. In this approach, large tube trailers are filled at large compression facilities and the CNG is delivered to the customer’s facility, where it is de-pressurized, off-loaded, and flowed into the customer’s gas (or dual-fuel) equipment. CNG is also being looked at by several gas utilities as another supply input into the distribution network at particularly constrained points.

MARKET ISSUES

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 and elsewhere,



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Supply Outlook

U.S. production reached new heights in 2018, 11% over 2017 levels. As of late 2019, EIA was forecasting that U.S. dry natural gas production will average 92 Bcf/d for 2019, up 10% from the previous record in 2018.

In September 2019, the Potential Gas Committee (PGC) at the Colorado School of Mines released its 2018 biennial report, *Potential Supply of Natural Gas in the United States*. The assessment reported that the U.S. possesses a technically recoverable natural gas resource potential of 3,374 Tcf, which is the highest resource evaluation in the PGC’s 54-year history. The future supply of domestic natural gas continues to increase due to the emergence and advancement of key technologies that unlock gas production from reservoirs such as shale formations.

Canada, which has considerable natural gas reserves, remains an important energy partner, although its share of the U.S. natural gas market is expected to decline over the long-term. The NEB’s 2018 report, *Canada’s Energy Future*, projected that natural gas production and domestic demand will increase over the next decades, with the power generation market and LNG exports as key market drivers.

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

Increased domestic production in the U.S. affects LNG imports. LNG imports into the U.S. are substantially lower than a decade ago, and the focus for the U.S. gas market has shifted from *imports* to *exports*. Several LNG import facilities on both coasts and especially in the Gulf are adding liquefaction facilities so that they can export LNG to the world market. In 2018, the U.S. *exported* far more LNG (1 Tcf) than it *imported* (72 Bcf), a trend that will continue. One example of the new dynamic is Dominion’s Cove Point facility in Maryland; long an import facility, it recorded its first export shipment in the first half of 2018.

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

Efficiency Initiatives

The Northeast region is a recognized national leader in per capita energy efficiency. A 2019 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 2018 (latest data). Over 40% (\$572 million) of the national total was invested in the nine Northeast states alone.

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ACEEE stated that efficiency opportunities exist in multiple sectors: “While the roots of natural gas efficiency programs lie within residential markets, there 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 state of the national economy, production levels, storage levels, weather, and alternative fuel prices.

The natural gas price trend in this new era of domestic production continues to be positive for both consumers and the entire U.S. economy. In July 2008 natural gas commodity prices reached \$13.50/MMBtu (and oil hovered close to \$150 a barrel), whereas in mid-2019 the average natural gas commodity price was around \$2.50/MMBtu. Summer 2019 natural gas prices were at their lowest level in more than 20 years (EIA, July 2019).



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

EIA has projected an average commodity spot price of around \$2.50 per MMBtu in 2020.

Winter Challenges

The back-to-back winters of 2013-14 and 2014-15 set new records for both pipeline and gas utility sendout. The consistent cold weather tested regional energy delivery systems and resulted in significant energy price volatility. FERC’s 2013-14 winter assessment noted that “during each of these cold events, customers who had firm transportation capacity on natural gas pipelines generally managed to secure natural gas deliveries.”

After two mild winters, an historic cold snap tested the system once again, in

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late 2017/early 2018. From December 26, 2017 to January 7, 2018 the region experienced an extended and intense cold period (Boston had 15 consecutive days with minimum temperatures below normal.) The natural gas system performed extremely well throughout. The New England gas utilities set three new collective peak records in the first week of January 2018, with an all-time peak at close to 4.4 Bcf on January 6. In New Jersey and New York, most gas utilities hit new record sendouts. The growth in new customers and the extreme cold weather contributed to the very high demand. LNG inputs into the system from both the Everett and Canaport terminals were critically important. Interstate pipeline operators performed very well. System restrictions, such as operational flow orders, were in place to keep the system in balance throughout the period.

The high demand, record cold and system constraints did affect spot price volatility: spot prices hit extremely high levels, including a record on the Transco system in New York. While the Midwest price rose as high as \$6.50/MMBtu on January 5, the spot price was \$83 in Boston and \$140 in the New York City area.

Natural gas utility customers in the region are largely shielded from spot market price volatility thanks to gas utilities’ firm contract arrangements for pipeline capacity and storage arrangements. Market participants such as some power generators which rely on non-firm capacity are, however, subject to spot market prices and interruptions in capacity delivery according to their contract terms.

In March 2017, the EIA noted that “both the Boston and New York natural gas markets have experienced winter price spikes because of pipeline constraints during periods of peak demand. Natural gas pipeline expansion projects that were completed in recent years may have reduced, but did not eliminate, sharp price increases with anticipated cold weather.”

Again, points of constraint in the Northeast leaves the region subject to higher-than-average volatility in colder weather and higher demand.

The situation in the summer months is less challenging, although pipeline maintenance work can affect the regional market.



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.

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Gas and Electric Power Generation

The regional power generation fleet, already highly reliant on natural gas, is positioned to remain so. 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 are the leading fuel types for new proposed power generation capacity in the generator interconnection queues in New Jersey (where gas represents 85% of proposed new generation), Pennsylvania (85%), and New York (50%), and is fourth (10%) in New England. The Northeast states’ commitments to increased procurements of clean energy, notably offshore wind, may well change this profile over the next decade. Nevertheless, there is continued interest in natural gas even as renewables ramp up. In a May 2019 update on Pennsylvania, the EIA reported that natural gas is replacing nuclear and coal unit retirements: “From 2019-22, in Pennsylvania, 17 new natural gas-fired plants will be in various stages of development, bringing 8,460 MW of nameplate capacity online by 2022.”



In March 2017, PJM’s study of system reliability concluded that even with the addition of more natural gas and renewables, its system would remain reliable. The analysis identified “no limit to the amount of natural gas-fired generation that could be added to the system before it affected reliability.”

PJM’s “2018 Regional Transmission Expansion Plan” released in February 2019, noted that “[The] shift to natural gas continues....Natural gas powers 67 percent of the generation in PJM’s interconnection queue....Favorable fuel economics have emerged with the development of Marcellus and Utica shale formation natural gas reserves, located in the middle of PJM's footprint.”

Meanwhile, regional retirements of non-gas units continue. In New Jersey in 2016 PSEG announced the retirement of its last two coal units, citing the competi-

A new natural gas power plant in Bridgeport, CT that went into operation in mid-2019; 485 MWs.



Photo: PSEG Power

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tive market pressure presented by low natural gas prices. In Vermont in 2014, Entergy closed Vermont Yankee, in Massachusetts in 2019, it closed its Pilgrim nuclear facility, and in New York State in 2021, it will retire its Indian Point nuclear facility. In Massachusetts in 2017, Dynegy closed the Brayton Point coal plant.

The New York Independent System Operator (NYISO) noted in its May 2019 report “*Power Trends 2019*” that “the portion of New York’s generating capability from natural gas and dual-fuel facilities grew from 47% in 2000 to 59% in 2019....Reflecting economic and public policy investment signals, recent generation additions have primarily been natural gas-fueled in downstate New York and wind-powered in upstate.”

In 2018, new gas combined-cycle plants opened in Connecticut (805 MW, CPV Towantic plant), Massachusetts (674 MW, Salem Harbor unit), and New York (680 MW, CPV Valley Energy Center). In 2019, a combined cycle plant opened in Bridgeport, CT (485 MW), and two gas peakers totaling just over 500 MW opened in MA. By early 2020 a gas unit (1100 MW) in New York is scheduled to become operational.

Public policy and legislative initiatives in most of the region are clearly prioritizing non-fossil fuel units for future generation and encouraging electric utilities to contract for substantial amounts of offshore wind and imports of Canadian hydro. Solar continues to make inroads behind-the-meter as its technology costs decline.

Nevertheless natural gas will continue to serve as the backbone of the power system even as the Northeast region moves toward a system more reliant on clean energy. The importance of natural gas to the region is underscored in the biennial “Regional System Plan” from ISO-NE in 2017:

“Natural-gas-fired generation’s proportion of the system capacity mix is expected to grow from 44.5% in 2017 to approximately 50.9% by 2020 and 56.0% by

2026. Further retirements of coal and oil generators are expected after 2020 due to generally low natural gas prices, renewable energy additions, and pending environmental regulations.”

Fuel choices and power system reliability remain highly topical at national and regional/state energy forums. Fuel security and grid resilience are under review by FERC and the RTOs. The future of coal and nuclear, the adequacy of

The Northeast states have added over 1 million new natural gas customers since 2012.



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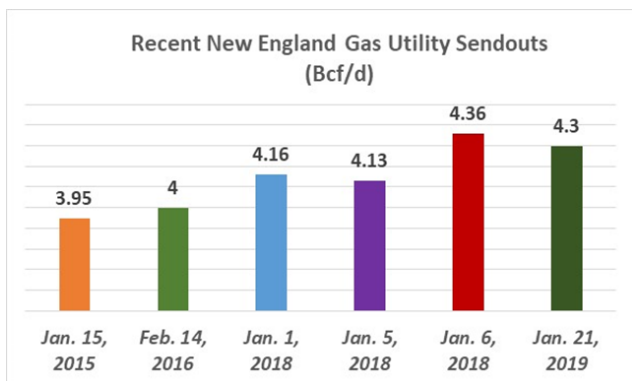
pipeline infrastructure in areas like the Northeast, the balancing of intermittent renewable resources on the system, the valuing of capacity in power markets, and the role of carbon emissions and carbon pricing, onshore connectivity, and solar acreage are complex issues. Debate will continue into 2020 and beyond as the Northeast region’s power markets evolve to reflect the changing policy and regulatory environment.

Utility System Expansions - and Limitations

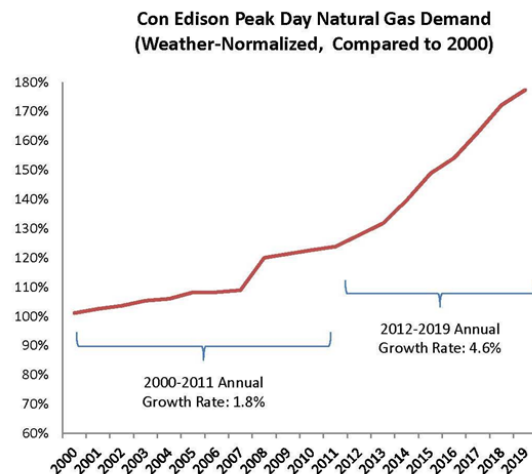
Since 2012, the number of homes heating with natural gas in the Northeast region has increased by over one million (to over twelve million heating customers). U.S. Census data for 2018 indicated that natural gas remains the predominant heating choice for new home construction in the Northeast.

Gas demand has been rising due to its advantageous price, reliability, and efficiency. In New York City, a “Clean Heat” initiative led to the conversion of significant building load from oil to gas as city regulations sought to eliminate the use of #6 oil by 2020 and #4 oil by 2025. Con Edison reported the conversion of 6,500 large buildings from oil to natural gas in New York City between 2011 and 2016.

As noted earlier, rising demand and new customer additions are running up against system delivery constraints. Five utilities in Massachusetts have declared moratoria on new customer connections because of supply and delivery constraints. In 2019, Con Edison and National Grid announced moratoria on new customer connections in the New York City area because of system constraints. Con Edison subsequently announced plans to secure additional pipeline capacity with



Natural gas utilities have seen increasing peak day demand on their systems in recent years. The chart above highlights recent utility sendouts in New England; on the right is a Con Edison chart



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both Iroquois and Tennessee Gas Pipelines, to be available, if permitted, in 2023, to address the moratorium in parts of Westchester County. Con Edison is also implementing a range of options to manage growth, from greater efficiency, to incorporating CNG, LNG and renewable natural gas, to incentives for customers who upgrade their heating equipment or install heat pumps to reduce natural gas usage. In November 2019, the State of New York and National Grid announced that the utility would lift a moratorium on new customer connections in Brooklyn, Queens, and Long Island. National Grid cited “significantly enhanced demand response; energy efficiency programs to reduce the demand for natural gas at peak times; and increasing reliance on portable compressed natural gas” as its next steps. It also agreed to spend \$8 million for new energy efficiency and gas conservation measures “designed to relieve stress on the system and reduce peak-day gas usage during this two-year period.”

The actions underscore the tight supply/demand balance that exists in major parts of the region, from downstate New York to New England, but adding new capacity in this region is seldom easy.

In 2019 a few communities in California and Massachusetts enacted local building ordinances to prohibit gas (and other fossil fuel) connections for new customers, citing environmental concerns and the desire for an all-electric system.

Nevertheless the utilities in the region continue to strive to meet customer demand and support reliability, affordability, and a sustainable environment and economy.

Assessing the Future Role of Natural Gas As Interest in Decarbonization and Electrification Grows

The benefits of natural gas – lower price, lower emissions, domestic supply – contribute to continued levels of customer conversions and new customer development.



The natural gas industry recognizes the interest of policymakers, regulators, customers, and the public in decarbonizing the energy system as much as possible. Natural gas utilities have proposed various pathways to decarbonization, including greater efficiency, incorporation of renewable natural gas, and the accelerated replacement of older, more “leak-prone” system components. Several utilities have proposed pathways that in-

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clude a strategic role for natural gas. For example, Con Edison’s “Smart Solutions” proposes multiple options, including gas demand response, non-pipeline solutions, enhanced energy efficiency, gas innovation, and parallel planning for a pipeline. In April 2019 National Grid released “Delivering the Future of Heat,” which includes a program to facilitate RNG interconnections, an expanded geothermal pilot, a green gas tariff, a power-to-gas pilot project, and a hydrogen blending study. In June 2019 Central Hudson Gas & Electric issued “Powering the Path to a Cleaner Future.” The utility noted its “commitment to making investments in infrastructure and technology that cost effectively reduce carbon emissions, while continuing to provide reliable, resilient, and affordable power.” One of the central parts of its strategy is “integrating natural gas benefits.”

Concurrently, several national and regional advocacy groups and consultants are promoting “strategic electrification” or “beneficial electrification” as the new overarching energy system paradigm, under which all systems – heating, power generation, and transportation – would operate via electricity, and that fossil fuels would be substantially reduced and eventually eliminated.

The costs and practicality of electrification are a concern. In mid-2018, the American Gas Association (AGA) released “Implications of Policy-Driven Residential Electrification” prepared by a cross-discipline team of experts at ICF, who assisted in the evaluation of AGA’s residential electrification policy scenarios focused on space and water heating. The report found that policy-driven electrification could be “burdensome to consumers and to the economy”; “have profound impacts and costs on the electric sector”; and be “a very costly approach for a relatively small reduction in emissions.”

ACEEE has released several studies that see value in converting homes heated with heating oil and propane to electricity, but find less value in converting natural gas homes, especially in colder climates. In a September 2018 blog post, Steven Nadel of ACEEE wrote: “For the residential sector, recent ACEEE research has found that some applications (oil- and propane-heated homes and homes in the South) can meet the criteria for beneficial electrification discussed above. For these applications it can make sense to electrify the next time a heating or cooling system or water heater needs to be replaced. But for many homes, electrification may not currently make sense and as a result, natural gas use will likely continue for decades, particular-



A compressor station on the TGP system in New Hampshire.

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ly in the North.”

In January 2019, NYSERDA released “New Efficiency: New York - Analysis of Residential Heat Pump Potential and Economics,” assessing the potential of residential heat pumps. It noted that “generally, installations replacing natural gas have negative IRRs.” (page 55)

The importance of natural gas as a reliable balancing fuel for offshore wind remains generally acknowledged. In its April 2018 “National Electrification Assessment,” the Electric Power Research Institute (EPRI) noted the central role for gas in power generation over the next several decades. “Natural gas use continues to grow in all four EPRI scenarios based on its operational flexibility and an assumed cost of around \$4/MMBtu...Direct gas use in industry and gas-fired electric generation grows while gas use in building heat remains relatively flat over time.” (page 42)

The growing interest in electrification and a relative ambivalence about the future role of natural gas in some policy circles was addressed in a May 2017 paper from the Natural Regulatory Research Institute (NRRI), “Questioning the Future of Natural Gas:” “A reasonable argument is that U.S. and state energy policy should encourage the use of natural gas for different uses rather than its suppression. A proper balancing of economic and environmental considerations would likely reach that conclusion. Those who advocate less natural-gas usage generally skew their finding by giving little if any weight to the economic effects....Climate change concerns should certainly be a factor in developing energy policy, but not the sole or even overriding factor.”

In November 2019, the International Energy Agency (IEA) released its latest “World Energy Outlook,” which noted the strong growth of natural gas worldwide, a growth pattern that is expected to continue: “Natural gas had a remarkable year in 2018, with a 4.6% increase in consumption accounting for nearly half of the increase in global energy demand. We asked in 2011 whether the world might be poised to enter a ‘Golden Age of Gas’, and now it appears that global gas consumption is very close to those 2011 projections.”

IEA also noted that gas faces global headwinds as well: “However, the gas industry faces some commercial and environmental challenges as well as some major variations in the storyline in different parts of the world.”



Infrastructure Siting Challenges and Regulatory Delays

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Energy infrastructure has always encountered siting issues. Examples include siting wind turbines on mountain ridges or offshore, nuclear power almost anywhere, and electric and gas transmission.

Siting challenges for fossil fuel projects appear to have reached a new level in the U.S. and Canada in a time of growing awareness of climate change. Today’s increasing “dependence” on natural gas is viewed as an obstacle to the deployment of “clean energy.” Fossil fuels should stay in the ground and new infrastructure should be stopped, some argue, lest, once built, it remains in service for decades and restrains the use of renewables.

In the U.S., delays at the state level, particularly regarding the issuance of state water quality certificates, are adding to project costs and prolonging uncertainty. To secure federal approval, natural gas pipeline projects must demonstrate market need and financial viability, and their routes must meet environmental requirements. Contract commitments by proposed customers or shippers are essential to the process.

The Northeast region, as a highly congested area, poses challenges for any energy development. Local concerns about the impacts of new developments are often amplified by social media. Thus, utilities need to improve their stakeholder outreach, advocate the benefits of energy infrastructure, and bring new customers to the table. Public policy requires all sides to weigh the costs and benefits in order to move beyond polarization.

Environmental Considerations and Accomplishments

Environmental issues will remain central to debates about energy system usage and infrastructure expansion. The natural gas industry can contribute by noting past progress and offering future solutions.

Reductions in air emissions from power generation

Because natural gas compares favorably to other fossil fuels regarding air emissions, it remains 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

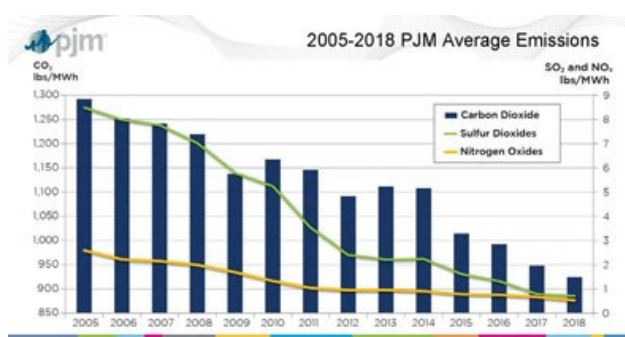


Chart: PJM, May 2019

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“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.”

In 2019, the EIA reported that energy-related CO₂ emissions in the U.S. rose in 2018, but were 12% below the 2005 levels, mostly because of changes in the electric power sector: “In recent years, the U.S. electricity generation mix has shifted away from coal and toward natural gas and renewables. The shift from coal to natural gas lowers the CO₂ emissions’ intensity because natural gas produces lower emissions per unit of energy used than coal and because natural gas-fired generators typically use less energy than coal plants to generate each kilowatt-hour of electricity.”



Photo: PA DEP

At the regional level, air emission trends remain favorable. NY ISO reported that emissions rates from the power sector dropped by 51% for CO₂, 89% for NO_x, and 98% for SO₂ over the last two decades. ISO-NE reported that from 2001 to 2017, total emissions from power plants in New England declined by 98% for SO₂, 74% for NO_x, and 34% for CO₂.

In December 2018 ISO-NE stated: “This ongoing trend to meet electricity needs with higher-efficiency, lower-emitting gas-fired generators instead of oil- and coal-fired generators has been the biggest contributor to the long-term decline in regional emissions.”

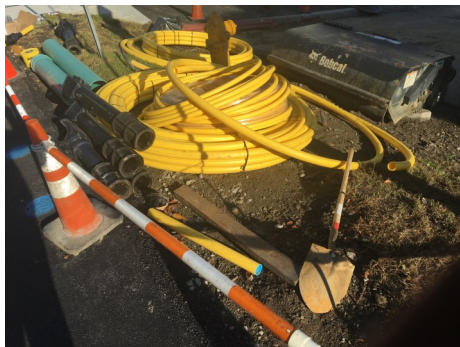
PJM reported substantial declines in NO_x, SO₂, and CO₂ from 2005 to 2018 (see chart).

Reductions of methane emissions in natural gas system operations

The natural gas industry is cognizant of its responsibility to reduce emissions throughout its system operations. Many of NGA’s distribution and transmission company members participate in the EPA’s Natural Gas STAR Program and progress continues on this front. In 2018, Natural Gas STAR partners reported methane emissions reduction of 130.6 Bcf in the U.S., providing “cross-cutting benefits” according to EPA. Reducing pipeline leaks is of paramount interest (see section on infrastructure replacement below).

Natural gas systems in total account for about a quarter of all U.S. methane emissions, or nearly 3% of all U.S. greenhouse gas (GHG) emissions. Since 1990, methane emissions related to the U.S. natural gas system have declined by 14.2%, according to the EPA’s April 2019 national GHG inventory report. The report, reflecting 2017 data, noted: “The decrease in transmission and storage emissions is

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largely due to reduced compressor station emissions (including emissions from compressor and equipment leaks)...Distribution system emissions, which account for 7 percent of CH₄ emissions from natural gas systems and less than 1 percent of non-combustion CO₂ emissions, result mainly from leak emissions from pipelines and stations. An increased use of plastic piping, which has lower emissions than other pipe materials, has reduced both CH₄ and CO₂ emissions from this stage, as have station upgrades at metering and regulating (M&R) stations. Distribution system CH₄ emissions in 2017 were 73 percent lower than 1990 levels.”

In the distribution sector, the main emphasis is to accelerate the replacement of older, potentially more “leak-prone” pipe. 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.

The latest GHG data from New York indicated that methane emissions related to “natural gas leakage” have declined by 20% in the last dozen years; in Massachusetts, methane emissions from natural gas systems declined by 67% since 1990.

Shale gas development

Development of shale gas in the U.S. 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.” An October 2011 paper by the National Regulatory Research Institute (NRRI) noted 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 flow-

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back water on the surface.” Proper procedures and oversight are necessary at all stages of the process.

The Pennsylvania DEP’s “2017 Oil and Gas Annual Report” released in August 2018 noted: “Although there is no evidence that hydraulic fracturing has resulted in a direct impact to a water supply in Pennsylvania, there are cases where related oil and gas activities have adversely affected private water supplies. DEP investigates all stray gas-related complaints and if it is determined that a water supply is adversely affected by oil and gas activities, DEP works with the responsible operator to ensure the water supply is restored or replaced.”

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

Accelerated Pipeline Replacement

Related to safe operations and environmental performance is the accelerated replacement and repair of older pipeline system components (pipes constructed of bare steel or cast-iron) that are considered more “leak-prone.” The U.S. Department of Energy observed in January 2017: “Safety remains the primary policy driver for LDC pipeline and infrastructure repair programs. However, the significance of methane emissions is becoming more recognized and companies, regulators, and other stakeholders are seeking ways to incorporate emission reductions into utility programs while limiting the cost to consumers.”

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, but those percentages are declining as system replacement continues.

Pipeline Safety Management and Public Awareness

Pipeline safety is always a priority for the industry. Federal and state regulatory requirements are extensive, and recent regulations have been announced to enhance operations safety, from transmission and



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distribution integrity management to control room operations. While the rate of incidents is declining nationwide at gas transmission and distribution levels, “high profile, high consequence” incidents, as termed by PHMSA, have occurred in California, Pennsylvania, New York, and Massachusetts.

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 by using methods like “accelerated infrastructure replacement.”

NGA and its members continue to work on important initiatives in the areas of public awareness and new technologies. NGA introduced a “First Responder utility online safety training program” based on an award-winning program developed by National Grid.

Following the September 13, 2018 Merrimack Valley incident north of Boston which had widespread impact in three communities and received widespread attention, Massachusetts Governor Charlie Baker led the state’s gas utilities to commit to implementing a pipeline safety management system (PSMS).

NGA is presently leading an initiative of Massachusetts and other utilities in the region to implement PSMS. The utilities and regulatory agencies are also incorporating analyses from the National Transportation Safety Board (NTSB) and PHMSA’s recommendations.

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, and wood waste, and food waste plants.

In the Northeast there is growing interest in implementing RNG. Some examples include:

- Vermont Gas in 2018 became the first utility in the nation with a retail RNG offering.
- National Grid has been an active proponent for many years of incorporating biogas into the natural gas system.



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- In fall 2018, Con Edison announced a plan to construct up to three renewable gas facilities that would convert food waste, sludge, yard, and other waste into natural gas. The projects would reduce the need for conventional natural gas by up to 7,100 dekatherms on a peak winter day.
- In fall 2018 Liberty Utilities in New Hampshire announced an RNG project to capture the gas currently being produced by decomposing organic matter at the Bethlehem, NH landfill and process it to match the chemical composition of conventional natural gas. The project is expected to provide approximately 475,000 dekatherms of RNG annually in the first 10 years of operation, all of which will be used to serve customers in New Hampshire. Liberty Utilities noted: “The supply of RNG from the Bethlehem landfill represents approximately 6% of Liberty Utilities’ total annual sales in New Hampshire. Capturing, cleaning and using this gas not only combats climate change, it also reduces emissions at the landfill.”
- In spring 2019, Summit Natural Gas of Maine announced that it will partner with the dairy industry to develop home-grown RNG by constructing an anaerobic digester in Clinton, the state’s dairy capital. Summit Natural Gas plans to match 5 percent of its Maine residential gas demand for the next year by purchasing renewable gas attributes (similar to carbon credits) at no cost to ratepayers.

In September 2019, NGA and GTI released “Interconnect Guide for Renewable Natural Gas in New York State.” The report was sponsored by and developed in coordination with several New York natural gas utilities. While developed for New York State, the report provides a guideline for RNG pipeline interconnections that will be applicable and of value throughout the U.S. and Canada. It provides a framework and technical guidance by which project developers and the local gas utility can use common core principles and a rigorous technical framework to facilitate maximizing the acceptance and introduction of RNG into the natural gas pipeline network.

Natural Gas Vehicles

Natural gas vehicles (NGVs) are 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 (NO_x) relative to commercial diesel engines.”

The market for heavy-duty vehicles remains strong especially for the bus and refuse truck sectors.

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Even though CNG fueling stations are being added, availability remains relatively limited in the region. UGI opened a new CNG station in 2019 in Pennsylvania, and the first CNG station in the Bronx began operations in July 2019 (incorporating RNG).

In New York, CNG “virtual pipeline” facilities have been proposed for several locations. In fall 2018, Con Edison announced plans for “the construction of two to five compressed natural gas (CNG) and liquefied natural gas (LNG) storage sites in Westchester County. The supply would reduce the need for conventional natural gas pipeline supplies by 40,000 dekatherms on peak winter days.”

Massachusetts and Pennsylvania have LNG fueling stations, and some initiatives are underway in the U.S. and Canada for “LNG highways” to establish fueling stations to facilitate truck travel. There is also some interest in using LNG as a fuel for heavy-duty trucks that travel defined routes and even for marine transportation such as ferries and cruise ships.



A new CNG vehicle fueling station opened in the Bronx, NY, summer 2019. Photo: Clean Energy

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. NYSEARCH is also conducting an evaluation and test program for methane emissions technology, and evaluating residential methane detector technology.

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



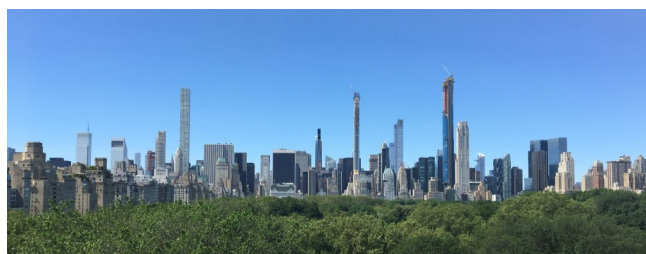
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NGA and its members continue to support innovative advances in natural gas technology.

The Year Ahead

NGA will continue to post updates throughout the year at:

www.northeastgas.org



II.

REGIONAL ENERGY OVERVIEW

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

Among the areas addressed are:

- *economic profile*
- *primary energy mix*
- *electric generation mix*
- *state energy consumption.*

NORTHEAST ECONOMIC PROFILE

STATE	POPULATION (2018)	HOUSEHOLDS (2018) [occupied housing units]	LABOR FORCE (Sept. 2019) [thousands]	GROSS DOMESTIC PRODUCT (GDP) (2019, 1 st qtr) [\$ billions]	GDP as % OF U.S. TOTAL (2018)	PER CAPITA PERSONAL INCOME (2018)
Connecticut	3,573,665	1,378,091	1,911	282	1.3	\$76,456
Maine	1,338,404	570,307	691	66	0.3	\$48,905
Massachusetts	6,902,149	2,624,294	3,839	582	2.8	\$71,683
New Hampshire	1,356,458	531,212	772	87	0.4	\$61,294
New Jersey	8,908,520	3,249,567	4,476	640	3.0	\$68,236
New York	19,542,209	7,367,015	9,519	1,720	8.2	\$68,668
Pennsylvania	12,807,060	5,070,931	6,491	809	3.8	\$56,225
Rhode Island	1,057,315	406,573	555	62	0.3	\$54,850
Vermont	626,289	261,373	346	34	0.2	\$54,173
U.S.	327,167,434	122,735,000	164,039	21,060	100	\$54,420

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

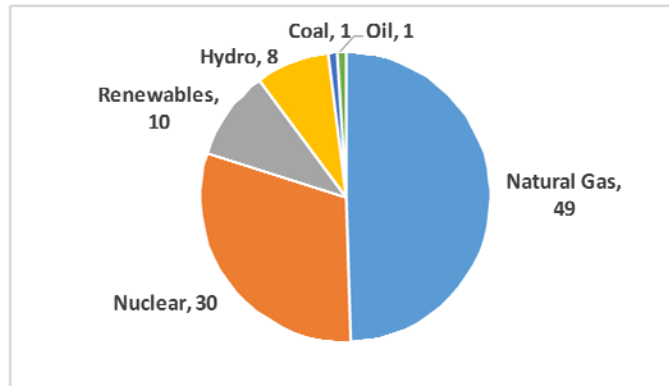
	Natural Gas	Oil	Nuclear	Renewables	Coal	Electric Flows
CT	34	41	24	6	<1	-6
ME	12	47	-	40	-	-4
MA	32	39	4	7	<1	17
NH	17	48	33	21	2	-20
NJ	34	42	17	4	<1	2
NY	35	35	12	13	<1	3
PA	32	27	20	5	15	
RI	51	42	-	4	-	
VT	9	58	0	30	-	-23
US	29	37	9	11	14	

*Sources: U.S. Energy Information Administration (EIA), "State Energy Data Report 2017," released 2019. Electric flows shown for states where numbers make material difference. * Vermont imports 23% as well.*

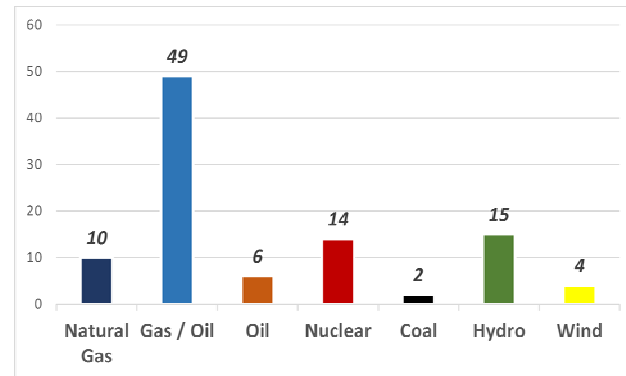
ELECTRIC GENERATION FUEL SOURCE

(% of total)

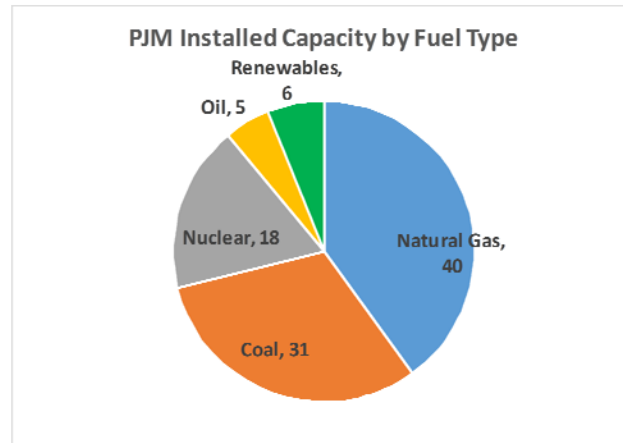
NEW ENGLAND



NEW YORK



PJM



Sources:
 ISO New England,
 2018 sources of total
 electric energy produc-
 tion;
 NY ISO, 2019 "Power
 Trends";
 PJM, "2018 Regional
 Transmission Expan-
 sion Plan, State Re-
 ports," released 2019.

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 2017," released 2019. 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 2017.

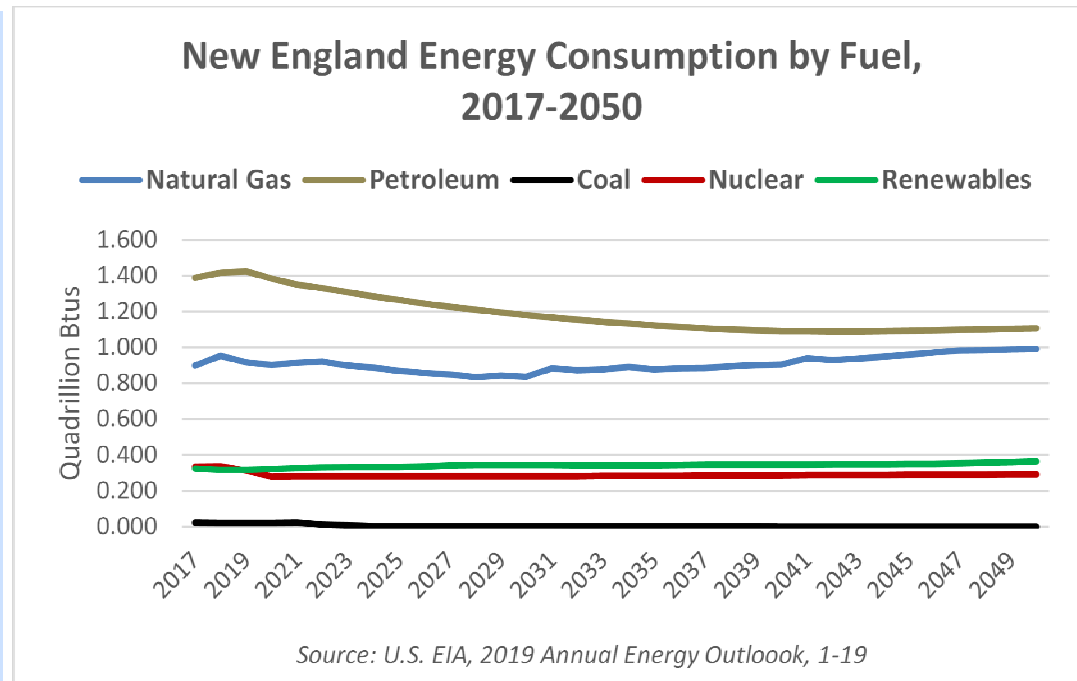
	Per Capita, 2017, Consumption		Natural Gas		Petroleum		Coal		Electricity	
	MMBtu	Rank	TBtu	Rank	TBtu	Rank	TBtu	Rank	TBtu	Rank
CT	203.2	46	246.2	35	311.2	33	2.5	47	96.0	37
ME	293.6	27	45.1	48	191.2	41	2.2	48	38.3	44
MA	207.5	45	462.8	21	577.0	20	12.4	43	179.2	27
NH	235.2	41	53.7	47	159.2	46	3.6	45	36.8	47
NJ	240.2	39	734.1	11	941.8	10	16.5	40	250.4	20
NY	188.1	50	1,280.1	6	1,338.5	5	19.6	38	494.7	5
PA	297.7	26	1,403.7	5	1,241.9	7	669.5	6	487.9	6
RI	174.0	51	94.8	44	80.3	50	-	50	25.2	49
VT	206.4	45	12.3	50	80.8	49	-	51	18.5	51
<i>Northeast</i>			4,332.8		4,921.9		726.3		1,627.0	
<i>U.S.</i>	300.2		28,110.0		37,460.9		13,839.6		12,704.1	

PROJECTED ENERGY CONSUMPTION GROWTH, NEW ENGLAND

U.S. EIA projects natural gas to grow at an annual rate of 0.1% in New England through 2050.

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

- Renewables, 0.4%
- Coal, -11.1%
- Nuclear, -0.4%
- Oil, -0.8%.



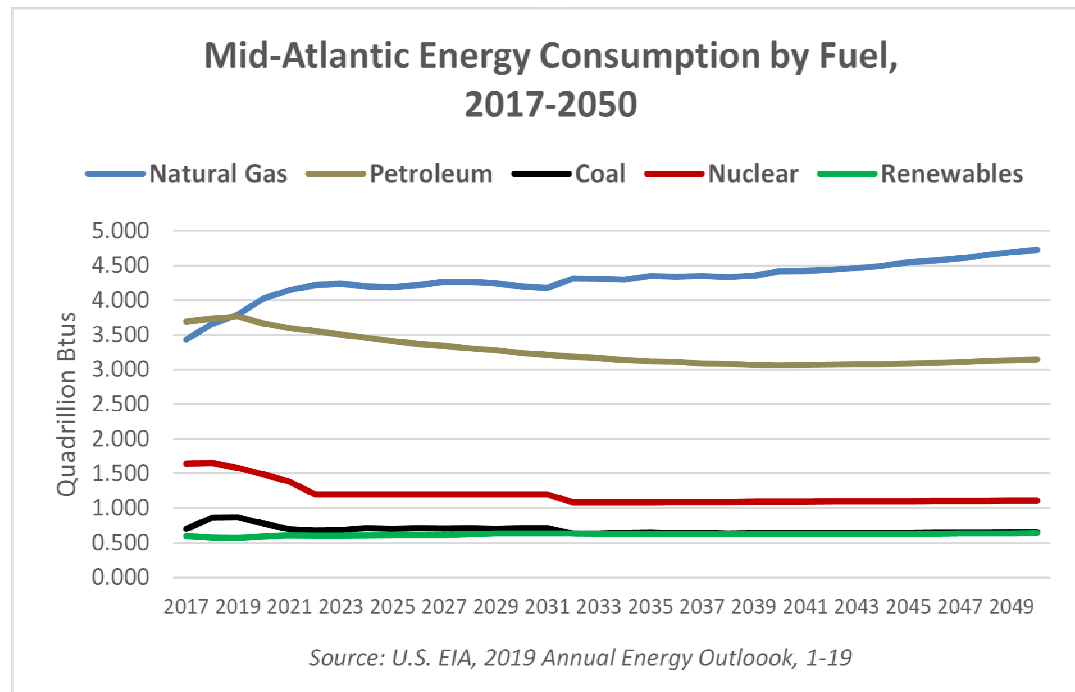
Source: U.S. Energy Information Administration, "2019 Annual Energy Outlook"

PROJECTED ENERGY CONSUMPTION GROWTH, MID-ATLANTIC

U.S. EIA projects natural gas to grow at an annual rate of 0.8% in the Mid-Atlantic region through 2050.

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

Renewables, 0.3%
Coal, -0.8%
Nuclear, -1.2%
Oil, -0.5%.



Source: U.S. Energy Information Administration, "2019 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 Partners, an Enbridge company. 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 3.08 Bcf/d.

Columbia Gas Transmission, Inc. is a subsidiary of TC Energy and is headquartered in Houston, TX. The company serves customers along its 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 more than 650 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. CET falls under the oversight of the Federal Energy Regulatory Commission. CET operates Con Edison Gas Pipeline and Storage, LLC, which invests in gas pipeline and storage businesses. In January of 2016, Con Edison Transmission announced its first investment in natural gas infrastructure with the Mountain Valley Pipeline. CET also formed a joint venture with Crestwood Equity Partners, known as Stagecoach Gas Services. Stagecoach Gas Services operates 41 billion cubic feet of storage capacity and approximately 185 miles of pipeline. Con Edison Transmission owns a 71.2% stake in Honeoye Gas Storage. Honeoye Gas Storage is a 6.7 Bcf natural gas storage field located in Ontario County, NY.

Dominion Energy 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 Energy Transmission, Inc. maintains 3,900 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.

Empire Pipeline is a subsidiary of National Fuel Gas Company. Empire is a 24-inch diameter natural gas transmission pipeline that originates at the U.S./Canada border at Niagara, and extends easterly 249 miles from Buffalo, NY to near Syracuse and then south to Corning. Constructed in 1992 and in service since 1993, Empire has a rated capacity in excess of 750 million cubic feet per day.

Everett LNG, a subsidiary of Exelon Generation (Constellation), operates an LNG import terminal in Everett, MA. 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, formerly known as Distrigas, has received over 1,200 cargoes, and served more than 350,000 truck loads.

Excelerate Energy operates the Northeast Gateway Deepwater LNG Port facility located approx. 13 miles offshore near Cape Ann, MA. The facility received its first shipment in May 2008. The physical infrastructure consists of a dual subsea buoysystem and an approx. 16 mile long pipeline connecting into the HubLine pipeline operated by Algonquin Gas Transmission. The Northeast Gateway infrastructure is designed to accommodate gas deliveries up to 800 million cubic feet per day.

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 TC Energy 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 1.7 Bcf/d. It interconnects with TransCanada, Dominion, Tennessee and Algonquin.

Maritimes & Northeast Pipeline (M&NE) is a partnership of Enbridge, Emera and ExxonMobil. It transports gas between New England and the Canadian Maritimes. The total pipeline is 684 miles. U.S. capacity is 833 MMcf/d; its capacity in Canada is 555 MMcf/d. It interconnects with the PNGTS system in Westbrook, ME.

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 TC Energy/Columbia Pipeline Group, National Grid and DTE Energy. It began commercial operations in December 2008. It interconnects with eight systems. Its winter peak day is about 1.7 Bcf/d.

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.

Neptune LNG is an LNG facility located approximately ten miles off the coast of Gloucester, MA. It is owned by ENGIE. It was completed in 2010. It connects with Enbridge's underwater HubLine system via a 13 mile-interconnect. It was designed to deliver from 400 to 750 million cubic feet per day. It has been inactive since its start-up. It requested a multi-year suspension of its operating license in 2013 from the U.S. Maritime Administration (MARAD) which was granted. In December 2017, Neptune requested an extension of the license suspension from MARAD. The suspension was extended by MARAD in 2018 for another four years, or until 2022. MARAD notes: "the Neptune Port has remained inactive over the past several years and will likely remain inactive for the foreseeable future. For these reasons, Neptune requested MARAD's authorization to formally suspend port operations for a period of four years. The suspension period became effective June 26, 2018, and will extend for a period of four years, to be measured in calendar days."

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 TC Energy system. It has a capacity of about 100 Dth/day.

Portland Natural Gas Transmission (PNGTS) is sponsored by an international consortium of energy companies - TC Pipelines LP and Energir. It transports western Canadian gas and Marcellus gas to New England markets at Dracut, MA and to Maine/Atlantic Canada markets at Westbrook, ME. 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 240 Dth/d. It interconnects with the Maritimes & Northeast Pipeline at Westbrook, ME; from there, the Joint Facilities line extends to Dracut, MA.

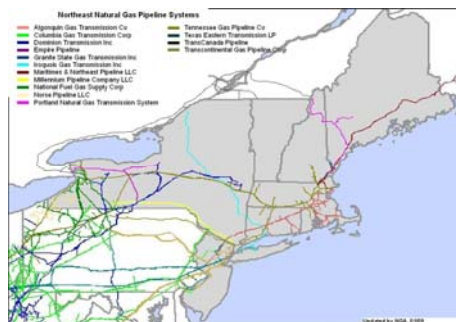
Repsol operates the Canaport LNG facility located in Saint John, New Brunswick, Canada; its project partner is Irving Oil. The facility received its first shipment in June 2009. The physical infrastructure consists of three storage tanks with total capacity of 9.9 Bcf. The terminal has a maximum sendout 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 400 Bcf to the market. The facility marked its 10th year of operation in 2019.

Tennessee Gas Pipeline Company is a business unit of Kinder Morgan. The Tennessee Gas Pipeline has 11,750 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 109 Bcf of storage. It recorded a systemwide peak day of 11.7 Bcf/d in January 2019.

Texas Eastern Transmission Company is a business unit of Spectra Energy Partners, an Enbridge company. Its system incorporates approximately 9,096 miles of pipe, from the U.S. Gulf Coast to New Jersey. Its peak capacity is 10.84 Bcf/d, with storage of 74 Bcf.

TC Energy (formerly known as 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 650 Bcf of working gas storage capacity. It acquired the Columbia Pipeline Group in the U.S. in 2016.

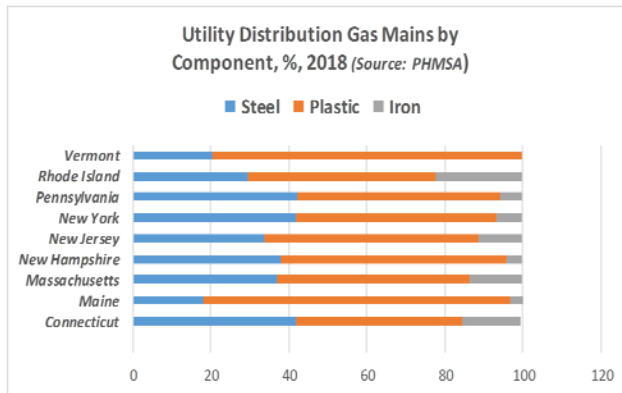
Transcontinental (Transco) is a subsidiary of Williams Company. The Transco pipeline comprises a 10,200-mile pipeline system, extending from South Texas to New York City. The system design capacity is 15.8 billion cubic feet per day. In the Northeast, it provides gas service to New York City, New Jersey 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.

The chart below shows percentage of pipeline mains by material by state as of 2018. 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 58% of all U.S. miles of main and 74% of services.



STATE / U.S.	DISTRIBUTION MAIN MILES	TRANSMISSION MILES
Connecticut	8,168	598
Maine	1,285	507
Massachusetts	21,714	1,134
New Hampshire	1,989	251
New Jersey	35,007	1,566
New York	49,307	4,583
Pennsylvania	48,501	10,365
Rhode Island	3,201	95
Vermont	862	119
U.S. total	1,307,699	301,558

Source: PHMSA, U.S. Department of Transportation, 2018 data.

NORTHEAST PIPELINE PROJECTS IN PROCESS

Several infrastructure projects were placed into service in the region in 2019, even as several more have been delayed due to state environmental reviews. Several other projects are in the regulatory and development process for the period 2020-2022 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
Portland XPress	PNGTS	PNGTS has executed Precedent Agreements with several Local Distribution Companies (LDCs) in New England and Atlantic Canada to re-contract certain system capacity set to expire in 2019 as well as expand the PNGTS system to bring its certificated capacity up to 0.3 Bcf/d. The approximately \$80 million Portland XPress Project (PXP) will proceed concurrently with upstream capacity expansions. The in-service dates of PXP are being phased-in over a three-year period .	2019-20	Announced 3-17. Filed application with FERC for Phase I, 4-18. Phase I went in-service on Nov. 1, 2018 with volumes of 40,000 Dth/day. Phase II, approved by FERC, is scheduled for Nov. 2019 in-service. Phase III was approved by FERC, 7-19, and is scheduled to be in-service, Nov. 2020.
Westbrook XPress	PNGTS	Phase I increased the certificated capacity on the northern portion of its system from Pittsburg, New Hampshire, to Westbrook, Maine, by 42.4 Dth/d, effective November 2019. Phase II would add 63 Dth/d in 2021; Phase III would add 18 Dth/d by 2022.	Phase I, 2019; Phase II, 2021; Phase III, 2022	Filed with FERC, 12-18. Phase I completed, 2019.

This table is based on publicly-available information as of Nov. 2019; 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. 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.	2020	Filed with FERC, 3-17. FERC issued final environmental impact statement, 2-19. FERC issues certificate to build, 5-19. NYS DEC denies water quality certificate, 5-19. NJ DEP denies water quality certificate, 6-19. Williams resubmitted revised proposal to both agencies.
Atlantic Bridge	Enbridge	Incremental expansion on Algonquin and Maritimes & Northeast, to serve New England and Canadian Maritimes. Capacity of 132,700 Dth/d. Partial service began in Nov. 2017 at 40,000/day. Full project volumes available from New Jersey to Massachusetts as of fall 2019; final segment is proposed compressor station in Weymouth, MA.	Nov. 2017 (partial)/ 2020	Announced, Feb. 2014. Filed with FERC, Oct. 2015. FERC issues certificate, 1-17. FERC allows construction work to begin on certain facilities in CT, 3-17. Partial service began, Nov. 2017. FERC granted 2-year permitting extension, Dec. 2018. MA DEP issued air quality permit, 1-19. MA CZM issues permit, 11-19. FERC authorizes construction of station to begin, 11-27-19.
Empire North Expansion	Empire Pipeline	The proposed project enables Empire to provide an additional 205,000 dekatherms per day (Dth/d) of incremental firm interstate natural gas transportation service to local gas distribution markets and market centers in the northeastern United States and Canada.	2020	Open season concluded, Nov. 2015. Filed with FERC, 2-18. Approved by FERC, 3-19.
Gateway Expansion	Williams / Transco	Designed to create 65,000 dekatherms per day of firm transportation capacity for northeastern markets. Transco has executed precedent agreements with PSEG Power, LLC (PSEG) and UGI Energy Services, LLC for firm transportation service under the project.	2020	Filed with FERC, 11-17. Approved by FERC, Dec. 2018.

This table is based on publicly-available information as of Nov. 2019; project details may change.

NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
PennEast Project	AGL Resources, NJR Pipeline Company, South Jersey Industries, UGI Energy Services, Enbridge 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.	2020	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. FERC issued final EIS, 4-17. Approved by FERC, 1-18. State environmental review process continues.
Station 261	Tennessee Gas Pipeline / Kinder Morgan	The 261 Upgrade Projects will create 72,400 dekatherms per day (Dth/d) of additional transportation capacity of natural gas on the existing Tennessee Gas Pipeline system. Projects are located in Agawam, MA and include the Looping Project and the Horsepower (HP) Replacement Project. The Looping Project involves the installation of 2.1 miles of a 12-inch diameter pipeline loop that will run parallel and adjacent to an existing TGP pipeline. The company will also remove an inactive 6-inch diameter pipeline and replace it with the new 12-inch diameter pipeline loop upgrade in certain locations. The HP Replacement Project involves the replacement of two existing turbine compressor units with one new, cleaner-burning turbine compressor unit, as well as the installation of auxiliary facilities at TGP's existing Compressor Station 261. Customers are Columbia Gas of MA and Holyoke Gas & Electric.	Nov. 2020	Announced late 2017. Filed with FERC, 2018.
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.	2020	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. FERC grants 2-year extension, 11-18.

This table is based on publicly-available information as of Nov. 2019; project details may change.

NORTHEAST PIPELINE PROJECTS IN PROCESS (cont'd)

PROJECT	COMPANY	DESCRIPTION	EST. IN-SERVICE	STATUS
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.	2020	Announced spring 2012. Filed with FERC, 6-13. FERC 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. U.S. Court of Appeals for 2 nd District upholds NY DEC denial of certificate, 8-17. FERC finds that NYS DEC did not waive its authority in decision, 1-18. Constitution announces it will seek rehearing at FERC, 1-18. Constitution petitions U.S. Supreme Court, 1-18, re: U.S. Second Court of Appeals decision. Supreme Court declines to hear case, 4-18. FERC denies request for rehearing, 7-18. Pipeline developers announce they will appeal to federal district court, 7-18. FERC grants 2-year extension, 11-18. FERC issues order, 8-19, following Appeals Court decision, determining that the NYS DEC had waived its authority under the Clean Water Act by waiting too long to decide on certificate; FERC approves Constitution's ability to proceed.
Northern Access	National Fuel Gas Supply & Empire Pipeline	Capacity of 350,000 Dth/day on Empire, and 140,000 to be delivered to Tennessee 200 line. Approx. 99 miles of 24" pipeline and a compressor station upgrade and one new compressor station.	2022	Filed with FERC, March 2015. Approved by FERC, 2-17. NYS DEC denies water quality certificates, 4-17. FERC denies rehearing of its permit, 8-18, stating NYS DEC had waived its authority on water quality certificate by its delay in rendering decision. Federal appeals court rules that NY DEC did not provide sufficient information to support its denial of project's water quality certificate, 2-19.

This table is based on publicly-available information as of Nov. 2018; project details may change.

INCREASING GAS POTENTIAL IN THE U.S.

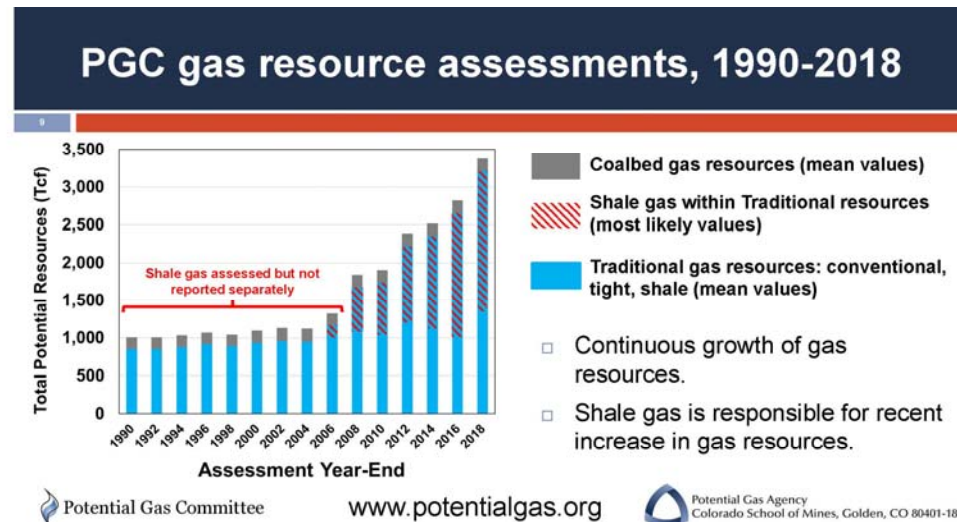
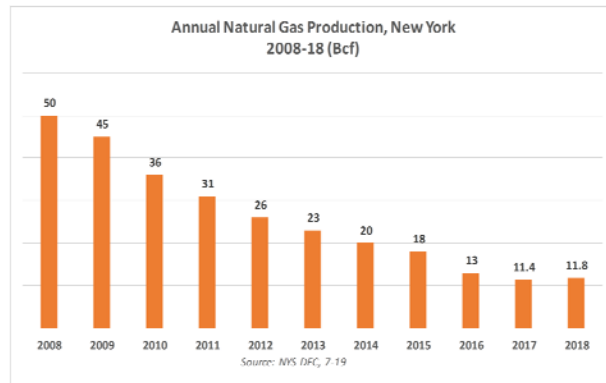


Chart: Potential Gas Committee, September 2019

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 2018 assessment, released in September 2019, 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 3,374 trillion cubic feet (Tcf). The 2018 assessment is “the highest resource evaluation in the Committee’s 54-year history.”

NATURAL GAS PRODUCTION IN NORTHEAST U.S.

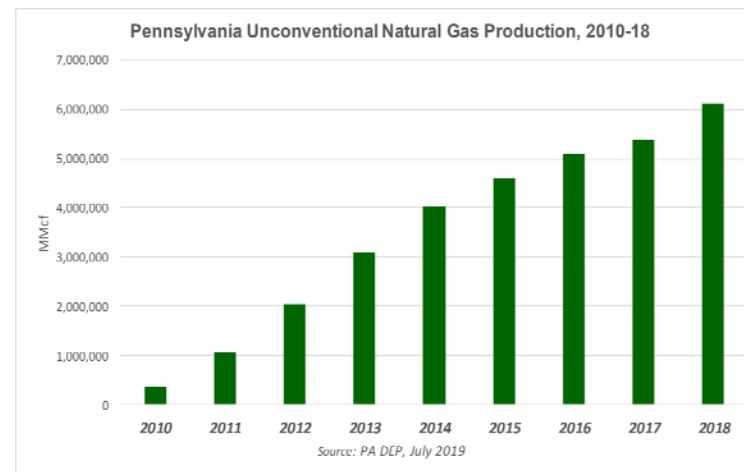


Source: NY State Dept. of Environmental Conservation/ Office of Oil & Gas

The New York State Department of Environmental Conservation / Division of Mineral Resources reports that gas production in the state in 2018 was 11.8 billion cubic feet (Bcf), a slight increase over the prior year. Annual production is less than one-third what it was in 2008. 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 based on data from the Pennsylvania DEP. State production in 2018 set a new record, at 6.1 Tcf.

Pennsylvania is the second largest producing state in the U.S., behind only Texas. EIA noted in August 2018 that Marcellus and Utica production “collectively accounted for about 29% of total [U.S.] production in July 2018. Recent infrastructure buildout in the region has allowed natural gas to move out of the region and has reduced the prevailing discount to the national benchmark price at Henry Hub and to regional prices.”



LNG SERVING NEW ENGLAND MARKET

Import facilities:

Everett LNG facility, Everett, MA (part of Exelon Generation/Constellation).
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 Excelebrate Energy.
- Sendout capability of 0.8 Bcf/d in vapor via underwater HubLine.

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 414 such facilities in the U.S., with demonstrated peak working gas capacity of 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 763 Bcf, which represents 8.2% 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 2.6% of the U.S. total.

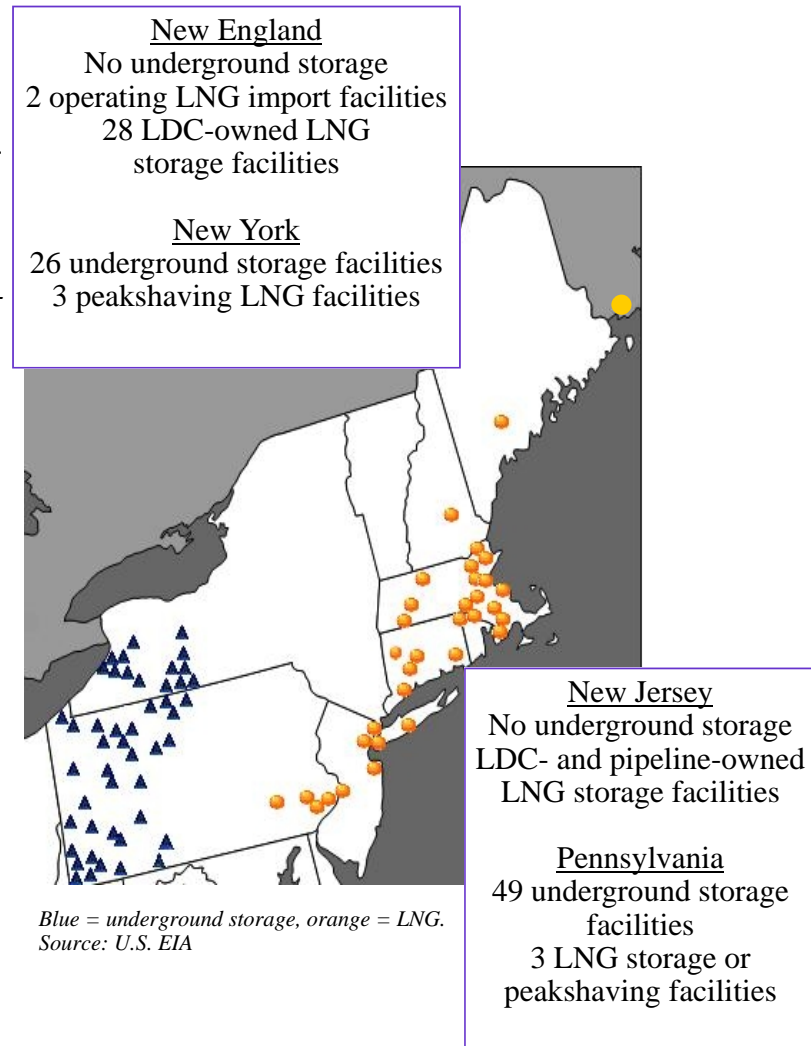
There is no underground storage in New England or New Jersey, as the map indicates, because of the unsuitability of the region's geology.

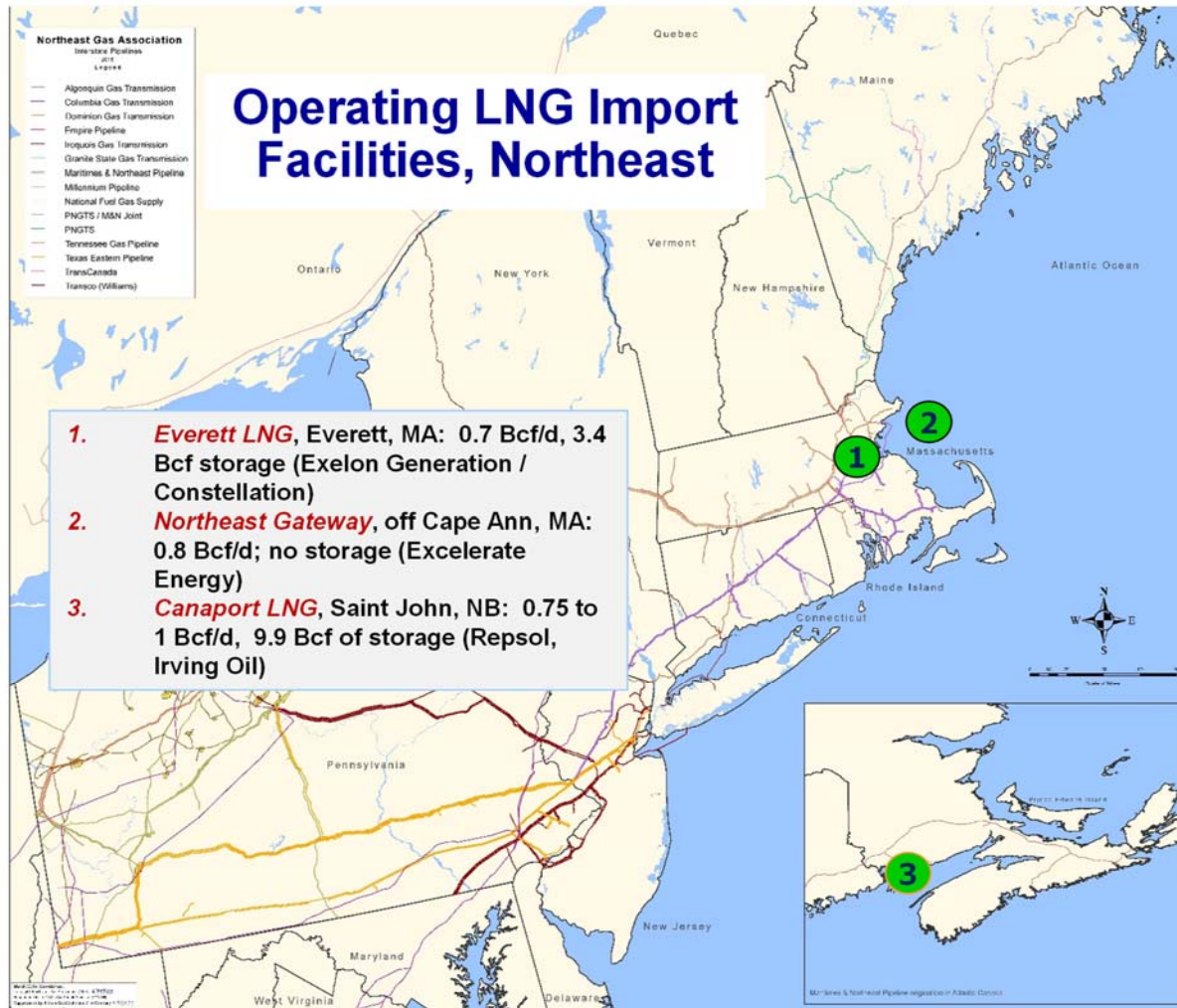
The region also accesses underground storage in Canada, notably the Dawn facility in Ontario.

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.

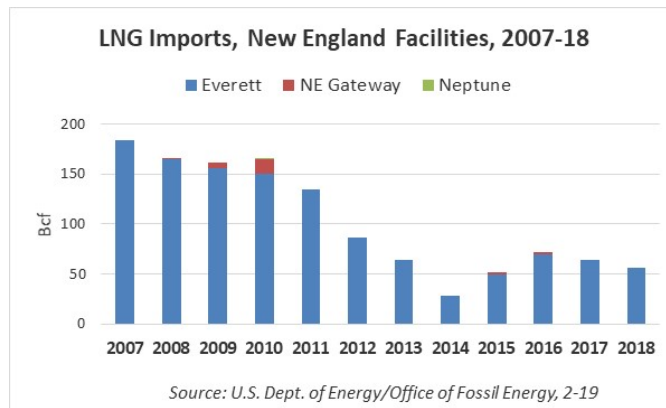
In addition, the LDCs operate above-ground LNG storage tanks for peak-shaving.

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 NORTH-EAST TERMINALS



LNG imports in 2018 by New England facilities totaled 56.3 Bcf, compared to 64 Bcf in 2017. The Everett LNG facility imported all of that total in 2018.

An offshore LNG facility - Northeast Gateway - imported no cargoes in 2017 or 2018, but did bring in volumes in January-February 2019, totaling about 5 Bcf.

The role of LNG remains critical to regional supply in the constrained Northeast market.

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

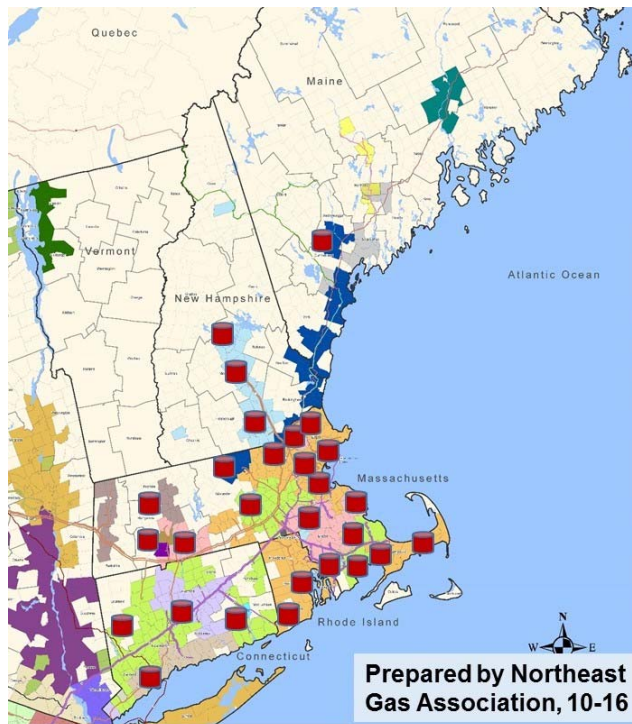
Liquefied natural gas (LNG) is an important component of the region's gas supply, especially for peak winter needs. The Everett LNG facility, a subsidiary of Exelon Generation, owns and operates a land-based facility at Everett, MA. There is also one operating facility located offshore near Gloucester, MA—Northeast Gateway—owned by Excelerate Energy. Another offshore facility owned by ENGIE called Neptune, also near Gloucester, MA, is currently decommissioned.

Repsol's Canaport LNG facility in nearby New Brunswick, Canada has supplied over 400 Bcf to the market since it began operation ten years ago, in 2009. It made 21 Bcf available to the regional market in 2018, via seven marine cargoes (source: National Energy Board of Canada). It sourced its supply in Trinidad, Norway, the Netherlands—and Louisiana, from the Sabine Pass facility.



LNG delivery trucks fueling at the Everett LNG facility, for transport to a local gas distribution company facility.

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. Overall, it represents about 27% of peak day supply for the region’s natural gas utilities. For some 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.

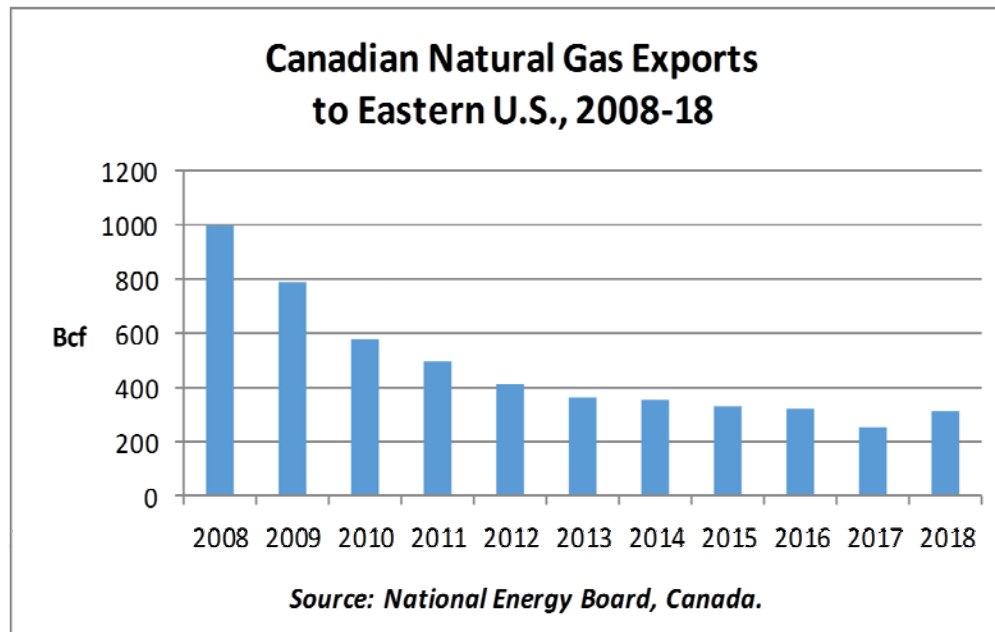
PROPANE / LP AIR: STORAGE CAPACITY AT NEW ENGLAND GAS LDCs

Year	Number of Communities with Facilities	Number of Tanks	Storage Capacity in MMBtu
2003	36	274	1,066,778
2018	13	94	341,426

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. Five natural gas utilities in New England still utilize propane within their supply portfolio, although the overall capacity has decreased substantially in the last two decades. (PECO Energy in Pennsylvania also utilizes LPG as part of its supply portfolio, along with LNG.)

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 above, Eastern U.S. imports have declined considerably over the last few years; Canadian gas exports to the Eastern U.S. are down by nearly 70% since 2008.

Overall, Canadian gas exports to the U.S. declined slightly in 2018, with exports to the U.S. Midwest the only point receiving greater volumes that year.

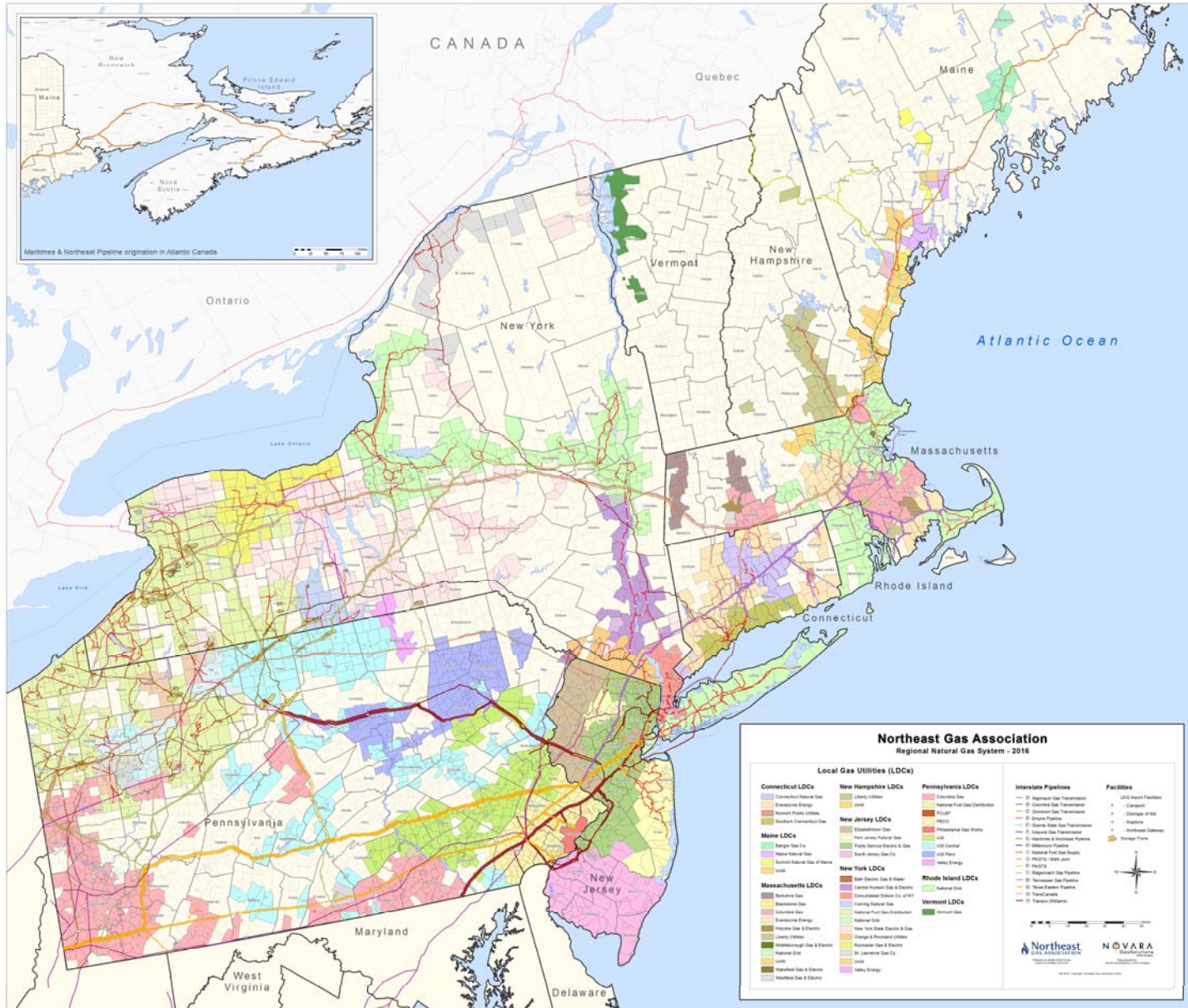
IV.

NATURAL GAS TRENDS IN THE NORTHEAST

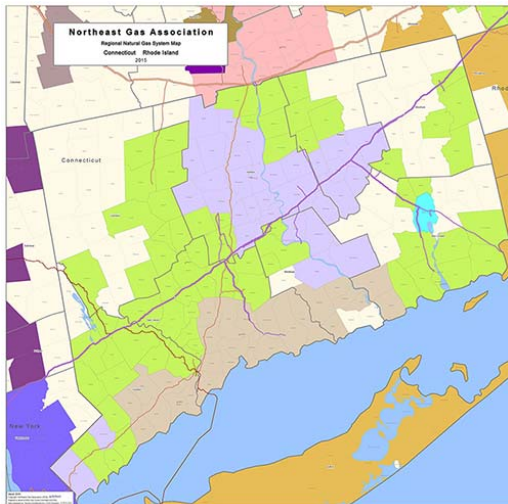
This section provides an introduction to the natural gas industry in the Northeast.

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 619,000 natural gas customers in the state.

Natural Gas Efficiency Program

Spending (2018):

\$42.9 million

Natural Gas Use in Connecticut

Primary energy: 34%

Electric generation via gas: 59%

% of households with gas as main heating fuel: 36%

Annual consumption: 272 billion cubic feet (Bcf) of natural gas.

Natural Gas Pipelines Serving Connecticut

- **Algonquin Gas Transmission**, a subsidiary of Enbridge.
- **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.

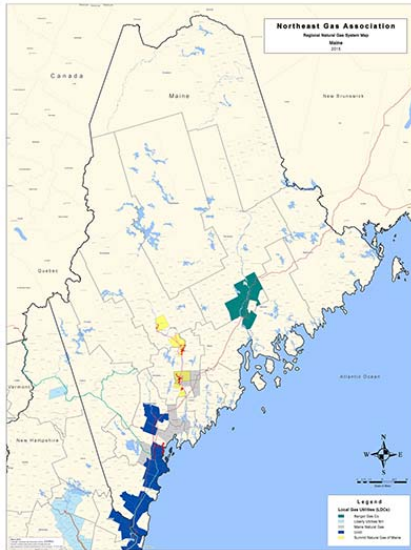
Underground Storage

None.

Natural Gas Production

None.

MAINE



Natural Gas Utilities in Maine

There are 4 natural gas utilities:

Bangor Natural 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: 12%

Electric generation via gas: 25%

% of households with gas as main heating fuel: 8%

Annual consumption: 45 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are approximately 48,000 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 TC Energy and Energir.
- **Maritimes & Northeast Pipeline.** It is owned by Emera, Enbridge 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.

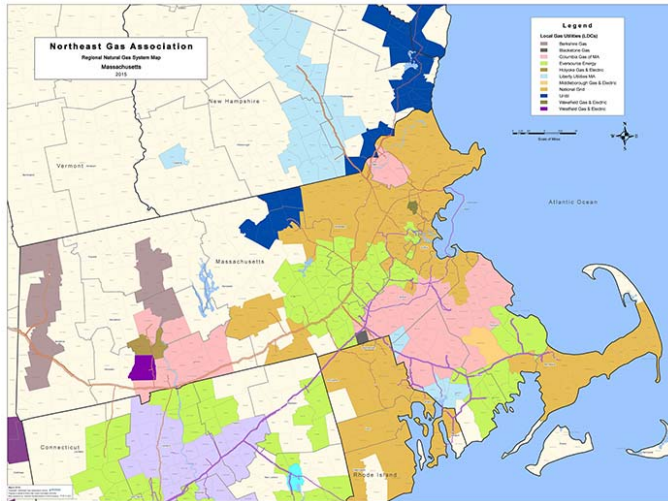
Natural Gas Production

None (although plans for RNG).

Natural Gas Efficiency Program Spending (2018):

\$1.5 million

MASSACHUSETTS



Natural Gas Pipelines Serving Massachusetts

- **Algonquin Gas Transmission**, a subsidiary of Enbridge.
- **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.

- **Everett LNG**, a subsidiary of Exelon Generation/Constellation
- **Northeast Gateway**, a subsidiary of Exceleerate 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: 32%

Electric generation via gas: 67%

% of households with gas as main heating fuel: 52%

Annual consumption: 430 billion cubic feet (Bcf) of natural gas.

Local Gas Utilities:

There are eleven natural gas utilities in the state.

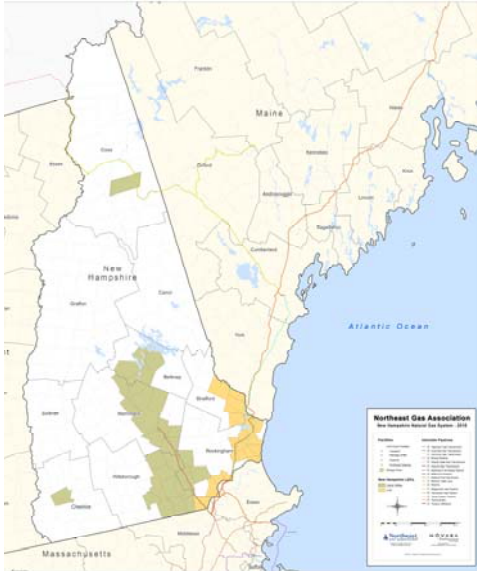
Natural Gas Utility Customers:

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

Natural Gas Efficiency Program Spending (2018):

\$249.3 million

NEW HAMPSHIRE



Natural Gas Utilities in New Hampshire

There are 2 natural gas utilities:

Liberty Utilities

(brown area on map)

Unitil Corp.

(orange area on map)

Natural Gas Use in New Hampshire

Primary energy: 17%

Electric generation via gas: 32%

% of households with gas as main heating fuel: 21%

Annual consumption: 49 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers :

There are approximately 126,000 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 TC Energy and Energir.
- ***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.

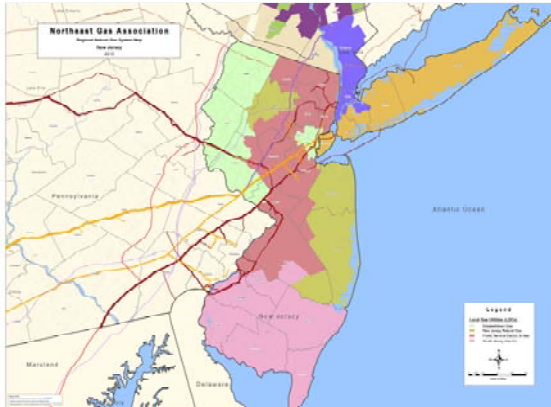
Natural Gas Production

None (although plans for RNG).

Natural Gas Efficiency Program Spending (2018):

\$7.9 million

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: 66%

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

Annual consumption: 764 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are 3 million natural gas customers in the state.

Natural Gas Pipelines Serving New Jersey

- ***Algonquin Gas Transmission and Texas Eastern Transmission,*** subsidiaries of Enbridge.
- ***Columbia Transmission,*** a subsidiary of TC Energy.
- ***Dominion Energy 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.

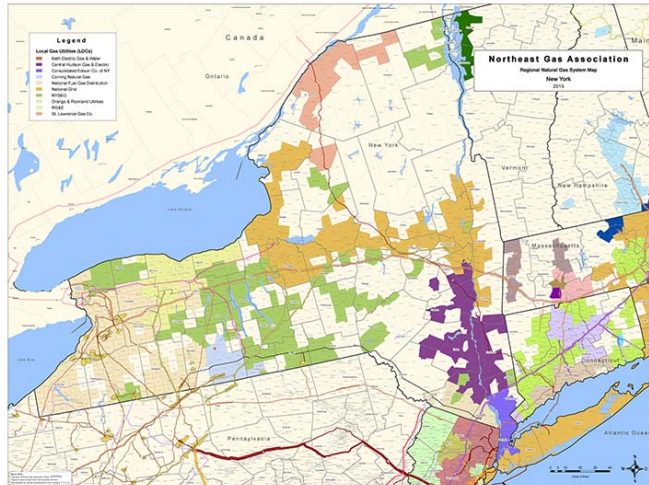
Natural Gas Production

None.

Natural Gas Efficiency Program Spending (2018):

\$90.1 million

NEW YORK



Natural Gas Use in New York

Primary energy: 35%

Electric generation capacity: 59%
(with oil)

% of households with gas as main heating fuel: 60%

Annual consumption: 1,323 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 2018, production was 12 Bcf.

Natural Gas Efficiency Program Spending (2018):

\$141.7 million

Natural Gas Pipelines Serving NY

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

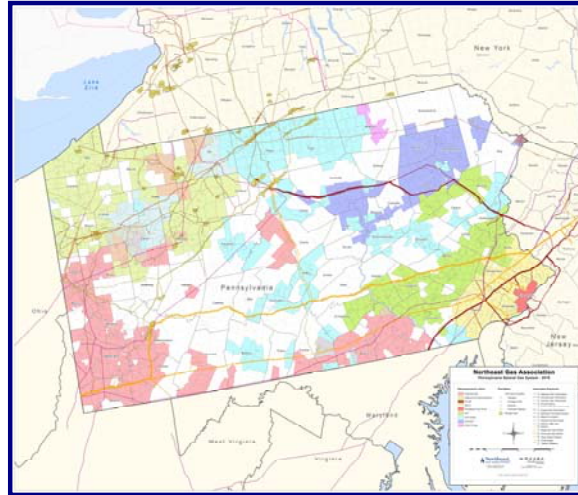
LNG Storage in New York

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

Underground Storage

246 Bcf.

PENNSYLVANIA



Natural Gas Use in PA

Primary energy: 32%

Electric generation capacity: 34%

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

Annual consumption: 1,189 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 3 million natural gas customers in the state.

Natural Gas Production

In 2018, production was 6.1 Tcf.

Natural Gas Pipelines Serving PA

- **Columbia Transmission (TC Energy)**
- **Dominion Energy Transmission**
- **Equitrans**
- **National Fuel Gas Supply**
- **Stagecoach Gas Services**
- **Tennessee Gas Pipeline Company**
- **Texas Eastern Transmission**
- **Transcontinental Pipeline.**

LNG Storage

There are four liquefied natural gas (LNG) facilities.

Underground Storage

763 Bcf.

Natural Gas Efficiency Program Spending (2018):

\$8.8 million

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: 52%

Electric generation capacity: >90%

% of households with gas as main heating fuel: 56%

Annual consumption: 99 billion cubic feet (Bcf) of natural gas.

Natural Gas Utility Customers:

There are approximately 268,000 natural gas customers in the state.

Natural Gas Pipelines Serving Rhode Island

2 natural gas pipelines transport gas:

- ***Algonquin Gas Transmission***, a subsidiary of Enbridge.
- ***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.

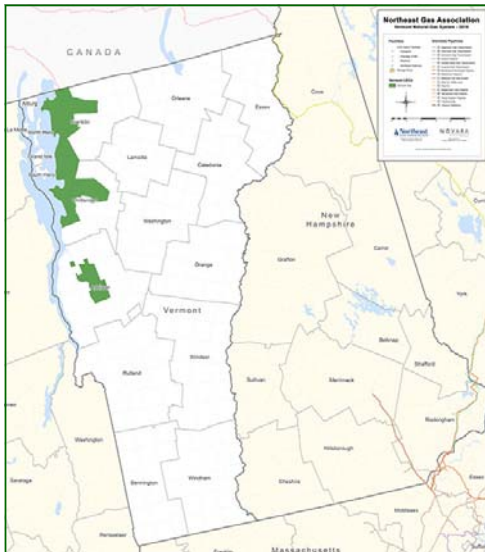
Natural Gas Production

None.

Natural Gas Efficiency Program Spending (2018):

\$27.2 million

VERMONT



Natural Gas Utility Customers :

There are 52,000 natural gas customers in the state.

Natural Gas Pipeline Supplying Vermont

1 natural gas pipeline transports gas to the VT border:

- ***TC Energy***

LNG Utility Storage in Vermont

None.

Underground Storage

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: 9%

Electric generation capacity: 0%

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

Annual consumption: 13 billion cubic feet (Bcf) of natural gas.

Natural Gas Production

None (although RNG process is in development).

Natural Gas Efficiency Program Spending (2018):

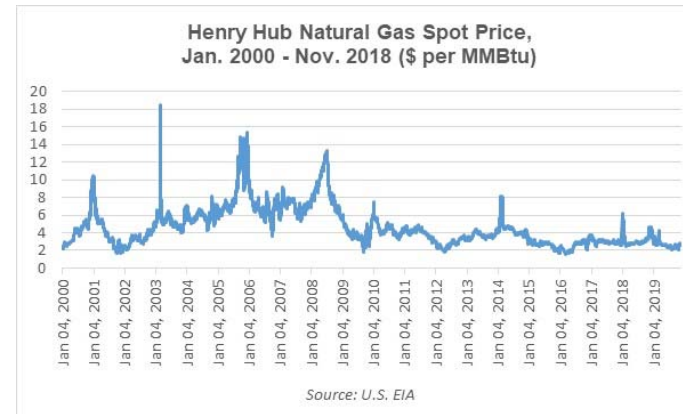
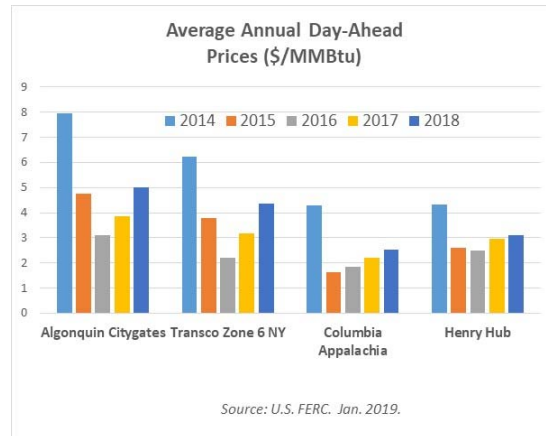
\$2.9 million

NORTHEAST STATES' ANNUAL NATURAL GAS CONSUMPTION BY SECTOR, 2018 (Bcf)

STATE	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	ELECTRIC POWER	TOTAL*
CT	53	58	25	136	272
ME	3	9	19	14	45
MA	130	118	48	134	430
NH	8	10	10	21	49
NJ	248	167	64	285	764
NY	486	330	91	415	1,323
PA	253	165	230	538	1,189
RI	20	13	9	57	99
VT	4	7	2	—	13

*Source: U.S. Energy Information Administration, "Natural Gas Annual 2018," released October 2019. Numbers are rounded off. Delivered energy consumption. * Vehicle fuel consumption not shown, which slightly increases total number for some states.*

NATURAL GAS PRICE TRENDS



U.S. natural gas prices in 2019 have continued on a generally stable and low path, in a period of continued strong production levels. As of fall 2019, U.S. EIA projects the 2020 Henry Hub price to be in the range of \$2.50.

The Northeast market however, remains vulnerable to greater spot price volatility compared to the national average, reflecting infrastructure constraints, as seen in the chart above on the left. The U.S. Dept. of Energy noted in a 2015 report that “because the natural gas market is both efficient and transparent, natural gas price behavior can provide valuable insights into the underlying regional supply and demand conditions.”

EIA notes that for New England and New York, “Pipeline constraints still exist in the area, and day-to-day price volatility is likely.” Spot market volatility is most prone to impact “non-firm” or interruptible customers, with particular impacts on the power sector in the region, and thus ultimately electric customers. The Northeast region - a high-demand region but one characterized by pipeline infrastructure constraints - has experienced periods of the highest gas and power spot price volatility in the U.S. over several recent winters - in 2013/14, 2014/15, and 2017/18. EIA noted in November 2019, looking ahead to the winter of 2019-20, that “New England’s Algonquin Citygate price is typically significantly higher than the Henry Hub price throughout winter because of high heating demand and high utilization and constraints on key natural gas pipelines in the region.”

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 2018.

For the 9 state region, natural gas in 2018 represented 59% of home heating, compared to 21% for heating oil and 16% for electricity.

According to the most recent data, natural gas represented 60% 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 39.9%. Heating oil is second at 35%. Electricity is 14%.

Source: U.S. Census Bureau, "Profile of Selected Housing Characteristics." Data is 2018, 1-year estimates.

STATE	2018 %	2000 %	1990 %
Connecticut	Gas, 36 Oil, 40 Elec., 17	Gas, 29 Oil, 52.4 Elec., 14.6	Gas, 26.3 Oil, 54.4 Elec., 15.1
Maine	Gas, 8 Oil, 62 Propane, 11	Gas, 3.5 Oil, 80.2 Elec., 4.4	Gas, 1.8 Oil, 69.5 Elec., 11.7
Massachusetts	Gas, 52 Oil, 25 Elec., 17	Gas, 43.9 Oil, 39.4 Elec., 12.4	Gas, 38 Oil, 44 Elec., 13.5
New Hampshire	Gas, 21 Oil, 44 Propane, 16	Gas, 18.4 Oil, 58.1 Elec., 7.6	Gas, 15.2 Oil, 55.8 Elec., 12.4
New Jersey	Gas, 75 Oil, 8 Elec., 13	Gas, 66.8 Oil, 19.4 Elec., 10.3	Gas, 57.5 Oil, 29.2 Elec., 10
New York	Gas, 60 Oil, 20 Elec., 12	Gas, 51.7 Oil, 33.1 Elec., 8.7	Gas, 45.7 Oil, 39.6 Elec., 8.5
Pennsylvania	Gas, 51 Oil, 16 Elec., 24	Gas, 51 Oil, 25.5 Elec., 16.5	Gas, 49.5 Oil, 27.9 Elec., 14.8
Rhode Island	Gas, 56 Oil, 29 Elec., 10	Gas, 46.3 Oil, 42.1 Elec., 7.6	Gas, 40.7 Oil, 47 Elec., 7.9
Vermont	Gas, 18 Oil, 42 Propane, 17 Wood, 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, 2012-19



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

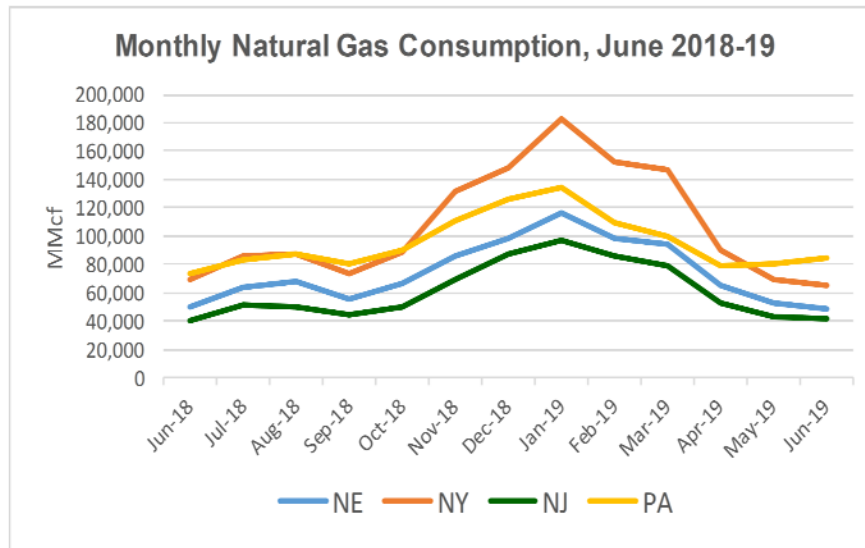
	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Natural Gas	11,356	11,529	11,705	11,802	11,918	12,070	12,270	12,488
Heating Oil	5,464	5,244	5,097	4,923	4,774	4,724	4,635	4,483
Propane	814	846	856	884	933	982	982	997
Electricity	3,014	3,038	3,093	3,253	3,326	3,386	3,526	3,646
Wood	583	585	569	511	471	477	402	303

U.S. EIA data indicates that the number of natural gas households in the Northeast U.S. has increased by 1.1 million since 2012. (Note: The 2019/20 numbers are still preliminary.)

In the same period, heating oil lost 980,000 households, electricity gained 632,000, and propane gained 183,000.

Source: U.S. EIA, October 2019

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



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

This graph displays the monthly variations in gas consumption in New England, New Jersey, New York and Pennsylvania for the illustrative period of June 2018 through June 2019. As can be seen, all four regions are winter-peaking systems. January 2019 represents the highest monthly consumption period for all of the states.

January 2019 was not as cold as the year prior, but several pipelines recorded new sendout records on days in that month, and several utilities came close to new records as well, reflecting new customer additions and intense if short-duration cold weather.

PROJECTED NATURAL GAS ADDITIONS IN REGIONAL ELECTRIC GENERATION SECTOR

PROPOSED GENERATOR ADDITIONS BY FUEL TYPE

Northeast Electric Power Systems

	Natural Gas	Wind	Solar & Other Renewables	Energy Storage
NY ISO	5,894 MW	4,746 MW	734 MW	385 MW
ISO-NE	2,047 MW	14,073 MW	3,083 MW	2,265 MW
NJ (PJM)	6,783 MW	3,537 MW	472 MW	257 MW
PA (PJM)	11,467 MW	925 MW	1,081 MW	144 MW



Natural gas has been an increasingly significant fuel in the Northeast electric power system over the last 20 years. The region’s three electric grid operators, as shown in the data table above, report that natural gas remains a leading choice for proposed new generating capacity. Renewable energy, imported hydro from Canada, and efficiency (not portrayed) are the other leading projected future power sources at this time. Offshore wind is a source of particular interest to the states in the region, and the numbers via state procurements keep increasing.

Data sources for table:

ISO-NE, September 2019 web posting
 NY ISO, “2019 Load & Capacity Data Report.” “Natural Gas” category is both natural gas and dual-fuel.
 “2018 New Jersey State Infrastructure Report,” released May 2019 by PJM
 “2018 Pennsylvania State Infrastructure Report,” released May 2019 by PJM
 Note: capacity numbers for wind & solar are nameplate capacity.

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:

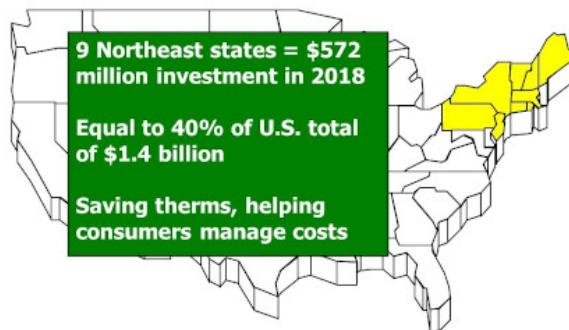
- *Natural gas vehicles*
- *Power generation technologies*
- *Efficiency investments*
- *Environmental issues*
- *RD&D advances.*

NATURAL GAS EFFICIENCY

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.

As the American Council for an Energy-Efficient Economy (ACEEE) has noted, efficiency opportunities exist in multiple sectors: “While the roots of natural gas efficiency programs lie within residential markets, there are now programs serving multiple types of natural gas customers - from homeowners to large industries. There are opportunities for improved energy efficiency across the spectrum of customers and technologies using natural gas. 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.”

Northeast States Lead U.S. in Gas Efficiency Investments



Source: ACEEE, "2019 State Energy Efficiency Scorecard", released Oct. 2019

The 2019 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; and that all the Northeastern states were in the top 20.

In 2018, \$1.4 billion was invested in natural gas efficiency programs nationwide, according to the ACEEE. Of that, over one-third of the national total (\$572 million, or 40%) was invested in the nine Northeast states (CT, ME, MA, NH, NJ, NY, PA, RI and

VT). This commitment will continue in coming years.

RENEWABLE NATURAL GAS

Renewable Natural Gas (RNG) is a pipeline-compatible, gaseous fuel derived from biomass or other renewable sources. It has lower lifecycle CO_{2e} emissions than geological natural gas and is compositionally equivalent and fully interchangeable with natural gas. It is the product of raw biogas (from anaerobic digestion) or syngas (from biomass gasification) that has been upgraded to pipeline quality.

Regardless of the biomass source or conversion technology, when the raw gas is appropriately upgraded to meet trace constituent compositional equivalency and interchangeability requirements, RNG is an overall low carbon product that facilitates meeting long-term decarbonization goals. In addition, in certain areas RNG recovery and introduction can be a viable option for meeting localized demand for pipeline natural gas.

In the Northeast, there is growing interest and initiatives toward implementing RNG. Vermont Gas is the first utility in the nation with a retail RNG offering. National Grid has been an active proponent for several years 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." Con Edison, Liberty Utilities NH, and Summit Natural Gas of Maine have also announced projects to utilize RNG, and other utilities are considering this option.



In September 2019, NGA and GTI released the “RNG Interconnect Guidance Document in NY State” intended to enhance understanding of both technical and policy issues to ensure RNG project interconnect success. While developed for New York State, this report provides a guideline for RNG pipeline interconnections that will be applicable and of value throughout the U.S. and Canada.

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 is particularly useful in the heavy-duty vehicle market, including transit buses and refuse trucks.

As with most alternative fuels, the availability of public fueling stations remains a challenge. According to the U.S. Department of Energy's Alternative Fuels Data Center, Pennsylvania has 47 public compressed natural gas (CNG) stations, New York State has 35, New Jersey 15, and New England 23. Nationally, there are about 900 CNG fueling stations. Efforts are underway to increase the number of publicly available stations. Pennsylvania has established 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 Massachusetts and Pennsylvania. In Canada, there is also a "blue road" of LNG fueling stations linking Quebec and Ontario trucking routes.



A new CNG fueling station opened in the Bronx, NY in summer 2019. (Photo: Clean Energy)

Finally, there is growing interest in "renewable natural gas" as an input to the transportation fuel stream. 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."



A refuse truck refueling at the iNatGas / AVSG station in Worcester, MA.

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.

Local gas distribution utilities in certain states are also utilizing portable CNG or LNG to supplement supplies in areas of pipeline constraints.

Shown in the photo is a CNG fueling station in Pembroke, NH 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 the majority of existing CHP capacity in the U.S. Total generating capacity in the U.S. from CHP is around 81 gigawatts, representing about 8% of total capacity. The greatest potential for CHP use is in such markets as commercial, institutional, light manufacturing, government and military sites. In the Northeast, universities and hospitals are among the key customers.

CHP is also seen as valuable for its capability in providing critical infrastructure resilience. It provides notable benefits (such as lower emissions) over traditional backup generation, which generally runs on diesel fuel.



Tufts University outside Boston completed a new central energy plant (CEP) in 2018 that uses energy-efficient cogeneration technology. As the university notes: “Fueled by natural gas, the CEP uses advanced cogeneration technology to produce energy as well as steam.”

On the left is a photo of the new facility, and on the right is a photo of some of the internal equipment (photo by VanZelm Engineers).



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: Innovative R&D

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. In 2019, NYSEARCH continued its work on evaluating technologies to measure methane emissions, among other initiatives

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



This photo illustrates field installations of MetGlas® in National Fuel Gas territory in Buffalo, NY in 2019 - part of a project to evaluate amorphous metal tape as a practical application for PE pipe location. Source: NYSEARCH

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 65% between 1990 and 2016.

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. Almost 1,500 billion cubic feet (Bcf) of methane emissions have been reduced by participating companies in the last twelve 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, 2-19

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

State	1990	2016	Percentage Change
CT	44.8	34.5	-23%
ME	23.5	16.6	-29.6%
MA	85.9	64.5	-24.8%
NH	21.6	13.8	-36%
NJ	130.5	111.4	-14.6%
NY	212.9	164.6	-22.7%
PA	283.3	218.6	-22.8%
RI	11.4	9.8	-13.9%
VT	6.9	6	-13.5%
US	5,991.6	5,189.4	-13.4%

ACHIEVING EMISSIONS REDUCTIONS IN THE POWER SECTOR

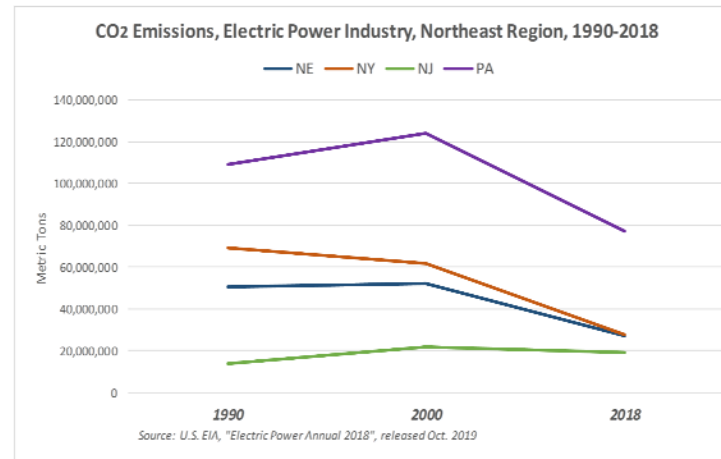
The electric utility sector in the Northeast has achieved major reductions in several air emission areas in recent years—in part thanks to new, more efficient power sources, from natural gas to renewables.

In New York State, from 1998 to 2018, NY ISO reports that emissions rates from the power sector dropped by 51% for CO₂, 89% for NO_x, and 98% for SO₂.

ISO-NE reports that from 2001 to 2017, total emissions from power plants in New England dropped by 98% for sulfur dioxide (SO₂), 74% for nitrogen oxides (NO_x), and 34% for CO₂.

PJM emissions data indicates a significant drop in SO₂, NO_x and CO₂ for its entire region, which includes declining trends for all three pollutants in both New Jersey and Pennsylvania.

U.S. power sector carbon dioxide emissions have fallen by 28% since 2005, with the substitution of natural gas for coal a key driver.

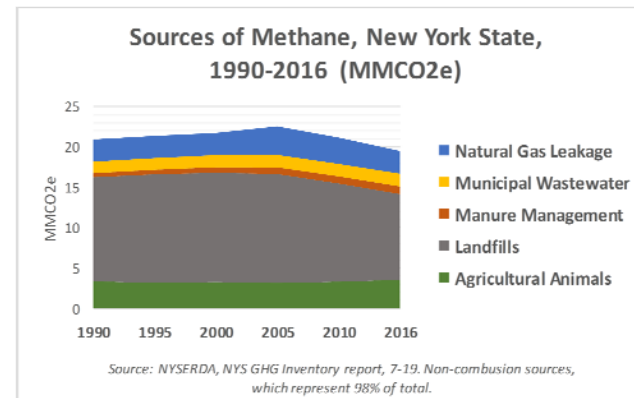


REDUCING METHANE EMISSIONS IN NATURAL GAS SYSTEMS

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 recent decades. CH₄ emissions from natural gas systems declined by 14% from 1990 to 2017, according to the U.S. EPA's 2017 Greenhouse Gas Inventory, released in April 2019.

The decline is due to the following, notes EPA: "The decrease in transmission and storage emissions is largely due to reduced compressor station emissions (including emissions from compressors and equipment leaks)... Distribution system emissions, which account for 7 percent of CH₄ emissions from natural gas systems and less than 1 percent of non-combustion CO₂ emissions, result mainly from leak emissions from pipelines and stations. An increased use of plastic piping, which has lower emissions than other pipe materials, has reduced both CH₄ and CO₂ emissions from this stage, as have station upgrades at metering and regulating (M&R) stations. Distribution system CH₄ emissions in 2017 were 73 percent lower than 1990 levels." [EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, pages ES-15 and 3-82]

Massachusetts has seen a considerable decline in methane emissions over the last 25 years. The MA DEP's greenhouse gas emissions inventory shows that methane (CH₄) emissions from natural gas systems declined by 67% from 1990 to 2017 (the most recent data year; note - 2017 data is still preliminary). New York State reports that methane emissions related to "natural gas leakage" in-state declined by 20% from 2005 to 2016. The leading sources of methane emissions in New York State are landfills (54%) and agricultural animals (18%), followed by natural gas (14%), according to NYSERDA's July 2019 GHG state inventory (2016 data). Also, "natural gas systems" overall represent 1% of total statewide GHG emissions in NY. Connecticut reported in June 2017 that the "contribution of methane emissions from natural gas distribution systems within Connecticut is less than one percent (0.03%) of all GHG emissions." 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.



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	139	1,221	16.6%
ME	0.09	36	2.9%
MA	1,288	2,925	19.4%
NH	7	81	4.4%
NJ	588	3,911	12.9%
NY	5,152	3,175	16.8%
PA	6,397	2,525	18.4%
RI	199	700	28.1%
VT	--	--	0.0%

Accelerated repair and replacement of more “leak-prone” natural gas distribution system components is an issue of high priority. 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 aggressively to accelerate this replacement process, in concert with efforts to reduce emissions and extend the systems to meet market demand.

2018 data, released 2019 by PHMSA

**NGA's MEMBER LOCAL
DISTRIBUTION COMPANIES**
(as of November 2019)

Bangor Natural Gas Company

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

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

Elizabethtown Gas

520 Green Lane
Union, NJ 07083
(800) 242-5830
www.elizabethtowngas.com

Elkton Gas

125 East High Street
Elkton, MD 21921
(866) 281-6483
www.elktongas.com

NGA's LDC MEMBERS *(as of 11-19)*

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://massachusetts.libertyutilities.com/fall-river>

Liberty Utilities NH
15 Buttrick Road
Londonderry, NH 03053
(800) 833-4200
www.new-hampshire.libertyutilities.com

Liberty Utilities NY
33 Stearns Street
Massena, NY 13662
(315) 769-3516
www.stlawrencegas.com

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.mged.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 11-19)*

National Grid
25 Hub Drive
Melville, NY 11747
(718) 643-4050
www.nationalgridus.com

40 Sylvan Road
Waltham, MA 02451
(781) 466-5000
www.nationalgridus.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 11-19)*

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

South Jersey Gas
3800 Atlantic Avenue
Atlantic City, NJ 08401
(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**
480 North Avenue
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 11-19)*

Algonquin Gas Transmission Co.
890 Winter Street, Suite 300
Waltham, Massachusetts 02451
(617) 254-4050
www.enbridge.com

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

Exelon Generation (Everett LNG)
116 Huntington Avenue, Suite 700
Boston, Massachusetts 02116
(617) 381-5700 *(Everett terminal)*
www.exeloncorp.com

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

**Portland Natural Gas
Transmission System (PNGTS)**
One Harbour Place, Suite 375
Portsmouth, NH 03801
(603) 559-5500
www.pngts.com

Repsol USA
2455 Technology Boulevard
The Woodlands, Texas 77381
(832) 442-1000
www.repsol.us/en

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 and compressed natural gas providers, and manufacturers and suppliers to the industry. These member companies provide natural gas to over 13 million customers in nine states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont).

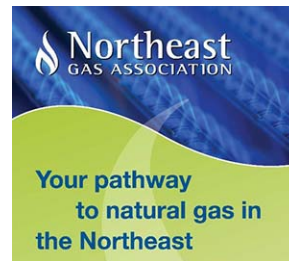
Mission Statement

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
Tel. 781-455-6800



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.nyserdera.org)
- “Patterns and Trends - New York State Energy Profiles: 2002 - 2016”

Pennsylvania Public Utility Commission
- “Pennsylvania Gas Outlook Report 2018”

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 2019”
- “Natural Gas Annual 2018”
- “Natural Gas Monthly”
- “State Energy Data Report”

Canada Energy Regulator (formerly the NEB)
- “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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