THE NEED FOR A BALANCED PORTFOLIO APPROACH TO ADDRESS NEW ENGLAND'S FUEL SECURITY PROBLEM

PREPARED FOR:

MASS COALITION for sustainable energy

APRIL 2018

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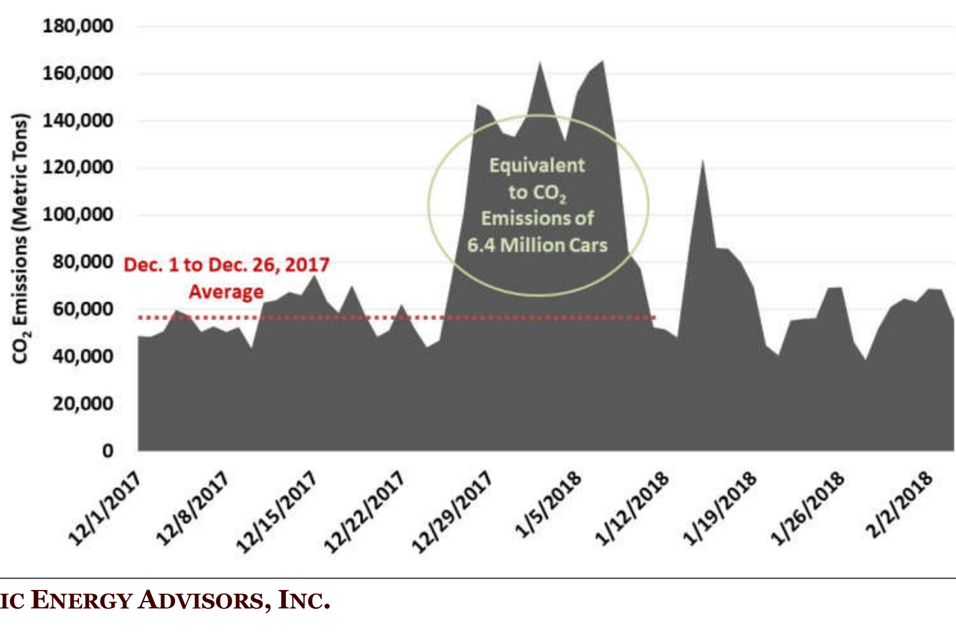
KEY FINDINGS

Immediate action and a balanced solution are required to reduce New England's greenhouse gas ("GHG") emissions and energy costs, and to ensure that the electric grid continues to operate in a safe and reliable manner. When considering measures to address the energy issues facing New England, there are a number of options available to policymakers. A balanced, multifaceted portfolio approach is required, as a single resource or fuel type is unlikely to reasonably address the region's needs and longer-term energy goals. Ultimately, it is important that action be taken now since solutions to address New England's energy issues have been debated for years, and implementation can take significant time. The development of additional natural gas transmission capacity should be included as part of a balanced solution to lower emissions from oil and coal, enhance energy reliability, and lower energy costs.

The New England fuel security problem is causing significant harm to consumers:

Increased Emissions: New England in general, and Massachusetts specifically, has committed to reducing GHG emissions by 80% from 1990 levels by 2050. Yet, New England must rely on higher GHG-emitting oil-fired and coal-fired power plants when natural gas deliveries are constrained. During the two-week cold snap this winter at the end of December and into early January, additional fuel oil and coal were used to generate electricity because natural gas was unavailable or too expensive. While the power sector is not the dominant source of GHG emissions in Massachusetts, natural gas constraints and the resulting reliance on oil-fired and coal-fired generation significantly increases GHG emissions and reverses progress that has been achieved in reducing GHG emissions. As shown in Figure 1, the effect of burning additional fuel oil and coal for power generation during the cold snap compared to the CO_2 emissions experienced during the period immediately before the onset of the cold weather, was equivalent to putting an additional 6.4 million cars on the road during this cold snap. This is more than the number of vehicles registered in Massachusetts. Additional sources of natural gas during this period would have reduced these incremental emissions.

Figure 1. Recent Electric Generation CO_2 Emissions Increases in New England

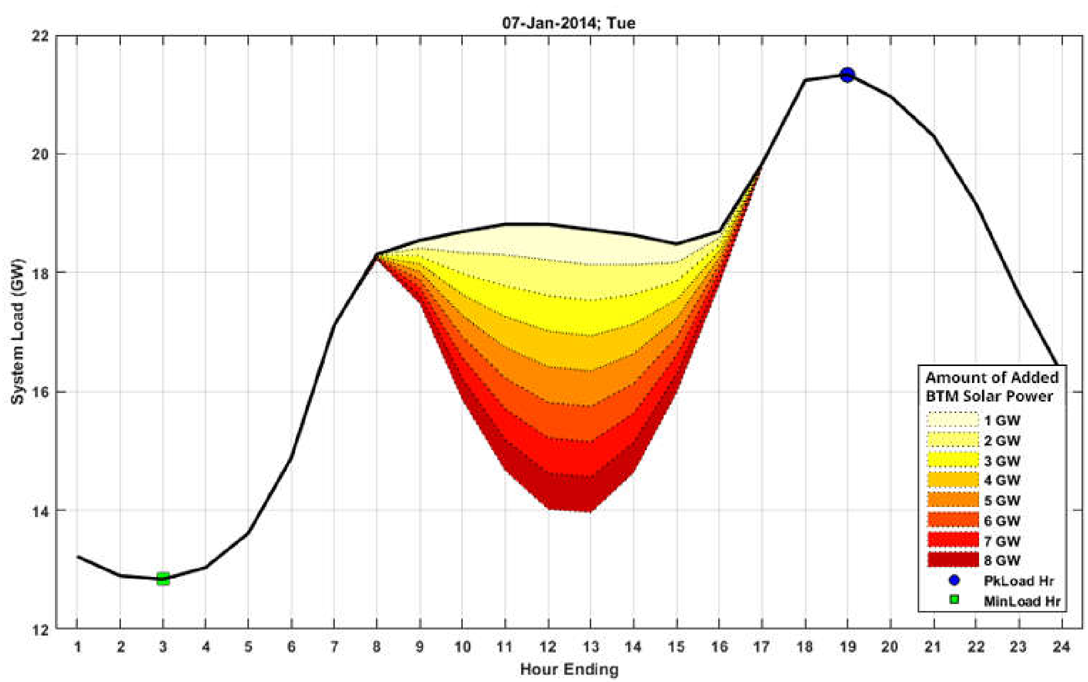


To provide another perspective, the additional CO_2 emissions from relying on oil-fired and coal-fired generation during this winter's two-week cold snap was equivalent to negating the annual emissions benefits of over 1,500 MW of solar power. It should be noted, however, that wind and solar generation are dependent upon weather conditions and cannot be called on to operate whenever required. As a result, solutions in addition to increased renewable generation, such as incremental natural gas capacity into the region and enhanced import electric transmission capability, are required to address New England's fuel security problem and to facilitate New England's greenhouse gas emission reduction goals.

Reliability Concerns: Another significant concern for New England is maintaining the reliability of the electric grid during high demand winter periods. Recent events have created serious doubts about the ability of New England's natural gas infrastructure to deliver sufficient quantities of natural gas to simultaneously meet both heating and electric demand during periods of constraint. ISO New England ("ISO-NE") identified that rolling blackouts will be required by the winter of 2024/2025 in 19 of 23 scenarios considered if New England's ability to provide for adequate fuel security is not significantly enhanced.

In addition, there is a significant amount of new renewable generation being proposed in New England as part of achieving GHG emissions reductions goals. However, renewable generation creates reliability challenges that must be met with flexible, dispatchable, natural gas-fired generation until sufficient battery storage is available. As shown in the graph below, solar generation has the potential to significantly reduce the need for traditional generation sources during the daytime, but solar power is not available during the peak electric demand period during the winter, which occurs around 6-7PM after the sun sets. The result will be a need for significant amounts of generation that can quickly ramp up or down to match the steeper changes in demand.

Figure 2. New England Winter Load Profile with Increasing Solar Power

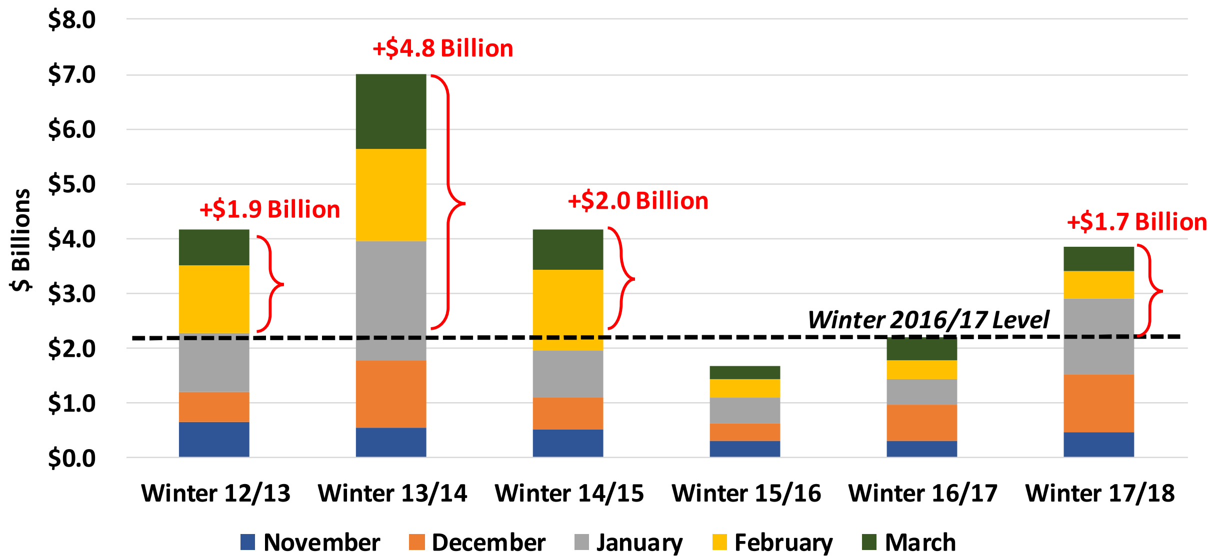


Energy Costs: Natural gas is the principal fuel for electric generation in the region. As shown in Figure 3, relative to the electric costs incurred last winter (*i.e.*, the winter of 2016/2017), the electric costs incurred by New England consumers both this winter and in other recent winters have been billions of dollars higher as a result of elevated natural gas prices.

- For example, electric costs this winter exceeded the total electric costs from last winter by $1.7 billion.

- Likewise, during the Polar Vortex winter of 2013/2014, costs to consumers were $4.8 billion higher than electric costs in the winter of 2016/2017 when the weather and natural gas prices were more moderate.

Figure 3. Magnitude of Costs to New England Consumers from Elevated Electric Prices



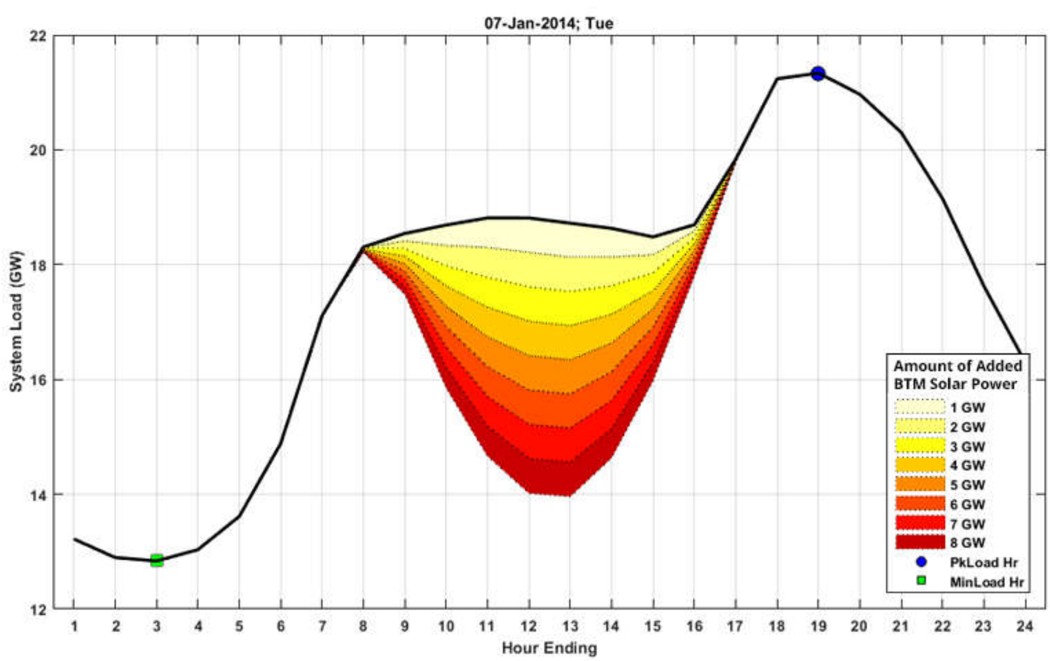
Impact on Economic Growth: The fuel security problem also exposes New England to indirect economic costs, including hindering economic growth and making New England less competitive in attracting investments from businesses. A recent report published by the U.S. Chamber of Commerce estimates that continuing the current "severely constrained ability to build new energy development infrastructure" into New England would result in a loss of 22,900 jobs and $2.0 billion in state GDP in New England, including a loss of 8,700 jobs and $792 million in state GDP in Massachusetts alone, over a four-year period.

SECTION 2:
A BALANCED SOLUTION IS REQUIRED

Immediate action and a balanced solution are required to reduce New England's GHG emissions and energy costs, and to ensure that the electric grid continues to operate in a safe and reliable manner. When considering measures to address the energy issues facing New England, there are a number of options available to policymakers. A balanced, multifaceted portfolio approach is required, as a single resource or fuel type is unlikely to reasonably address the region's needs and longer-term energy goals. Ultimately, it is important that action be taken now since solutions to address New England's energy issues have been debated for years, and implementation can take significant time.

Renewable generation is an important part of New England's changing energy mix, and will play a key role in the transition to a decarbonized economy. New England in general, and Massachusetts specifically, has committed to reducing GHG emissions from 1990 levels by 80% by 2050,[1] which will require significant increases in renewable generation, including solar and wind generation. However, additional natural gas-fired generation will be needed alongside these renewable resources to address the non-scheduled, variable output of these facilities. Solar and wind output is weather dependent and often does not align with the energy consumption patterns of consumers. For example, as shown in the graph below, solar generation has the potential to significantly reduce the need for traditional generation sources during the daytime, but solar power is not available during the peak electric demand period during the winter, which occurs around 6-7PM, after the sun sets. The result will be a need for a significant amount of natural gas-fired generation that can quickly ramp up or down to match the steeper changes in demand.

Figure 4. New England Winter Load Profile with Increasing Solar Power[2]



1 ISO New England, "The New England States Have an Ongoing Framework for Reducing Greenhouse Gas Emissions," March 1, 2017.

2 ISO New England, "Solar Power in New England: Concentration and Impact," 2018

In addition, while significant growth in renewable generation is expected, the total quantity is not enough to solve New England's energy issues. In its *Operational Fuel-Security Analysis* study, ISO-NE assumed aggressive growth in renewable generation, yet identified distressing reliability concerns by 2024/25, noting that, "[m]ore renewables help, but don't eliminate the risk."[3] Moreover, it is noteworthy that, during the most recent cold snap, wind resources contributed less than 4.5% of New England's total generation and solar facilities contributed less than 0.3%.[4] Even if extremely optimistic assumptions are made regarding the increase in renewable generation for the next few years, it is unlikely that wind and/or solar generation will alone be sufficient to address looming reliability issues.

Electricity imports via new electric transmission will also be used to meet demand in New England, but siting and construction of major transmission facilities is a difficult and time-intensive process. Given the critical need for new energy infrastructure on an expedited basis, and the development time required for larger projects, additional electric transmission alone may not be available in the time and quantity necessary to solve New England's energy issues.

Importing foreign liquified natural gas ("LNG") into New England is likely to continue for the foreseeable future; yet, LNG imports by ship are subject to a complicated supply chain. Heavy reliance on LNG would expose New England customers to various risks as well (*e.g.*, political risk at international supply sources; weather risks that can cause *force majeure* events resulting in delayed or even cancelled shipments; operational risk across a long and complex supply chain). Moreover, if LNG imports were significantly increased, LNG is subject to global market pricing, which requires New England to compete for supplies on the world market where prices are often higher.

Development of incremental natural gas pipeline capacity into New England is also a safe and reliable means of addressing New England's energy needs. Additional pipeline capacity could support ongoing goals to reduce reliance on fuel oil and help during the transition to increased renewable generation. Delivery of additional natural gas supplies would also address concerns regarding future fuel security and help moderate winter natural gas prices in New England. While the expansion of an existing pipeline could minimize siting and construction risk, it must be recognized that pipeline expansions require years of development time.

In the final analysis, it is clear that immediate action is required to both ensure that the electric grid continues to operate in a safe and reliable manner in the next decade and beyond, and to reduce energy costs being borne by New England customers. Among the universe of possible solutions, the development of additional pipeline capacity should be strongly considered by New England's policymakers as part of a balanced solution to lower emissions from oil and coal, enhance energy reliability, and lower energy costs.

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3 ISO New England, "Operational Fuel-Security Analysis," January 17, 2018, p. 53.

4 ISO New England, "Daily Generation by Fuel Type."

SECTION 3:
NEW ENGLAND'S FUEL SECURITY PROBLEM

A. NATURAL GAS IS THE DRIVING FACTOR IN NEW ENGLAND'S ENERGY MARKET

In New England, natural gas is the primary fuel source for space heating and electric generation. Consumers also use natural gas for cooking, clothes drying, and hot water heating, as well as various commercial and industrial processes. More than 2.1 million New England households (38%) heat with natural gas, the most of any heating type, and roughly half of New England's electricity is produced by natural gas-fired generation.[5] Moving forward, the reliance on natural gas as part of New England's energy mix is expected to increase further. Consumers are seeking opportunities to switch to natural gas from fuel oil and other heating alternatives due to the lower cost and environmental benefits of natural gas.[6] The clear trend of increasing reliance on natural gas for electric generation over the last fifteen years is expected to continue due to lower natural gas prices and fewer emissions, and also due to expected retirements of coal, oil, and nuclear plants, which will largely be replaced by natural gas-fired generation.[7]

Demand for natural gas in New England is highly seasonal such that peak monthly demand in the winter can be almost double summer monthly demand. In the winter, consumer demand for natural gas for space heating rises, increasing system demand overall. In the winter, there is also substantial demand for natural gas from electric generation. In the summer, demand for natural gas for electric generation rises; however, currently that increase is more than offset by the lack of heating demand from consumers. Figure 5 shows New England's monthly natural gas consumption by state. Each year, the largest peaks occur during the winter months due to heating demand, with smaller peaks occurring in the summer due to demand for natural gas by generators to meet air conditioning loads.

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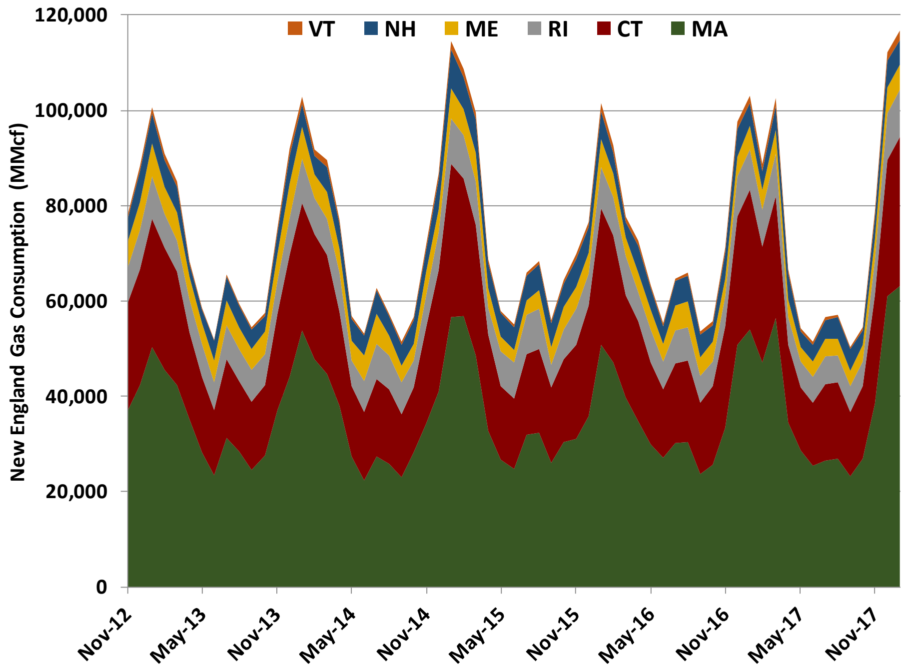
5 Commonwealth of Massachusetts, "How Massachusetts Households Heat Their Homes: Breaks down how Mass households heat by fuels including comparison to rest of New England," www.mass.gov/service-details/how-massachusetts-households-heat-their-homes; ISO New England, "Resource Mix," www.iso-ne.com/about/key-stats/resource-mix/.

6 Commonwealth of Massachusetts, "How Massachusetts Households Heat Their Homes: Breaks down how Mass households heat by fuels including comparison to rest of New England," www.mass.gov/service-details/how-massachusetts-households-heat-their-homes.

7 The Pilgrim Nuclear Power Station is expected to retire in May 2019. The Vermont Yankee Nuclear Plant closed in 2014. Pilgrim's retirement will leave two nuclear plants (three reactors) operational in New England, Seabrook Station in New Hampshire and Millstone Power Station in Connecticut. (ISO New England, "Resource Mix," www.iso-ne.com/about/key-stats/resource-mix/; ISO New England State of the Grid: 2018 Remarks and Slides, February 27, 2018, p. 6; "Natural gas and energy efficiency make up the biggest portion of new resources.").

Figure 5. Monthly Natural Gas Consumption by New England State[8]



B. NEW ENGLAND RELIES ON NATURAL GAS FROM OUTSIDE THE REGION

Although heavily dependent on natural gas, New England's access to natural gas supplies is limited. While the U.S. has abundant natural gas supplies, including as close to New England as Pennsylvania, there is no domestic production of natural gas in New England, nor any native underground natural gas storage. As a result, New England must source natural gas from outside of the region and deliver it to the region, which it does via two means – pipeline deliveries of natural gas produced in North America and shipped LNG produced overseas.

As shown in the following map, New England relies on five pipelines to deliver the vast majority of its natural gas. Of these pipelines, three, Algonquin Gas Transmission ("Algonquin"), Iroquois Gas Transmission ("Iroquois"), and Tennessee Gas Pipeline ("Tennessee"), provide more direct access to natural gas production in the mid-Atlantic region, where, in the wake of the shale gas revolution, a significant portion of U.S. natural gas is produced.[9] Natural gas produced in states as close as Pennsylvania is abundant; however, delivery of that natural gas to New England is limited by the total capacity of these pipelines, which is approximately 3.5 Bcf/d. Portland Natural Gas Transmission System ("PNGTS") imports natural gas that has traditionally been produced in western Canada. Maritimes and Northeast Pipeline ("M&NP") has traditionally imported natural gas from Atlantic Canada, but with the declining production and impending shutdown of Atlantic Canada's two

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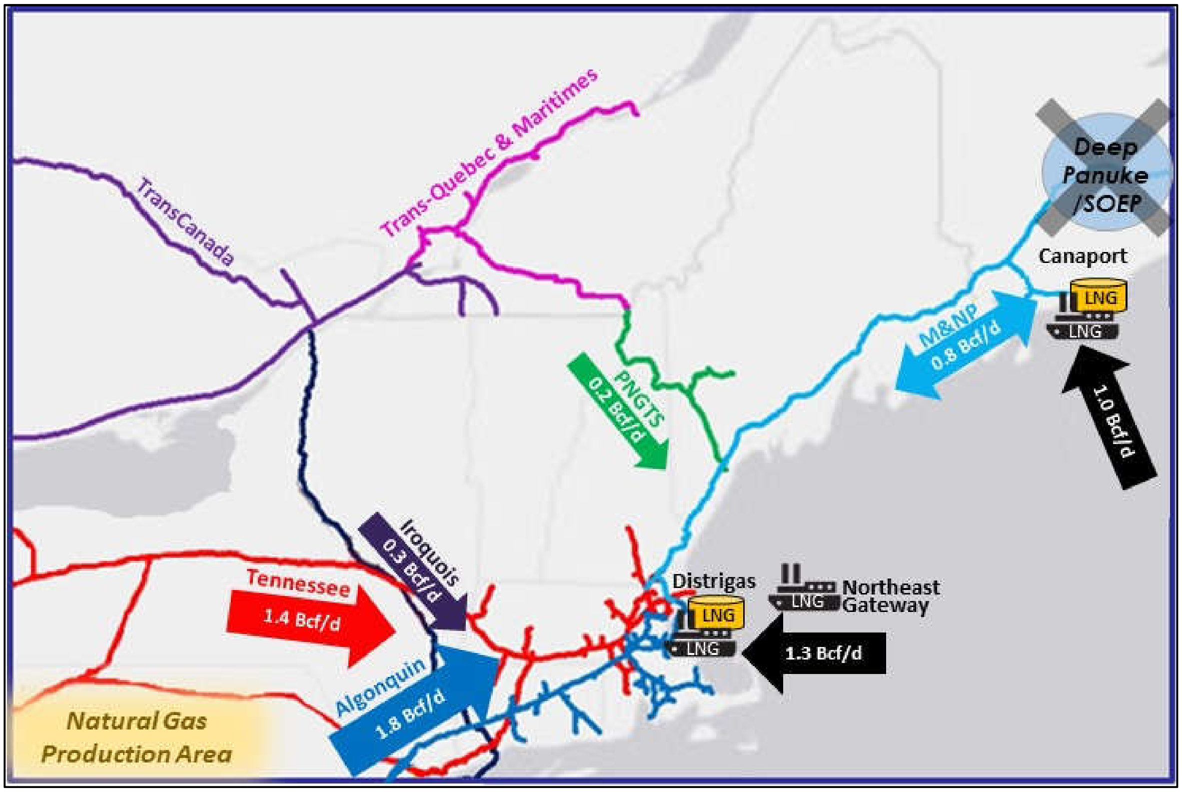
8 U.S. Energy Information Administration, "Natural Gas Delivered to Consumers by State."

9 U.S. Energy Information Administration, "Natural Gas Explained: Where Our Natural Gas comes From," October 25, 2017.

historical producing fields (*i.e.*, the Sable Island Offshore Energy Project and the Deep Panuke project), those supplies will soon cease to be available to New England.[10]

Figure 6. Natural Gas Infrastructure and Firm Delivery Capacity into New England[11]



The second means of importing natural gas into New England is via ocean shipments of LNG. There are currently three LNG import terminals serving New England.[12] Of these facilities, Distrigas and Canaport have on-site storage and thus the ability to receive cargoes of LNG and re-gasify it on demand. Northeast Gateway is an off-shore buoy terminal off the north shore of Massachusetts and has no on-site storage, and thus can only send natural gas onto Algonquin when a tanker is moored on-site and discharging natural gas into the system.

LNG tends to be considerably more expensive on a per unit basis than domestic natural gas delivered by pipeline due to the costs of production, liquefaction, shipping, and re-gasification, as well as because of competitive pressures of global demand for cargoes. Much of the time, natural gas prices in Europe and elsewhere are higher than those in the U.S. While some LNG is imported into Distrigas under long-term contract, other "spot cargoes" tend to gravitate towards higher priced markets, all

10 CBC News, "Encana Prepares to Close Deep Panuke Offshore Gas Project: With Sable Project Also Winding Down, Nova Scotia Offshore Gas Industry in Flux," June 13, 2017; S&P Global Platts Gas Daily, "Deep Panuke Abandonment to Spell End of Nova Scotia Offshore Play," March 22, 2018.

11 Northeast Gas Association, "2017 Statistical Guide," p. 38 and 49. Where ranges were provided, midpoints were used; Informational Postings of: Algonquin and Tennessee; ISO New England, "Forecast of Near-term Natural gas Infrastructure Projects," October 3, 2016.

12 A fourth facility, Neptune LNG, is also located in Massachusetts, but is currently not operational.

else being equal. Thus, to a significant extent, customers in New England compete for imported LNG supplies with customers in other parts of the world.

Lastly, while there is no underground natural gas storage in New England, gas utilities own and operate above-ground LNG and propane storage facilities. The gas utilities use these facilities for "peak shaving" purposes, meaning that they utilize these facilities on the highest heating demand days to meet customers' demands. Peak shaving storage allows gas utilities to manage these high-demand periods with natural gas they have purchased and stored during less extreme conditions. However, while an important resource for gas utilities for meeting peak demands, the total amount of "peaking" storage and delivery capability available is limited and can only provide maximum daily deliveries for a short period each winter. New England gas utilities have peak shaving storage assets with an aggregate storage capacity of approximately 16 Bcf and a daily dispatch capacity of 1.4 Bcf/d, meaning that the gas utilities have the ability to use peak shaving storage to support heating system demand at its full capacity for less than twelve days each winter.[13]

C. NEW ENGLAND EXPERIENCES PERIODS OF NATURAL GAS SCARCITY

Gas utilities are required by regulation to ensure that they have sufficient supplies available to meet the demands of their customers, including on the coldest days, which they typically achieve via long-term pipeline transportation contracts, the cost of which they are allowed to pass on to their ratepayers. Because gas utilities contract for pipeline capacity based on peak consumption, during periods when heating demand is lower, they make their remaining pipeline capacity available to resell in the market, where other participants (typically electric generators) can purchase and use it on a short-term basis. Thus, pipeline capacity is available to electric generators via release from gas utilities, but is generally either extremely scarce or not available at all during the periods of high winter demand when gas utilities need to use their contracted pipeline capacity to meet their customers' demands.

The existing commercial structure of the New England wholesale electric market does not incent gas-fired generators in the region to contract for and underpin the construction of additional pipeline capacity. In the competitive wholesale market, gas-fired generators are not assured recovery of the cost of long-term pipeline transportation contracts required for new pipeline capacity due to the structure of the electric market. Therefore, in most cases, they cannot financially justify the required long-term contractual pipeline commitments. In addition, pipelines are unable to build incremental pipeline capacity without sufficient long-term contracts to support the investment required of such a highly capital intensive and long-lived asset. Long-term firm contracts provide a pipeline with the recovery of fixed costs on a monthly basis over the term of the contract, are required to show market need for the project, and demonstrate that the project is in the public interest.

In recent years, new pipeline projects supported by long-term contracts from gas utilities to meet growth in their demand have provided an additional 0.58 Bcf/d of pipeline capacity into New England[14] However, the pipelines serving New England have not been expanded to accommodate increasing natural gas demand from electric generators. When natural gas demand is high, pipeline capacity remaining after meeting gas utility demands becomes scarce, which contributes to a fuel

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[13] Northeast Gas Association, "2017 Statistical Guide," p. 49.

[14] Algonquin AIM Project (0.34 Bcf/d); Algonquin Atlantic Bridge (0.13 Bcf/d); Tennessee Connecticut Expansion (0.07 Bcf/d); PNGTS Expansion (0.04 Bcf/d).

security problem in New England. This dynamic creates inherent tensions, particularly in the winter, as the infrastructure serving New England cannot economically provide enough capacity to serve both gas utility heating customers and electric generators.

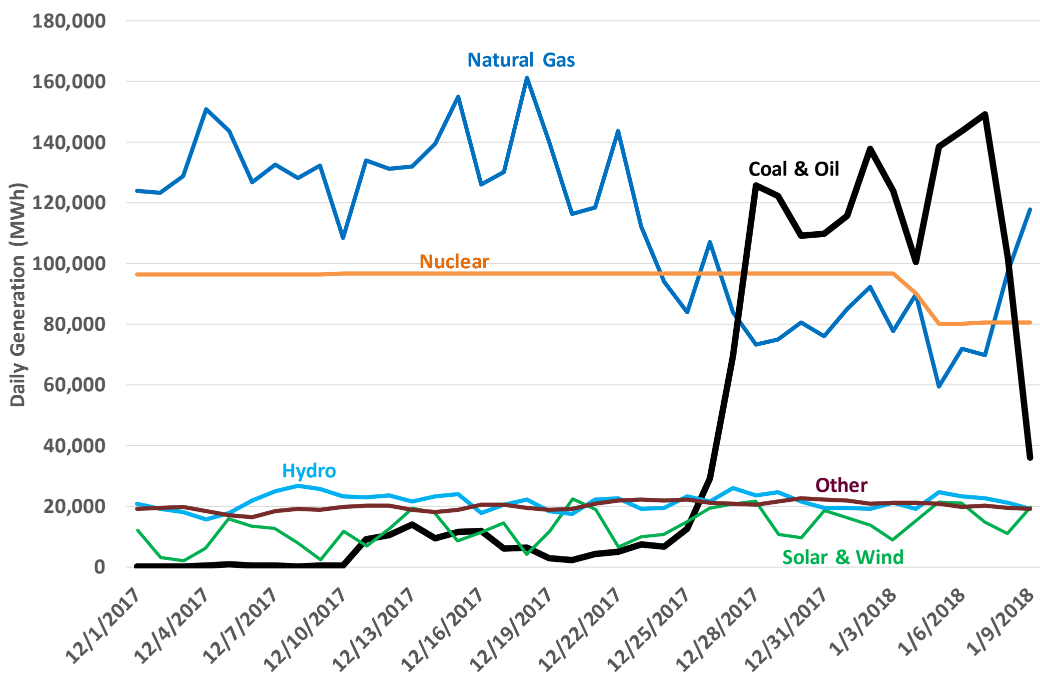
This fuel security problem has several negative consequences for New England. For example, pipeline constraints result in the increased use of fuel oil or coal to produce electricity, which significantly increases greenhouse gas emissions. The uncertainty surrounding generators' ability to obtain natural gas during high demand periods also raises concerns regarding the reliability of the electric grid. In addition, constrained pipeline capacity causes natural gas prices to rise, sometimes dramatically. Increases in natural gas prices in New England cause electric price increases, which are borne by New England consumers. Each of these negative consequences will be discussed in more detail in the following sections.

SECTION 4:
ENVIRONMENTAL IMPACT OF THE NEW ENGLAND FUEL SECURITY PROBLEM

New England's limited ability to deliver natural gas via pipeline from domestic production comes with environmental costs. As mentioned previously, all of the New England states have committed to significantly reducing GHG emissions. Yet, New England must rely on higher GHG-emitting oil-fired and coal-fired power plants when natural gas deliveries are constrained.

For example, during this winter's cold weather, New England relied upon significantly more coal-fired and oil-fired generation because natural gas was unavailable or too expensive. While the power sector is not the dominant source of GHG emissions in Massachusetts,[15] natural gas constraints and the resulting reliance on oil and coal-fired generation significantly increases GHG emissions and reverses some of the progress that has been achieved in reducing GHG emissions. Data provided by ISO-NE indicates that generation from coal and oil plants was significantly higher during the two-week cold snap in late December 2017/early January 2018 compared to the period immediately before the onset of the cold weather. As illustrated in Figure 7, generation from coal and oil plants surpassed generation from natural gas-fired plants during this cold snap.

Figure 7. December 2017/Early January 2018 Generation by Fuel Type

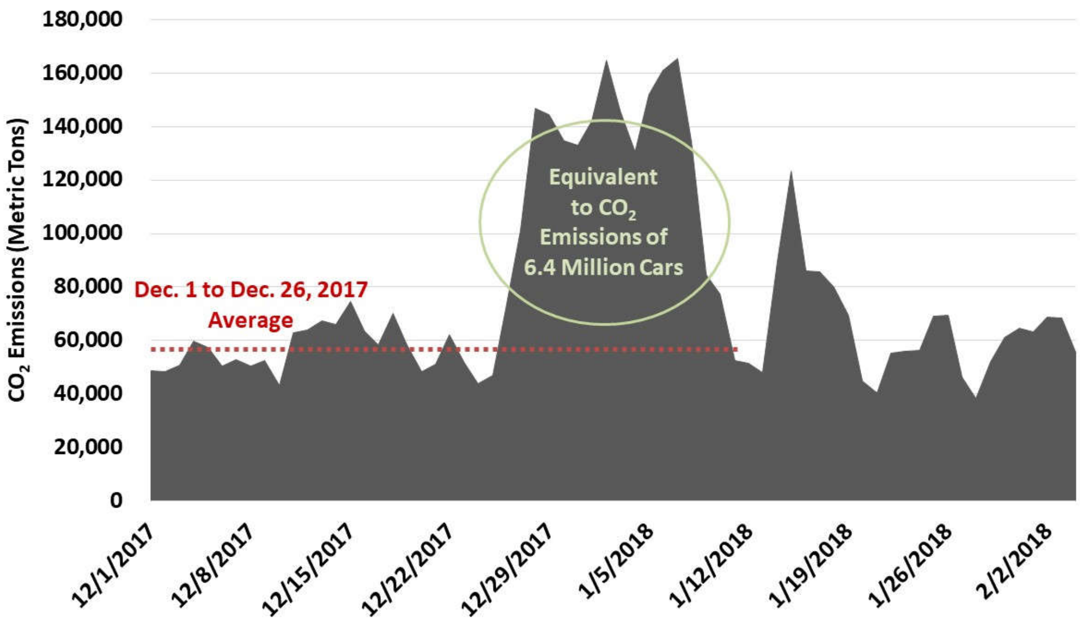


During this cold snap, daily generation from burning fuel oil and coal was close to 20 times higher than the period immediately before the onset of the cold weather, causing fleet-wide CO_2 emissions to more than double, from an average of 57,000 metric tons emitted per day to 139,000 metric tons

15 According to data published by the Commonwealth of Massachusetts, the transportation sector had the largest GHG emissions (39.4%), while the electric sector had 19.8% of GHG emissions in 2014. Commonwealth of Massachusetts, "MA GHG Emission Trends," www.mass.gov/service-details/ma-ghg-emission-trends.

per day.[16] As illustrated in Figure 8, using additional fuel oil and coal to generate electricity this winter when natural gas was unavailable or too expensive resulted in a total of approximately 1,150,000 metric tons of incremental CO_2 being emitted during the recent 14-day cold snap. This was equivalent to putting an additional 6.4 million cars on the road during this period, which is more than the number of vehicles registered in Massachusetts.[17] Additional sources of natural gas during this period would have reduced these incremental emissions.

Figure 8. Recent Electric Generation CO_2 Emissions Increases in New England



To provide another perspective, the additional CO_2 emissions from relying on oil-fired and coal-fired generation during this winter's two-week cold snap was equivalent to negating the annual emissions benefits of over 1,500 MW of solar power.[18] It should be noted, however, that wind and solar generation are dependent upon weather conditions and cannot be called on to operate whenever required. As a result, solutions in addition to increased renewable generation, such as incremental natural gas capacity into the region and enhanced import electric transmission capability, are required to address New England's fuel security problem and to facilitate New England's greenhouse gas emission reduction goals.

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16 ISO New England, "Daily Generation by Fuel Type." Assumed heat rates, by fuel type: coal = 12,800 Btu/kWh; gas = 7,400; oil = 12,100 based on S&P Global Market Intelligence generation data for 2016. Assumed CO_2 emission rates, by fuel type: coal = 205.7 lbs/MMBtu; gas = 117 lbs/MMBtu; oil = 161.3 lbs/MMBtu sourced from EIA, "CO_2 Factors for Fuels Used for Electricity Generation."

17 According to the U.S. Environmental Protection Agency ("EPA"), the average car in the U.S. emits 4.7 metric tons of CO_2 per year, which is equivalent to 0.18 metric tons in 2 weeks. (*See*, United States EPA, "Greenhouse Gas Emissions from a Typical Passenger Vehicle;" www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle). This analysis only includes CO_2 emissions. If NOx and SO2 emissions were included, the greenhouse gas emissions impact would be greater. *See, also*, Statista, "U.S. Automobile Registrations in 2016, by State;" www.statista.com/statistics/196010/total-number-of-registered-automobiles-in-the-us-by-state.

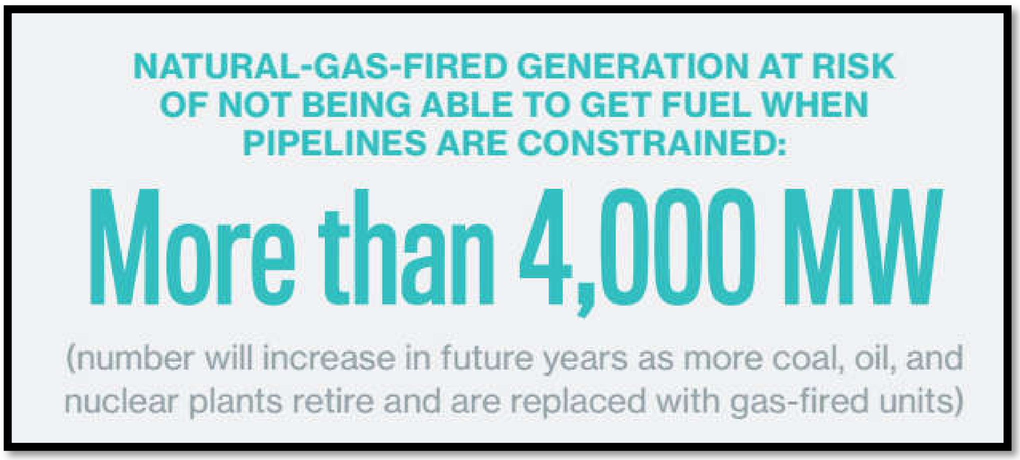
18 Assumes a CO_2 emission rate of 1,007 lbs/MWh for marginal generators (ISO New England, "2016 ISO New England Electric Generator Air Emissions Report," January 2018), and an annual solar generation capacity factor of 14.4% (ISO New England, "Final 2017 PV Forecast," May 1, 2017, p. 35).

SECTION 5:

RELIABILITY CHALLENGES OF THE NEW ENGLAND FUEL SECURITY PROBLEM

While limitations of the pipeline network impose environmental costs on energy consumers, a another significant concern is the reliability of the electric grid during high demand winter periods. Specifically, recent events have created serious doubts about the ability of New England's natural gas infrastructure to deliver sufficient quantities of natural gas to simultaneously meet both heating and electric demand during periods of high constraint. Moreover, there are indications that this situation could get worse in the near future.

The following was included in "ISO New England's 2017/2018 Winter Outlook":



In January 2018, New England faced challenges due to fuel constraints, as well as the unplanned outage at the Pilgrim Nuclear Power Station. In testimony before the U.S. Senate, the North American Electric Reliability Corporation indicated that New England needed to rely heavily on oil-fired generation for the duration of the cold snap, causing concerns regarding the ability to provide enough oil to maintain reliability:

> *While no records were set or peak forecasts exceeded, New England exhibited the greatest stress to the system.* There, high natural gas prices combined with record setting consumption for heating and other non-power generation uses resulted in increased use of fuel oil for generation over the entire period. This increased consumption depleted inventories, the resupply of which was delayed in transportation due to the winter storm (reported in the media as the "bomb cyclone"). As mentioned, a nuclear power station in Massachusetts was forced offline due to a transmission system outage on January 4, removing 685 MW of baseload generation for several days. While reliability was maintained, this event further tightened the capacity situation across the New England ISO footprint until temperatures warmed,

> oil supplies were replenished, and the nuclear plant came back online on January 10.[19] (emphasis added)

In other testimony before the U.S. Senate that day, Gordon van Welie, President and CEO of ISO-NE, the entity charged with ensuring reliability and dispatching the generation fleet in New England to meet electrical needs, expressed his own concern regarding the reliability implications of relying on oil-fired generation given the uncertainty of re-supplying oil during winter conditions:

> [Fuel supply constraints] raise reliability challenges. First, a high burn rate for oil-fired generators diminishes oil inventory which inevitably needs to be replaced. However, during a snow or ice event, replenishment can be difficult (or impossible). Second, emissions regulations limit the run-time of oil-fired generators. While we weathered a stretch of extremely cold weather and a blizzard, we remain concerned about resupply of these resources during the remainder of the winter season and are in close coordination with state and federal officials about the challenges of ensuring adequate oil supplies to the region. Finally, given the fuel constraints, the rapid depletion of the oil inventory, and the reality that resupply was several days away during the peak of the cold weather period, our biggest operating concern was that we would experience a large, multi-day system contingency during this period or that oil-fired generators would run out of fuel before they could be resupplied.[20]

In addition, ISO-NE indicated that as of January 8, 2018, more than 75% of the oil-fired generation fleet had less than three days of oil inventory.[21]

Moving forward, these reliability issues could become more pronounced. On January 17, 2018, ISO-NE released the *Operational Fuel-Security Analysis*, a study of fuel supply issues and their implications for New England.[22] To assess the situation, ISO-NE forecasted market outcomes under a range of scenarios for Winter 2024/25 to determine whether sufficient fuel security would exist to ensure effective electric grid operations in New England in light of changing market conditions, including the retirement of the Pilgrim Nuclear Power Station, increasing renewable generation, and retirements of coal plants. The study's key findings are as follows:

> [T]he possibility that power plants won't have or be able to get the fuel they need to run, particularly in winter, is the ***foremost challenge to a reliable power grid in New England.*** (p. 4; emphasis in original)
>
> …….
>
> In almost all future resource combinations, the power system was unable to meet electricity demand and maintain reliability without some degree of emergency actions. (p. 8)

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19 Testimony of Charles A. Berardesco, Interim President and Chief Executive Officer of North American Electric Reliability Corporation Before the United States Committee on Energy and Natural Resources, "The Performance of the Electric Power System Under Certain Weather Conditions," January 23, 2018, p. 5.

20 Testimony of Gordon van Welie, President & Chief Executive Officer, ISO New England Before the US Senate Committee on Energy & Natural Resources, January 23, 2018, p.2.

21 ISO New England, "Cold Weather Operations: December 24, 2017 – January 8, 2018," January 16, 2018, p. 19.

22 ISO New England, "Operational Fuel-Security Analysis," January 17, 2018; *see also*, North American Electric Reliability Corporation, "Special Reliability Assessment: Potential Bulk Power System Impacts Due to Sever Disruptions on the Natural Gas System," November 2017.

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> 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 the fuels used most often to generate the region's power. New England has no indigenous fossil fuels and therefore, fuels must be delivered by ship, truck, pipeline, or barge from distant places. (p. 14)

…….

> The results show that in most future power system scenarios studied, adequate levels of fuel would not be available throughout the entire winter…… Under the wide range of scenarios studied, in all but the most favorable future resource-mix combinations and in all key resource outage scenarios, the study shows that New England's fuel-security risk could become acute by winter 2024/2025, requiring frequent use of emergency actions. (p. 32)

…….

> The major trends affecting the New England power system are moving in a negative direction. (p. 33)

In short, the ISO-NE study identifies major potential problems for the reliability of the electric grid. ISO-NE found that, as early as 2024/25, the electric grid could be in jeopardy if New England's ability to provide for adequate fuel security is not significantly enhanced. It is noteworthy that the study is predicated on normal weather rather than on more extreme type weather such as that observed in recent New England winters. In fact, ISO-NE identified that rolling blackouts will be required in the winter of 2024/25 in 19 of 23 scenarios considered.[23]

23 This situation could be exacerbated by aggressive emissions reduction goals that include significant conversions to electric vehicles ("EVs"). The average EV uses electricity that is equivalent to approximately 40% of average Massachusetts residential consumption on an annual basis, and has a peak charging rate of approximately 7kW. Massachusetts' goal to have 302,000 EVs on the road by 2025 could increase annual electric usage by 875 GWh/year, and which could also affect electricity usage during peak periods as well. (*See, e.g.,* 10,027 miles/vehicle/year (U.S. Department of Transportation, Federal Highway Administration); 0.3 kWh/mile for a 2017 Nissan Leaf (U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy); average Massachusetts residential consumption of 7,188 kWh/year (U.S. Department of Energy, Energy Information Administration); 11,014 EVs sold in Massachusetts since 2011 (Global Automakers, Driving ZEV); and 7kW charging capacities (Green Car Reports and Chevrolet Product Information: 2018 Chevrolet Bolt EV)).

SECTION 6:

ECONOMIC COSTS OF THE NEW ENGLAND FUEL SECURITY PROBLEM

Energy prices in New England are the highest in the continental U.S, according to analysis produced by the Energy Information Administration.[24] New England's pricing dynamics for natural gas are largely explained by the relationship between weather and natural gas pipeline capacity. When temperatures drop, demand for natural gas for heating increases. When heating demand increases, gas utilities rely more heavily on their contracted pipeline capacity, reducing the availability of natural gas for short-term purchases such as those made by electric generators and industrial customers. When the availability of short-term natural gas is reduced, natural gas prices increase as parties (particularly electric generators) compete for that limited natural gas supply.

The region has experienced cold weather and record-setting natural gas prices multiple times in recent years. For example, during the "Polar Vortex" of January-February 2014, the Northeast U.S. experienced a period of extended extreme cold, and as a result, natural gas prices in New England increased to record levels. The following winter (*i.e.*, 2014/2015) saw cold weather and record setting snow fall for New England, and while natural gas prices did not reach record levels, they were still relatively high. The region again experienced a period of significant cold and snow this winter in late December 2017/early January 2018, sometimes referred to as the "Bomb Cyclone," and New England became what some observers called the "World's Priciest Gas Market."[25] The cold weather in early January 2018, coupled with an unplanned outage at the Pilgrim Nuclear Power Station,[26] which put further upward pressure on demand for natural gas as additional generation was required to be dispatched, caused natural gas prices to again reach record levels.

As shown in Figure 9, natural gas prices in winters that have experienced colder weather have been significantly higher than natural gas prices in relatively warmer winters. For example, during the Polar Vortex winter of 2013/2014, natural gas prices in Boston peaked at over $75/MMBtu, and averaged over $15/MMBtu.[27] This winter, Boston natural gas prices peaked at over $80/MMBtu, and averaged over $7.30/MMBtu. To put New England's natural gas prices in context, during the same winters shown in Figure 9, natural gas prices in the Pennsylvania production area, which is only a few hundred miles away, were significantly lower. In fact, since the winter of 2012/2013, Pennsylvania production area winter natural gas prices have never reached $9/MMBtu on any day and have averaged less than $3/MMBtu.

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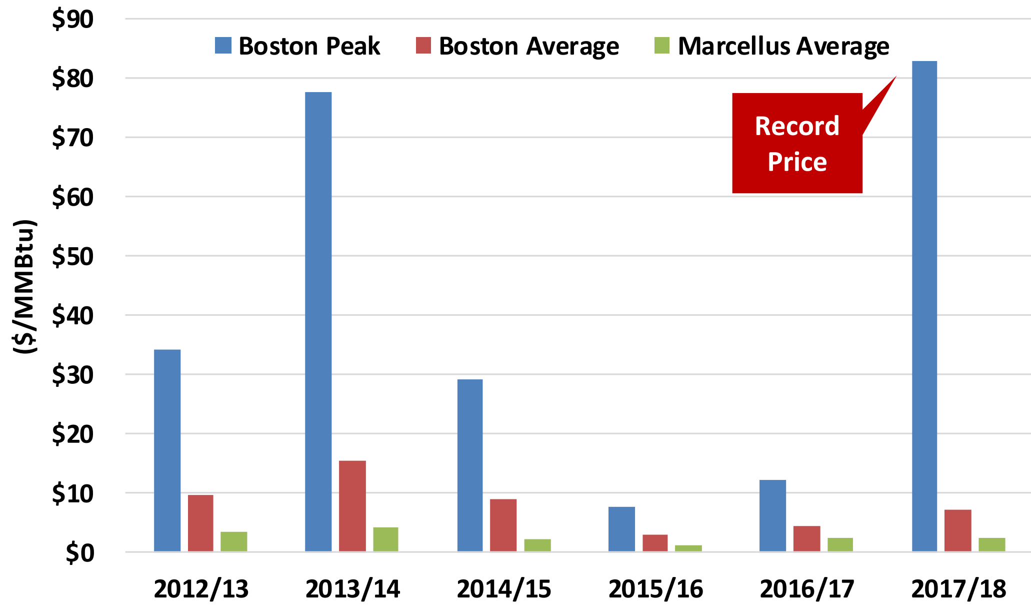
24 U.S. Energy Information Administration, "State Energy Data 2015, Table E15. Total Energy Price and Expenditure Estimates, Ranked by State, 2015," June 30, 2017.

25 Bloomberg Markets, "Cold Snap Makes New England the World's Priciest Gas Market," December 26, 2017.

26 Reuters, "UPDATE 2- Energy Shuts Massachusetts Pilgrim Nuclear Plant During Blizzard," January 4, 2018.

27 All price data in this section are the result of calculations by Concentric using data provided by S&P Global Market Intelligence. The winter heating season is typically considered to run from November through March, and that convention has been used herein.

Figure 9. Winter Natural Gas Prices – Boston v. Pennsylvania Area Production



For the most part, residential and commercial natural gas customers of gas utilities are insulated from these price increases due to gas utilities contracting for pipeline capacity and storage, as described previously. However, since electric generators in New England hold few or no such contracts, increases in the price of natural gas are passed through to consumers via increases in power prices.

The relationship between natural gas and power prices in New England is due to New England's reliance on natural gas for generation. Under most conditions, natural gas-fired generation sets electric prices in New England; occasionally, during periods in which the cost of natural gas becomes very high and/or natural gas is unavailable due to the lack of available pipeline capacity, more oil-fired generation is required to operate. Because fuel oil is relatively more expensive compared to (typical) natural gas prices, whether natural gas-fired generation is producing power with natural gas subject to elevated prices or oil-fired generation is being dispatched instead, either occurrence tends to result in electric price increases.

Due to the commercial structure of the New England wholesale electric markets, where generators' bids to produce power are largely based on their fuel cost, the price of natural gas significantly affects the price of electricity. Using the winters of 2013/14 and 2017/18 as examples, the impact of relatively high natural gas prices in New England on power prices is shown in Figures 10 and 11, highlighting that when natural gas prices have increased in New England, power prices have also increased.[28]

[28] In New England, wholesale electric prices are referred to as Locational Marginal Prices ("LMPs"). All power prices discussed herein refer to the Day-Ahead LMP for the MassHub, the key wholesale pricing index in New England. LMPs are transacted on an hourly basis. The data in Figures 10 and 11 are daily average prices calculated by Concentric using data provided by ISO-NE.

Figure 10. Winter 2013/14 Daily New England Power and Natural Gas Price

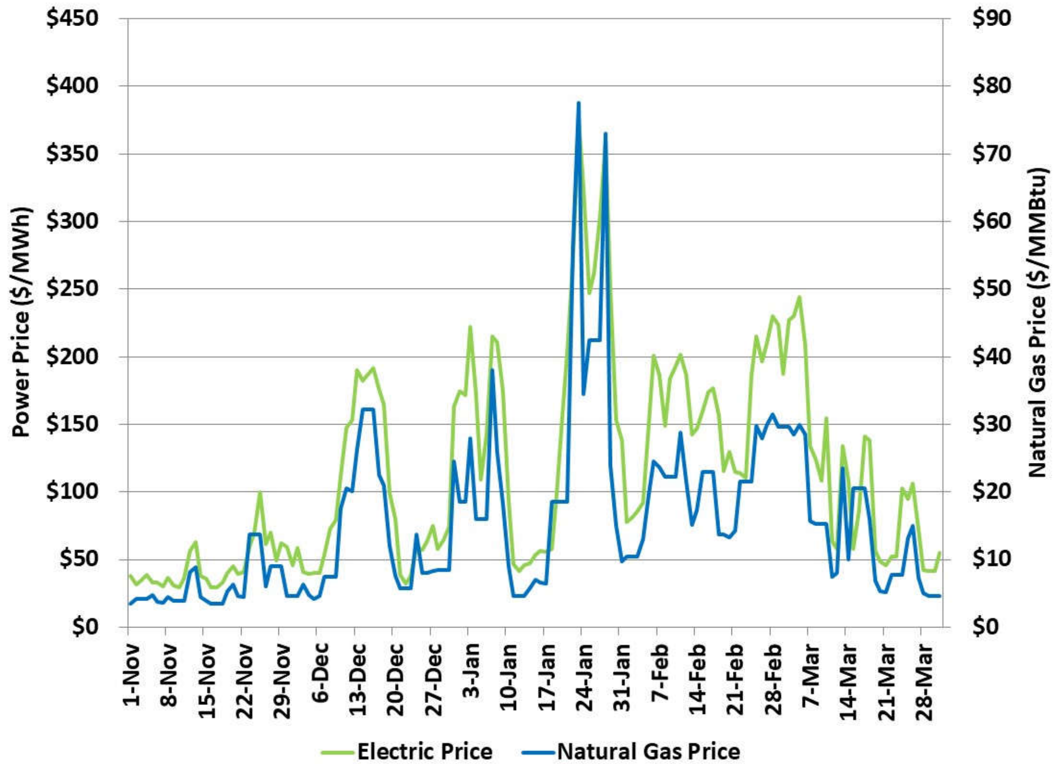
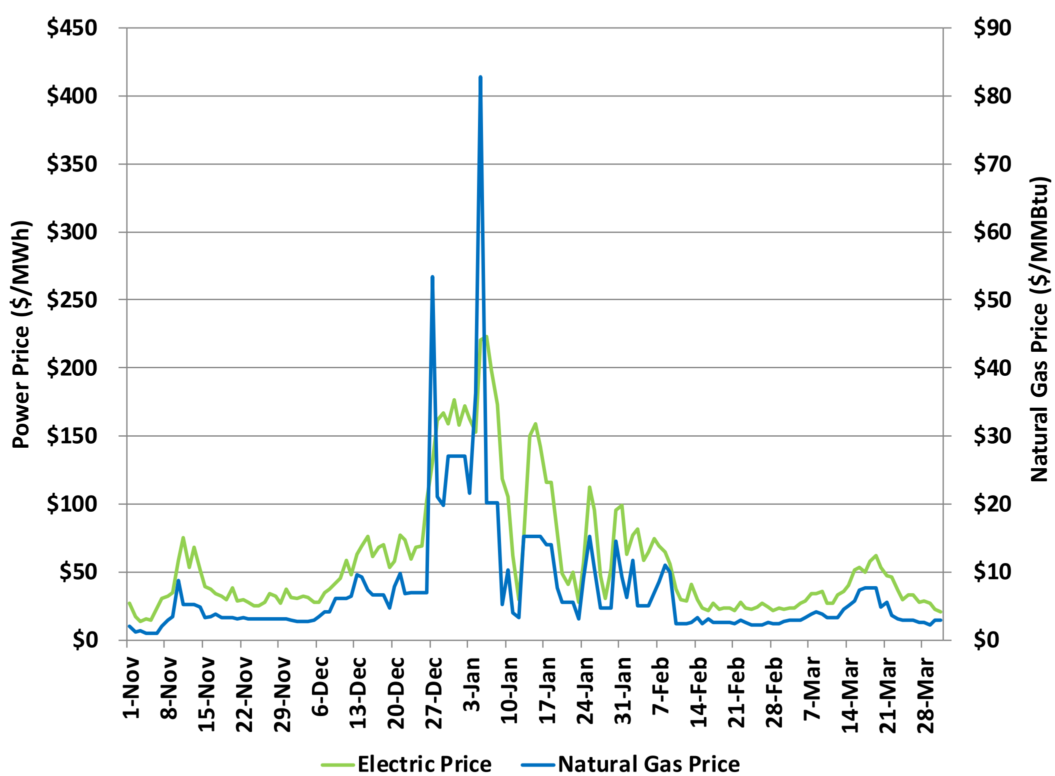
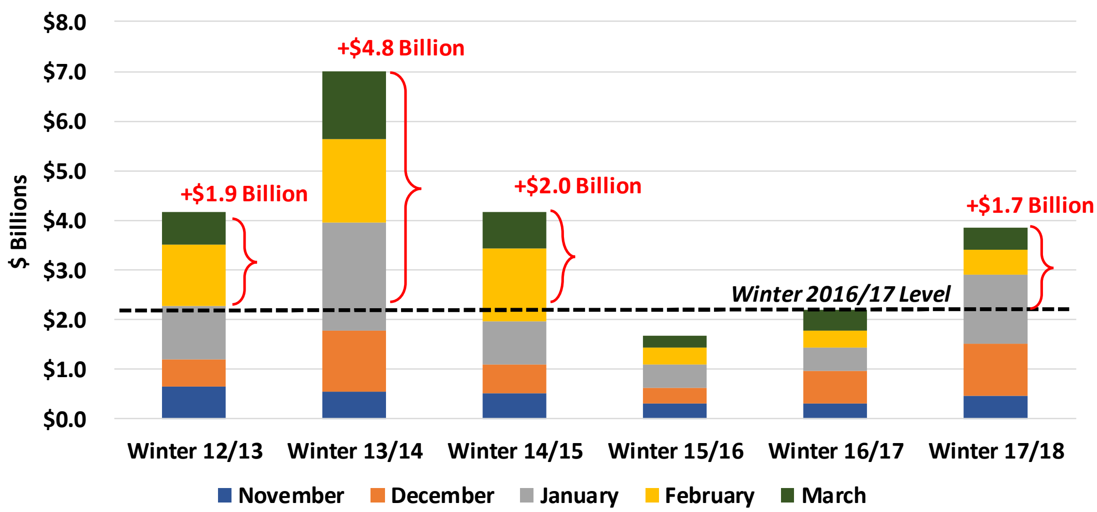


Figure 11. Winter 2017/18 Daily New England Power and Natural Gas Price



The costs that have been borne by New England consumers as a result of these energy price increases have been substantial. Specifically, as shown in Figure 12, electric costs in the Polar Vortex winter of 2013/2014 were $4.8 billion higher than electric costs in the winter of 2016/2017 when the weather and natural gas prices were more moderate. In addition, electric costs this winter exceeded the total electric costs from last winter by $1.7 billion.[29]

Figure 12. Magnitude of Costs to New England Consumers from Elevated Electric Prices



In actuality, the determination of the direct costs to consumers of high natural gas and electric prices is more complex (*e.g.*, prices vary by location in New England; there is a relationship between prices and demand on a daily and hourly basis; and consumption varies from winter to winter). However, these results reflect the order of magnitude of the costs that are directly passed on to New England electric customers when high natural gas prices create increases in power prices.

In addition, while electric customers have borne significant cost increases as a result of the elevated wholesale electric prices, natural gas customers that purchase supplies on the wholesale market have also been exposed to price increases. As noted, gas utility customers do not generally face higher costs when natural gas prices in New England are higher; however, those customers that purchase their own fuel, such as larger industrial customers, can be exposed to higher costs if they have not hedged their purchases and/or cannot curtail their operations during high-price periods.

Lastly, there are other, indirect economic costs to which New England is exposed. Higher energy bills create a "drag" on the economy that would not otherwise be present and hinders economic growth and opportunity. Elevated energy costs also tend to make New England less competitive than other areas in attracting investments from businesses. In fact, an April 2017 report published by the U.S. Chamber of Commerce estimates that continuing the status quo, defined as "a severely constrained ability to build new energy development infrastructure" into New England would result in a loss of 22,900 jobs and $2.0 billion in state GDP in New England, including a loss of 8,700 jobs and $792 million in state GDP in Massachusetts alone, over a four-year period.[30]

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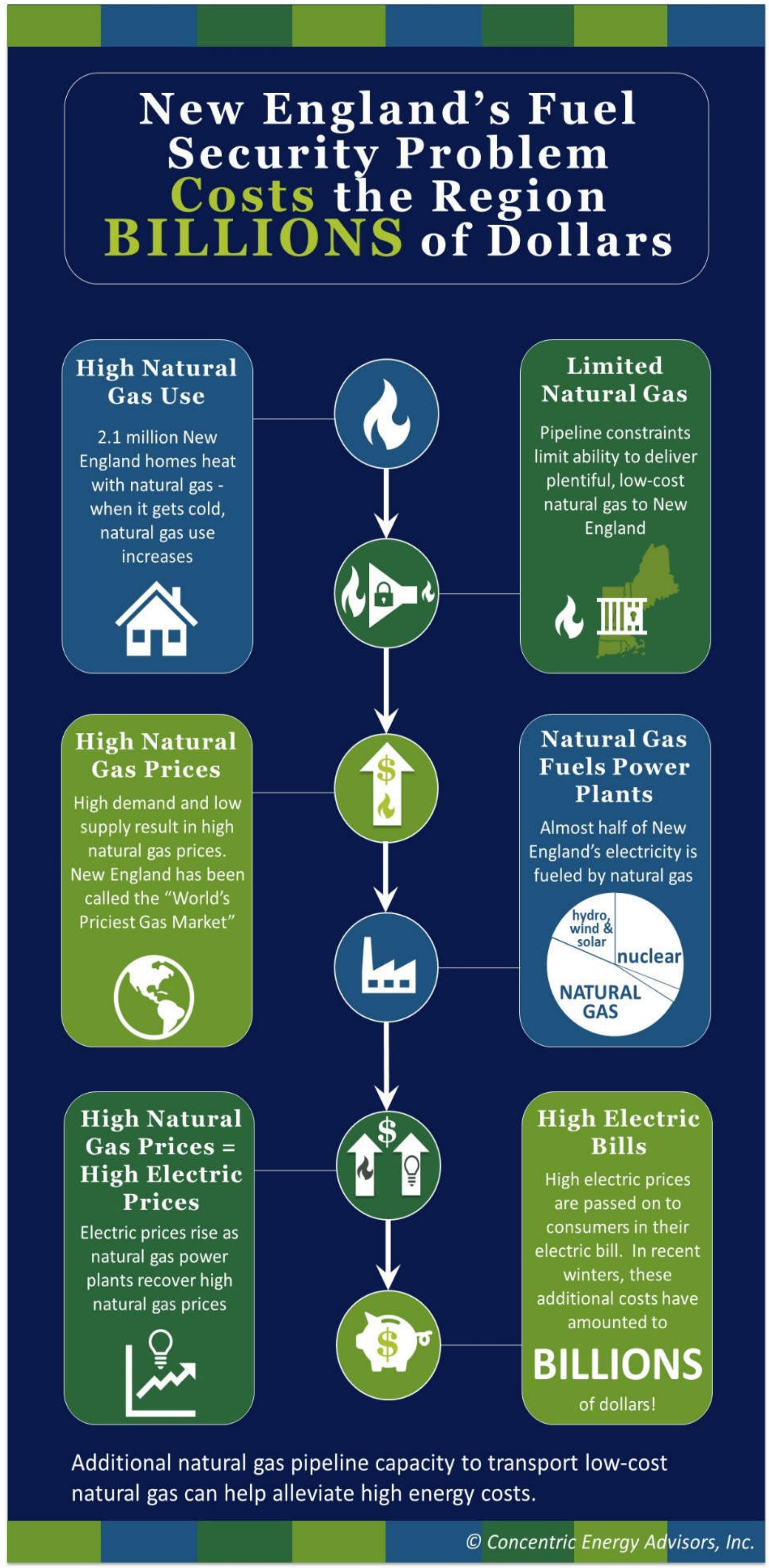
29 ISO New England, "Average Monthly Wholesale Load Cost Report," for the years 2012-2018, www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/mthly-whl-load-cost-rpt.

30 U.S. Chamber of Commerce Institute for 21st Century Energy, "What if… Pipelines Aren't Built into the Northeast?," April 2017, p. 11.

APPENDIX A:
SITUATIONAL ANALYSIS

- It is clear that immediate action is required to reduce GHG emissions and the energy costs being borne by New England customers, and to ensure that the electric grid continues to operate in a safe and reliable manner in the next decade and beyond.
- Natural gas is the most important fuel for home heating and electric generation in New England; however, a lack of local supply, and limited natural gas infrastructure create challenges in meeting New England's energy needs.
- As a result, New England must import natural gas via two sources – pipelines into New England and liquefied natural gas produced overseas.
- When heating demand increases, gas utilities rely heavily on their contracted pipeline capacity, reducing the availability of natural gas for short-term purchases such as those made by electric generators and industrial customers.
- Reduced natural gas availability causes power generators to rely on oil and coal, substantially increasing GHG emissions.
- With reduced availability, natural gas prices increase as competition for the limited pipeline capacity increases.
- The elevated costs that are borne by New England consumers as a result of these natural gas and electric price increases are substantial.
- Future strategies in New England to reduce GHG emissions, such as increasing use of electric vehicles, will increase the need for clean, affordable, and reliable energy sources.



Concentric Energy Advisors is a management consulting and financial advisory firm focused on the North American energy industry. Our firm was founded in 2002 by a small group of executive-level consultants committed to establishing a mid-sized energy consulting firm with capabilities and a reputation unsurpassed by any firm in North America. Since its inception, Concentric has grown more than eight-fold and has significantly expanded its service offerings, while remaining focused on achieving the highest standards of consulting excellence in the energy field.

The expertise of our staff spans all aspects of the North American energy markets. We offer a broad range of advisory and support services that enable our clients to address diverse needs comprehensively without the difficulty of retaining and coordinating multiple resources. Through our subsidiaries, CE Capital Advisors, Concentric Advisors ULC, and Concentric Energy Publications, we provide capital market advisory support, consulting services in Canada, and publish The Foster Report, respectively.

Concentric's experts have performed numerous strategic natural gas market assessments throughout North America for pipelines, producers, natural gas storage providers, LNG developers, and lenders. These assessments have evaluated historical and future markets for energy assets, and have considered aspects including risk assessments, comparative cost assessments, valuations, quantifications of savings associated with new infrastructure, and regulatory environment and policy assessments.

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