Natural Gas Infrastructure Constraints

During the last few years, inadequate infrastructure to transport natural gas has at times affected the ability of natural-gas-fired plants to get the fuel they need to perform. This fuel-security risk has become a pressing concern in New England, considering the major role natural-gas-fired generation plays in keeping the lights on and setting prices for wholesale electricity.

The performance of the largest and most flexible sector of generators is weakened by insufficient pipeline and storage capacity

New England Has Benefited from Natural-Gas-Fired-Generation

In 2000, natural gas fueled just 15% of the region's electricity. Since then, it has become the dominant fuel used to produce electricity in New England, displacing higher emitting and less economic power plants. With supply from the nearby Marcellus Shale and relatively

low construction costs, natural gas continues to be a top fuel choice for new generators. These new power plants are not only some of the most efficient in the country, but in the world. (Learn about the resource mix.)

The shift to natural gas has benefited the region in many ways:

- The use of relatively clean-burning natural gas, along with emission controls on fossil-fuel-burning generators and other factors, has contributed to a significant long-term decline in regional air emissions.
- Natural gas prices, typically lower than other fossil fuels for most of the year, have helped the annual energy market value remain well below its high of $12 billion in 2008 and reach record lows in 2016. Fuel costs are typically one of the major inputs in the wholesale price of electricity. Follow the effects of natural gas in the ISO's monthly analyses of electricity prices and demand.
- The ability of many natural-gas-fired plants to change output quickly helps to balance the variations in output from increasing levels of intermittent power resources that rely on the wind and sun.

Access to Fuel Has Become Uncertain during Winter

During many recent winters, regional gas utilities have been using most, if not all, of the capacity on the pipelines that carry natural gas into New England. This is particularly true during very cold periods when heating demand is high. This leaves very little to no pipeline capacity for electric generators, which creates a number of concerns for the power system:

- Reliability risks: Because such a large and still growing quantity of the region's generating capacity uses natural gas (learn more at Key Stats—Resource Mix), its unavailability can pose a serious risk to the reliable supply of electricity. This is particularly true when non-gas-fired resources are also unavailable, for example, due to:
  - Mechanical problems for some of the region's aging non-gas-fired generators

Reduced imports from neighboring grids dealing with the same weather

Delayed oil and LNG deliveries

Fuel-security risk is not as apparent during mild winters, when heating demand for natural gas is lower and there's more natural gas available for generators. However, New England winters are unpredictable. On the coldest days, fuel constraints could sideline thousands of megawatts of natural-gas-fired generation. When that happens, system operators turn to power plants with stored fuel—coal, oil, or nuclear—to meet demand. If the region were to experience a "perfect storm" of problems with grid resources, ISO system operators could be forced to use special measures to protect the grid. Those could include asking the public to conserve electricity or, in extreme cases, ordering load shedding (rolling blackouts affecting blocks of customers). This risk is likely to grow unless the region can find ways to offset the loss of more non-gas-fired power resources as they retire, as detailed in the ISO's *Operational Fuel-Security Analysis*.

Price volatility: Similarly, the price of natural gas tends to spike as temperatures drop and demand for the fuel increases. This has an immediate effect on wholesale electricity prices. For example, gas price spikes during the frigid winter of 2013/2014 (December–February) led to a record-high average wholesale electricity price of $137.59/megawatt-hour (MWh) compared to just $27.58 MWh during the 2015/2016 "winter that wasn't." See how prices for wholesale electricity track natural gas. More recently, price spikes were again experienced during cold snaps during December 2017 and January 2018.

Air emissions: Pipeline constraints can also affect regional air emissions during winter because the ISO has to run higher-emitting generators when gas-fired units can't access fuel or when the price of natural gas spikes.

Pipeline Development Hasn't Kept Pace with Demand

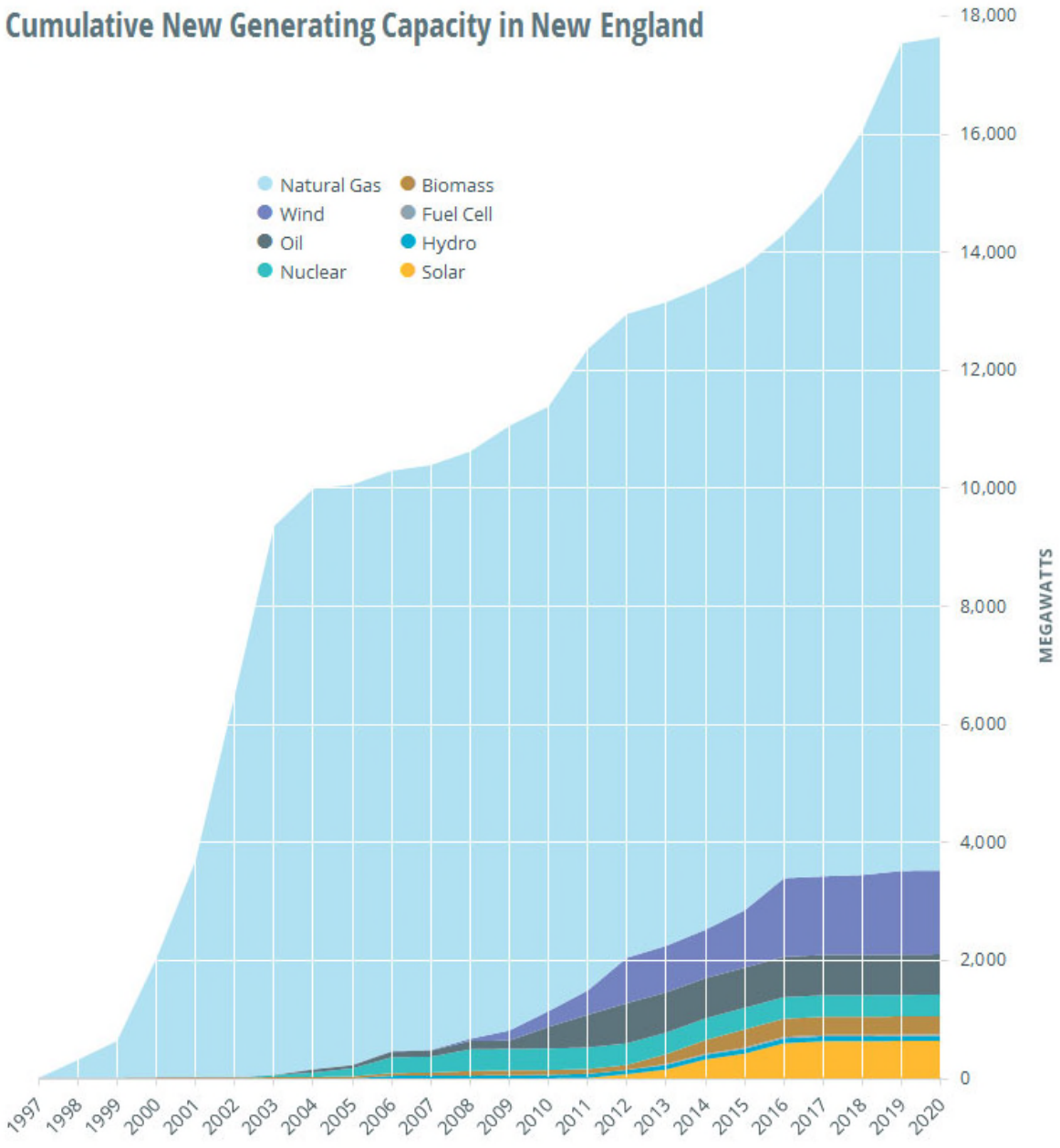
Fuel-security risks may be more acute in New England than in most other regions because New England is “at the end of the pipeline" when it comes to natural gas and the other fuels used most often to generate the region’s power. New England has no indigenous fossil fuels and therefore, fuels must be delivered by pipeline, ship, truck, or barge from distant places. Additionally, the natural gas pipeline system within New England is relatively small, and its access to the rest of the North American pipeline network is limited. This also makes the region vulnerable to pipeline interruptions. In regions with a more robust pipeline network, a failure at a single point on the pipeline system typically can be contained to a local area and routed around, but such an outage in New England will likely create significant impacts, as detailed in the ISO’s *Operational Fuel-Security Analysis.*

The tremendous growth in natural-gas-fired generating capacity is shown in the graph below. But the natural gas pipelines that deliver low-cost shale gas into the region have not been expanded at a commensurate pace. Further, pipelines are built and sized to serve customers with firm contracts for capacity, typically gas utilities, not electricity generators.

> Gas utilities commit to the long-term contracts required for incentivizing pipeline development.
>
> Generators, on the other hand, typically forego these premium contracts, instead arranging for fuel only as needed and relying on unused pipeline capacity for delivery.

Because generators have no guarantee for when or how long they’ll be called to run—and there’s no practical way for them to store excess pipeline gas or electricity on site—contracting for pipeline capacity only when needed helps natural-gas-fired generators keep their costs as low as possible to maintain competitiveness in the wholesale electricity markets.

While that strategy works for most of the year, on cold days the pipelines are running at or near maximum capacity solely to meet heating demand. During several recent winters, this situation has severely limited the delivery of fuel to much of the region’s power plants, which, in turn, threatened the reliable supply of electricity and drove up wholesale electricity prices and air emissions.



Note: New generating capacity for years 2016–2020 includes resources clearing in recent Forward Capacity Auctions.

Source: ISO New England

Some incremental pipeline capacity has been added recently under contract to gas utilities to serve increased demand from their retail gas customers. Over the next few winters, some of this capacity will likely be available for generators on the coldest days, helping to lessen fuel supply concerns and volatility in wholesale electricity prices. However, this extra capacity will eventually be used for heating, as gas utilities sign up more customers. To compound matters, most of the benefit from additional fuel available to generators on the coldest days will be canceled out as new natural-gas-fired generators fill the void of retiring non-gas-fired power plants. In other words, though the pipeline "pie" may be getting bigger, there will be more mouths to feed. When it comes to the power system's ability to meet electricity demand on the coldest days, the results may be a wash.

Generators Running on Oil also Raise Fuel-Security Concerns

Fuel security isn't just about natural gas. Adequate arrangements for oil delivery are also a concern for both generators that run exclusively on this fuel source and those natural-gas-fired generators that have the ability to switch to oil. That's why the ISO has been working to ensure these generators are properly incentivized to fill up their oil tanks before winter sets in.

"Dual-fuel technology" that allows generators to switch to oil may be the most cost-effective investment natural-gas-fired generators might take to ensure they can run when pipelines are constrained. However, state restrictions on air emissions may limit their ability to run on oil. Consequently, more natural gas plants may need to turn to LNG in winter when pipeline gas is unavailable or its price spikes.

Will Imported Liquefied Natural Gas (LNG) Fill the Gap?

While more natural-gas-fired generators may turn to LNG, several factors can impede generators' access to LNG when it's most needed.

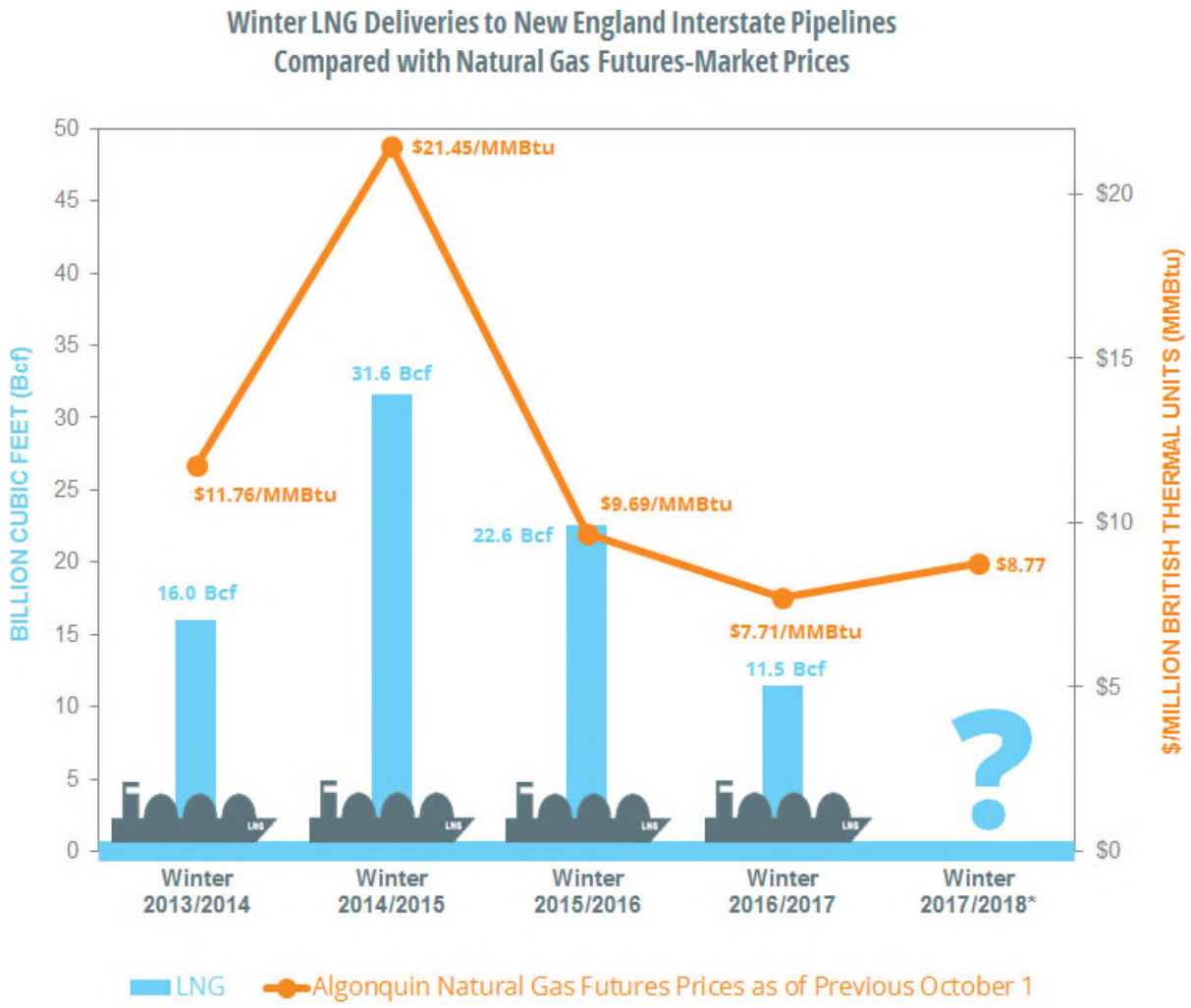
First, LNG is a global commodity that's imported to New England by ocean-going tankers, so it must

be contracted for months in advance—an option most generators elect not to pursue.

Second, the arrival of any spot LNG cargoes depends on global prices and vary from year to year; they also supply the entire Northeast and beyond—not just New England generators.

Third, severe weather could prevent the timely arrival of ships.

Over recent years, the ISO's Winter Reliability Program has helped incentivize a small number of generators to secure contracts for winter deliveries of LNG. These types of contracts, as well as the construction of on-site LNG storage, are among the options generators could invest in to satisfy upcoming performance requirements in the capacity market.



Note: Graph does not include the Mystic 8 and 9 gas-fired generators' fuel supply from the LNG facility.

*The preliminary total through mid-January 2018 was about 15.1 Bcf; more deliveries are expected before winter's end.

Source: LNG data from NatGas Analyst Tool by Genscape, a part of DMG Information (DMGI), www.genscape.com, based on scheduled deliveries posted to gas-industry bulletin boards. Futures data from *Winter Energy Market Assessment*, FERC (2014–2015, 2015–2016, and 2016–2017), and CME Group/NYMEX and OTC Global Holdings futures.

Will Adding More Renewables Help During Winter?

Wind and solar resources can offset some natural gas use, but their help with the fuel-security challenge is limited by still-low levels of regional installation, as well as the timing of their availability. Learn more in Integration of Renewable Resources and Other New

Technologies and in the ISO's *Operational Fuel-Security Analysis.*

The ISO's Efforts Have Mitigated the Fuel-Security Risk but Will Not Solve the Problem

Addressing the fuel-security issue is currently the region's highest-priority challenge. While the ISO doesn't have the authority to require generators to make long-term investments in fuel supplies, we have been developing tactics for the past six years to mitigate the fuel-security risk, such as:

- Developing new situational awareness and forecasting tools for our system operators to confirm fuel availability for natural-gas-fired units
- Improving communication and coordination with interstate pipeline operators
- Implementing Winter Reliability Programs that pay demand-response resources to be available and generators to boost winter fuel inventories of oil and LNG or to invest in dual-fuel technology (the ability to switch between different fuels, typically natural gas and oil)
- Fine-tuning the energy markets to strengthen resource performance
- Instituting "pay for performance" (PFP) enhancements that, starting in 2018, will reward resources that make the investments needed to ensure performance during periods of system stress, such as by contracting for adequate fuel, while resources that don't perform will forfeit capacity payments

While these efforts help, they are unlikely to result in a timely "fix": PFP incentives (i.e., the rate for PFP payment or forfeiture) will ramp up only gradually through 2024. Additionally, many states' increasingly stringent air emission limitations may prevent natural-gas-fired generators from installing cost-effective oil-fired backup fuel systems. As a result, the region's winter reliability concerns will continue until generators decide to sign contracts for LNG or greater natural gas pipeline capacity.

The Region May Face Expensive, Higher-Polluting Options in the Coming Years

Without timely action and investment to address the region's fuel-security risk, the region should expect significant energy market price volatility when the gas pipelines are constrained. Plus, the region may soon be forced to take stronger—and likely costly—steps.

> For example, a first step could be to further strengthen market incentives for generators to contract for fuel.
>
> As a last resort, the region could have to retain some non-gas-fired generators that would otherwise retire. These may be older, expensive, and higher-emitting—a strategy that runs counter to the New England states' ambitious carbon-reduction goals.

The ISO's *Operational Fuel-Security Analysis* sought to quantify the reliability risk so the region could discuss potential solutions with stakeholders as part of the Operational Fuel-Security Analysis Key Project.