

Demand Response for Natural Gas Distribution

Opportunities and Challenges

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THE **Brattle** GROUP

Agenda

- **Executive Summary**
- Setting the Stage
- The Natural Gas DR Value Proposition
- Challenges of Natural Gas DR
- Is there a Future for Natural Gas DR?

Executive Summary

- Natural gas supply constraints due to peak (heating) demand – most often caused by “polar vortex” type events – result in high daily natural gas and electric prices
- Price spikes largely affect electric customers; natural gas retail customers usually not exposed to wholesale daily price spikes at citygate locations
- Various solutions (e.g., new gas pipelines/expansions, better utilization of existing LNG infrastructure, etc.) are being proposed to solve the peaking issue
- Natural gas demand response (“Gas DR”) could be a part of the solution, but has been underexplored. It has the potential to:
 1. Help reduce gas and electric price spikes and improve electric sector reliability in the short-run
 2. Drive value in the long-term by deferring or avoiding costly infrastructure investments
 3. Provide environmental benefits in the short run by displacing oil in electric generation with cleaner burning natural gas and in the long run by avoiding a natural gas “lock-in”
- The potential for natural gas DR should be carefully analyzed and quantified
- Regulatory, market, and technical challenges for Gas DR exist and would need to be addressed

What is natural gas DR?

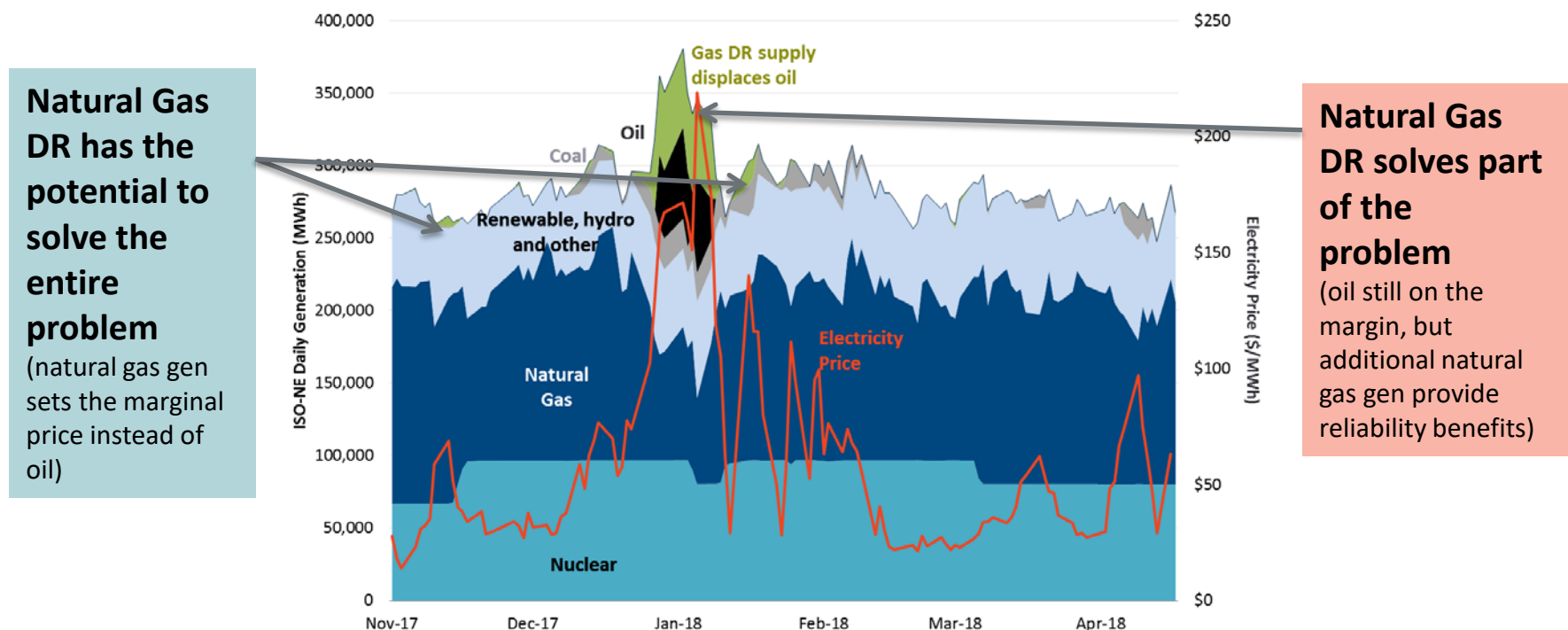
- Natural gas DR relates to reduction in demand by natural gas customers (residential, commercial, and industrial) during peak periods, either in response to prices or direct load control by the utility
 - Res/com: heating demand reduction (e.g., via thermostat control, via water heater temperature settings)
 - Com/Ind: interruptible service/fuel switching
- Natural gas DR is different from energy efficiency; energy efficiency reduces the overall demand while natural gas DR primarily reduces the peak demand

Focus of our presentation is primarily on the demand response provided by residential/commercial customers managing their heating demand (e.g., by raising thermostat temperature)

In the short-term, natural gas DR could entirely avoid some price spikes and help improve reliability

- Electric prices spike as high-cost alternatives to natural gas (e.g., oil) are the marginal fuel
- Natural gas DR could allow gas-fired generators to displace high-cost alternatives and potentially set electricity price; also improves grid reliability if fuel availability is the issue
- E.g., if natural gas DR reduced LDC demand by 10% on a peak day (413 MMcf/d), around 54,000 MWh additional electricity could be generated with natural gas (instead of oil)

ISO-NE Generation Mix vs. Wholesale Electricity Price, Winter 2017-18

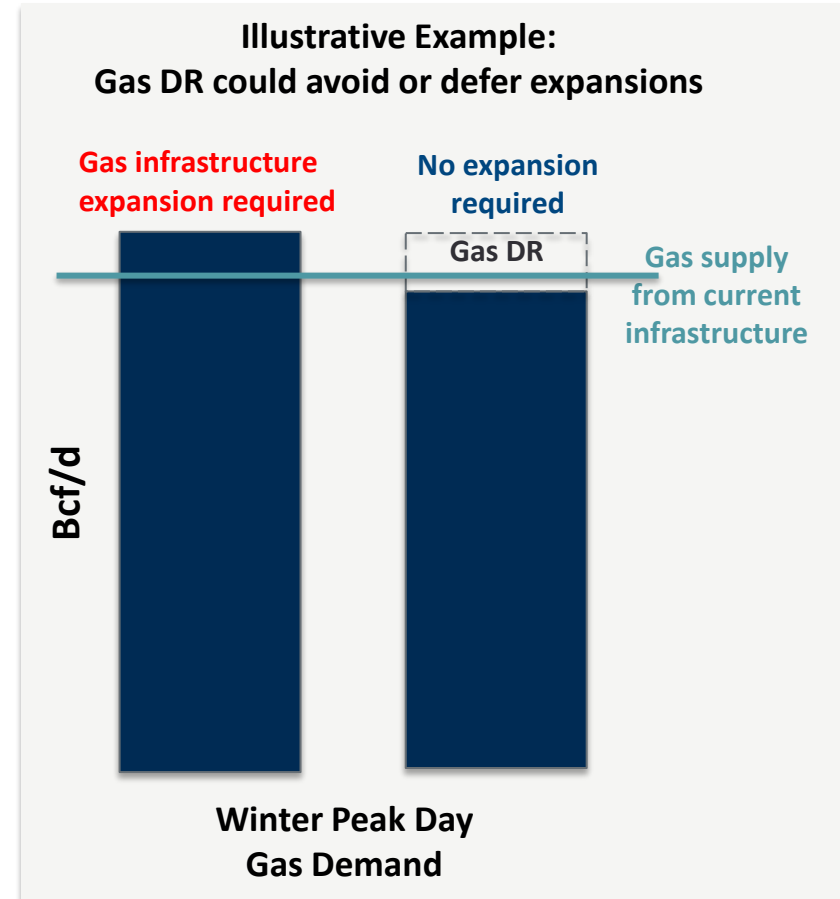


Sources: ISO-NE Daily Generation By Fuel (generation mix): <https://www.iso-ne.com/isoexpress/web/reports/operations/-/tree/daily-gen-fuel-type>; S&P Global Market Intelligence LLC

Note: "Renewables" include the solar and wind categories. "Other" includes the refuse and other categories.

Natural gas DR could also provide value by deferring or avoiding investments in the longer run

- Deferral of a \$100-\$500 million gas pipeline or LNG peak-shaving investment could save \$10-\$70 million/year (assuming 5-10% cost-of-capital and 30-year depreciation)
- Reduction in the size/scope of the required infrastructure project could also provide savings
 - E.g., Reduction in infrastructure needs by 100,000 Dth/d could result in cost savings of ~\$60 million/year (assuming levelized cost of pipeline expansion in New England is ~\$1.50/Dth)
- Could also defer or avoid gas infrastructure investments mandated by electric sector needs (potentially regulatory driven)
- May help improve average utilization of natural gas infrastructure



Size/cost of the gas DR opportunity and implementation challenges need to be explored

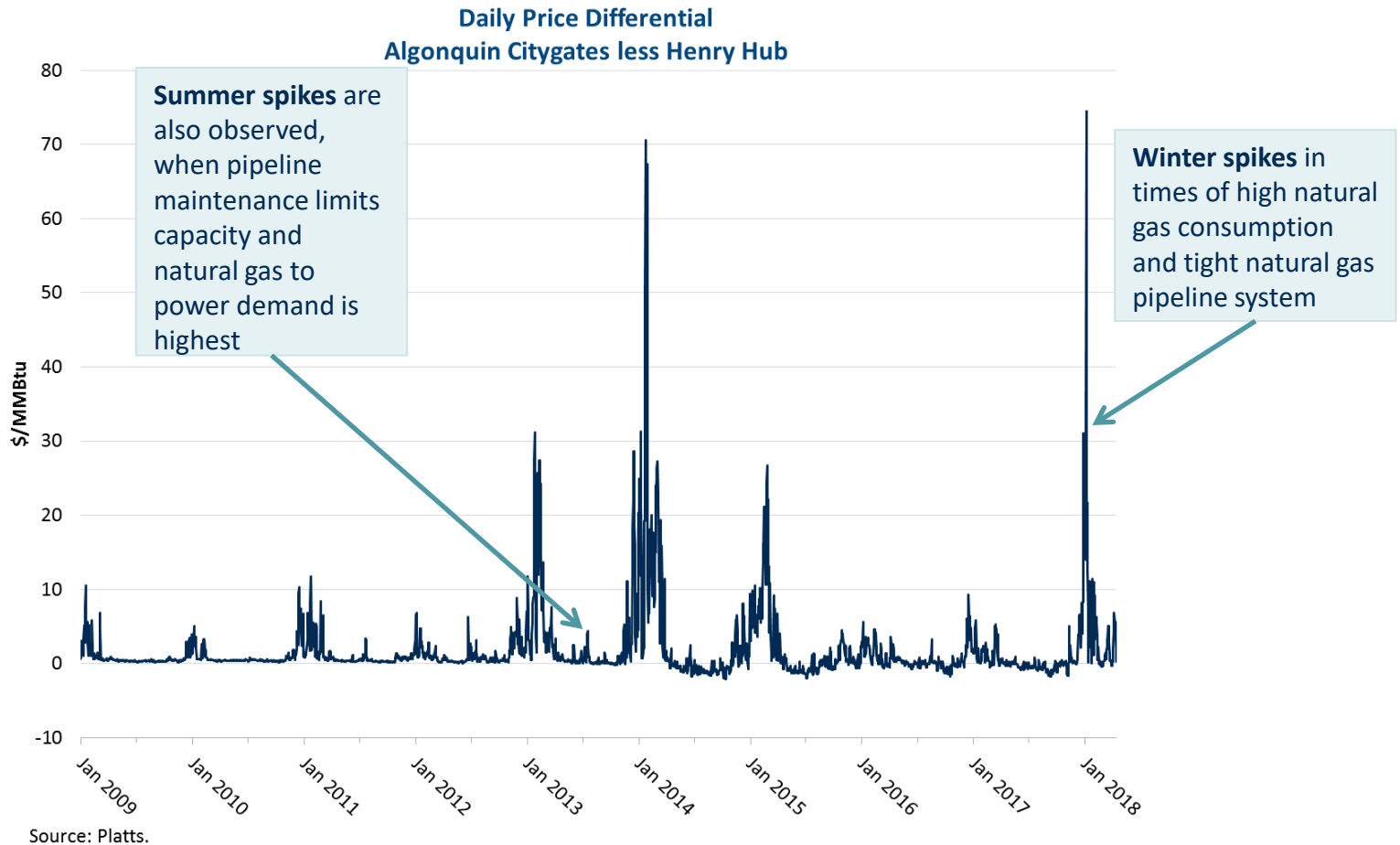
- How much gas DR could contribute to solving “polar vortex” type events requires an assessment of the technical, economic and achievable potential on a regional basis
 - Gas DR supply curves by region would help assess both the quantity of gas DR available and the cost of activating gas DR
 - Would provide a basis for evaluating the value of gas DR as an alternative to other proposed solutions
- Gas DR is a relatively unproven concept and therefore likely faces various challenges
 - It is unclear how much gas DR can be activated with existing technology
 - Market timing for electricity and gas is not aligned
 - Benefits are most likely to accrue to electric customers, but action is required by gas customers, which creates significant regulatory issues
- Gas DR potential studies could be useful to assess potential and identify various barriers for implementation

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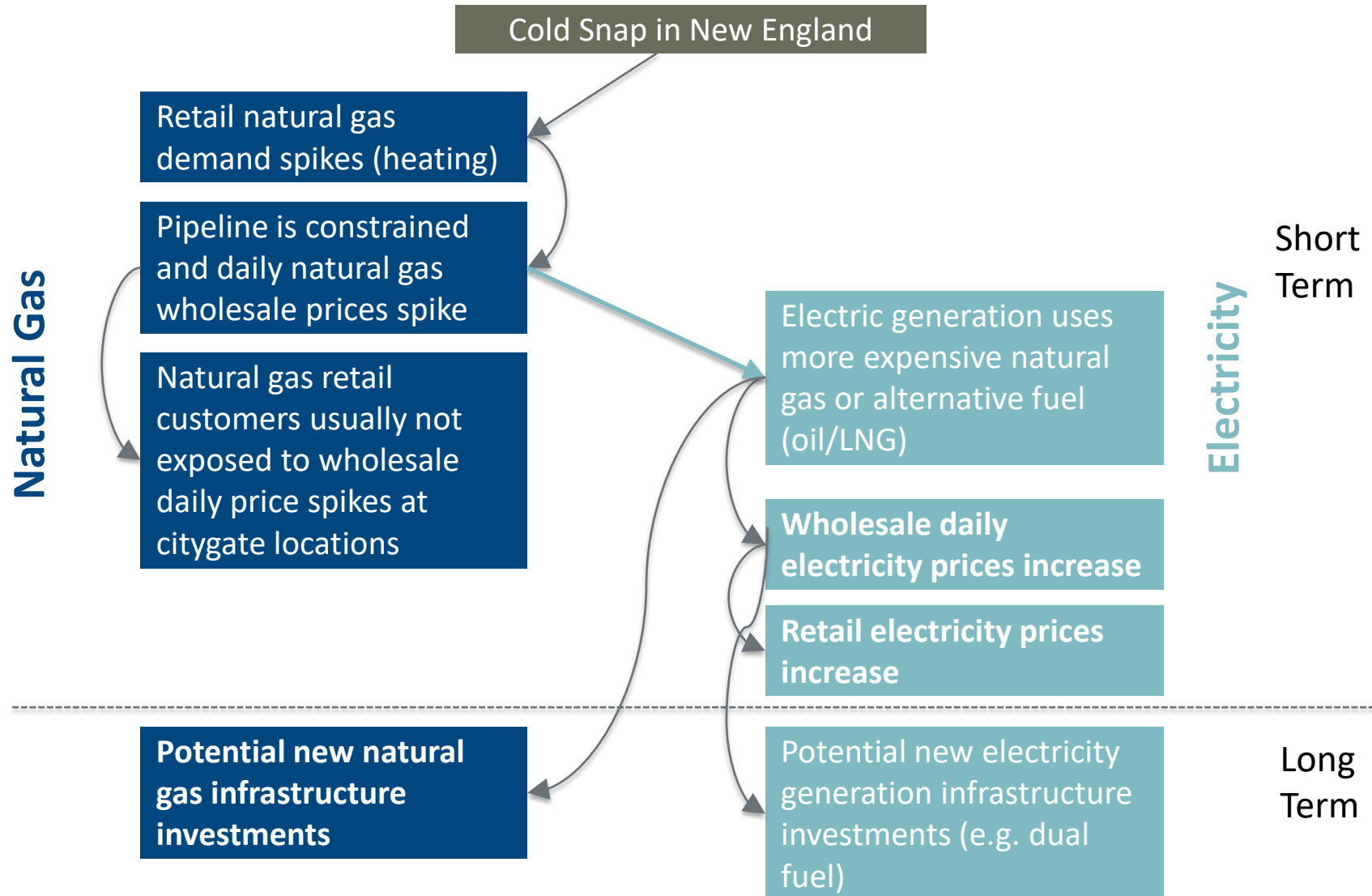
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Natural gas supply constraints during peak demand periods result in high prices

For example in New England, daily natural gas price spikes (relative to the Henry Hub) have been significant in recent years at citygate locations



Sporadic high gas demand leads to higher short term and potentially long term costs



Repercussions of record highs natural gas prices on peak day electricity generation

“[In 2017] fuel security was already of particular **concern within New England and southern California** because of limited natural gas transportation and storage infrastructure”

Commissioner Neil Chatterjee at FERC's
April 19 monthly open meeting

“[Commissioner Robert Powelson noted that] in California, a combination of nuclear plant closures, lower gas storage levels at Aliso Canyon and the state's ambitious target to get 50% of its energy from renewable resources have forced **FERC to approve reliability must-run agreements** for gas-fired units, which he called an **‘alarming situation.’ ”**

S&P Global Market Intelligence, April 19, 2018

“The intensely cold bomb cyclone weather event in early January [2018] resulted in record levels of U.S. natural gas demand and elevated wholesale natural gas and power prices around the country. A constrained natural gas pipeline network led to a significant increase in oil-fired and dual-fuel generation in New England and New York and, to a lesser extent, in the Mid-Atlantic.”

Northeastern Winter Energy Alert, EIA, Jan 22, 2018

Solutions available are often capital intensive, expensive or will take some time to achieve

	Cost	Capital Intensity	Implementation Speed	Environmental impact	Implementation challenges	Helps with winter peak
New gas pipelines						
Existing LNG Infrastructure						
New gas/LNG storage facilities						
Energy Efficiency						
Battery Storage						
Electric DR						
Natural Gas DR						

There is evidence that gas consumers do and can respond to signals

Modest decrease in thermostat temperature could reduce gas demand. In a 2014 presentation, Brattle estimated that a 1 degree (F) increase in temperature during the winter could lead to ~ 2% or 40 MMcf/day reduction in LDC demand in New England, and assumed that this estimation could be transposed to variation in thermostat temperature (i.e., ~2% or 40 MMcf/day reduction in LDC demand from decrease in thermostat temperature by 1 degree)

Gas energy efficiency programs have proven to be successful, including on peak days. SoCalGas's Seasonal Savings program for residential customers with a smart thermostat resulted in 8% gas heating savings during the winter of 2016-17. The MA DOER Nest Seasonal Savings programs resulted in a 3.5% heating savings in the winter of 2014-15 (73% of participants had gas fueled heating furnaces) – including significant results on the 10 peak days

Gas customers are price sensitive. Several studies have measured the price-elasticity of gas demand. E.g., recently, Auffhammer and Rubin, 2018 estimates a price elasticity on residential winter demand in California of -0.52 for low income and -0.32 for other residential customers

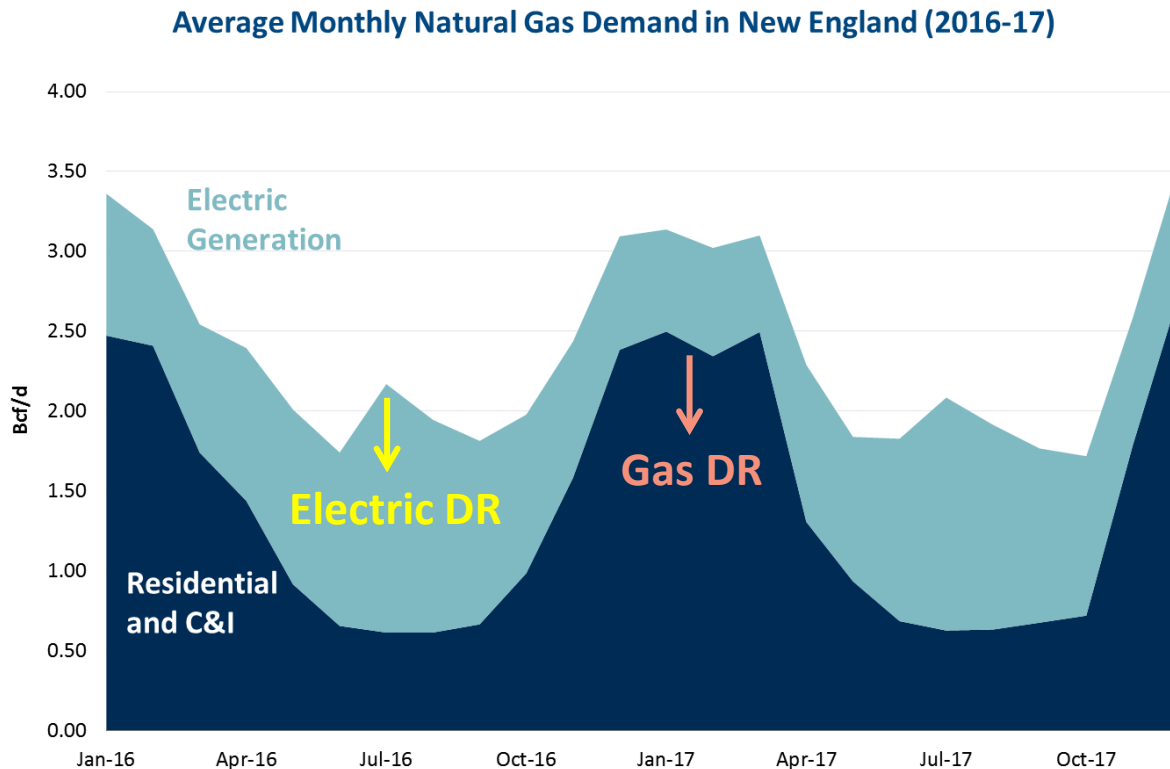
Interruptible rates for large C&I customers have long existed. E.g., lower rates offered by the utility in exchange for the right to curtail customers with the ability to switch fuels. However, gas utilities tend to limit the use of this lever

First residential gas DR initiatives show modestly encouraging results. SoCalGas 2016-17 Winter DR rebate pilot resulted in a 3.7% average reduction in demand on 3 of the 7 event days for residential My Account customers enrolled (with no smart thermostats) – other subsets of customers and other programs analyzed did not demonstrate any statistically significant results

Electric DR typically targets summer peak conditions, gas DR could help in winter peak conditions

Electric DR

Has the potential to reduce **summer peak** as it will impact gas demand for **electric generation** which peaks in the summer (air conditioning)



Gas DR

Has the potential to reduce **winter peak** as it will impact **residential and C&I** demand which peaks in the winter (space heating)

Source: The Brattle Group. Data from U.S. Energy Information Administration (2018).

Note: New England states include Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont

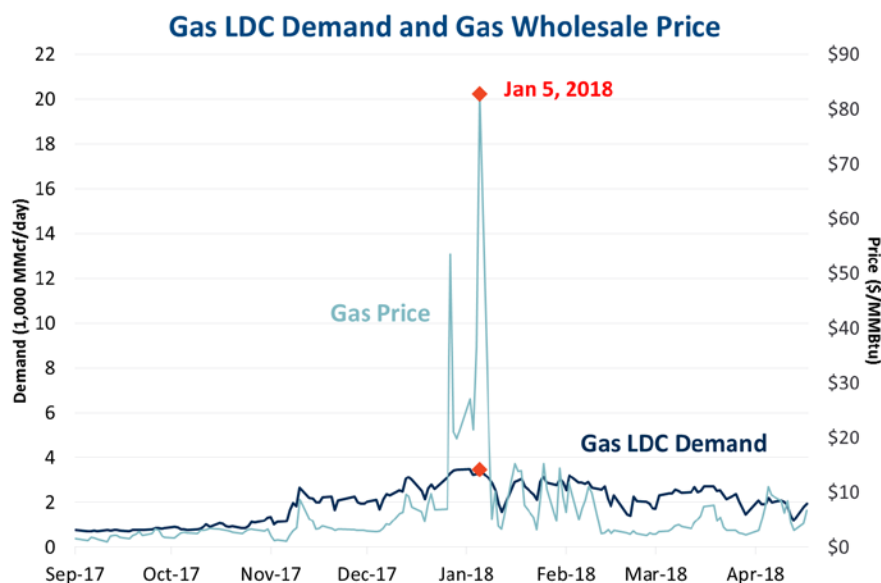
Electric DR programs are mostly focused on air conditioning, which is not available in the winter, when gas heating is dominant

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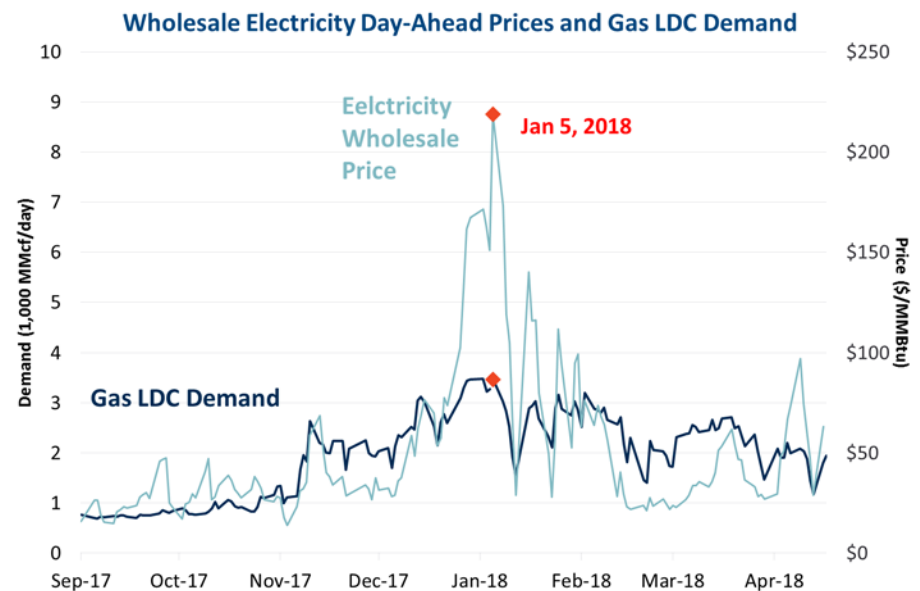
Peaking gas LDC demand coincides with wholesale electricity and gas price spikes

During the winter, both electricity and gas prices are strongly correlated with gas LDC demand, except on days when gas supply constraints occur and the marginal fuel switches to oil



Sources: S&P Global (prices) and Ventyx EV Operationally Enhanced Capacity dataset (demand).

Notes: Gas prices for Algonquin Citygates NG Price Hub. Demand for New England LDCs based on pipeline deliveries and not including LNG supply. New England gas utility sendouts totaled 4.13 Bcf on Jan 5, 2018 and 4.36 Bcf on Jan 6, 2018.



Sources: S&P Global (prices) and Ventyx EV Operationally Enhanced Capacity dataset (demand).

Notes: Electricity prices are for Northeast Mass Boston Price Node. Demand for New England LDCs based on pipeline deliveries and not including LNG supply. New England gas utility sendouts totaled 4.13 Bcf on Jan 5, 2018 and 4.36 Bcf on Jan 6, 2018.

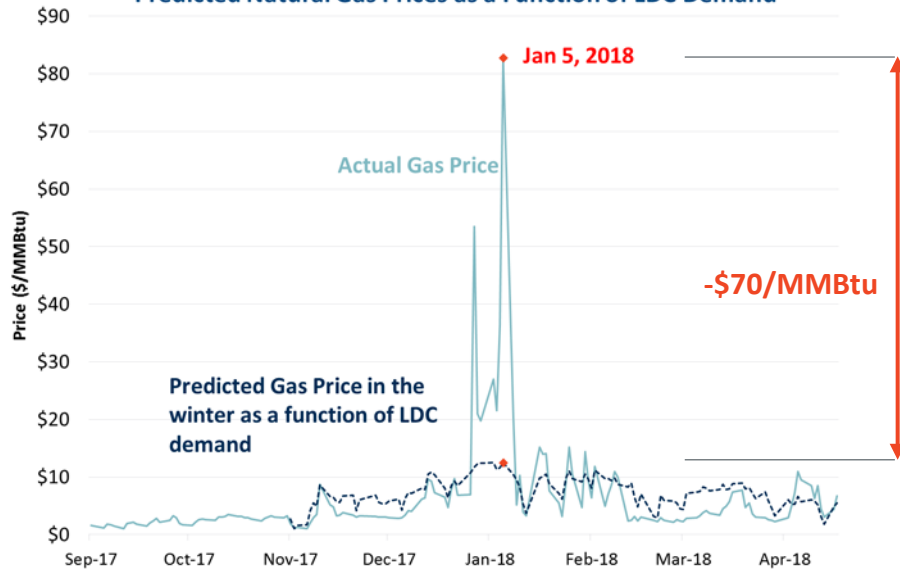
Jan 5, 2018 is the day with the highest electricity on peak price, highest gas price, and 2nd highest gas LDC demand in the winter 2017-18.

Reducing gas demand could help solve gas supply constraints and reduce price spikes

If constraints on the gas supply are relieved, wholesale electricity and gas spikes could be reduced

Illustrative Results

Predicted Natural Gas Prices as a Function of LDC Demand



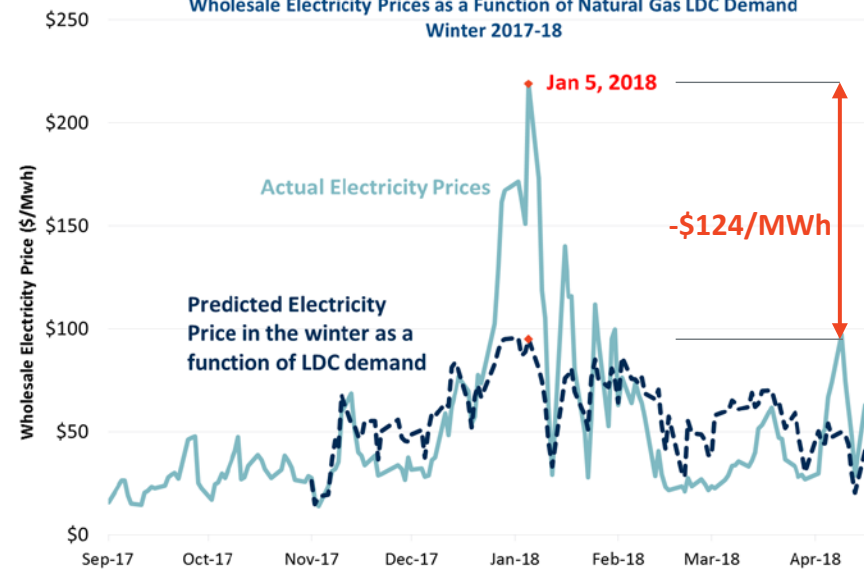
Source: S&P Global (actual price) and Brattle analysis (predicted price).

Note: Actual gas prices for Algonquin Citygates NG Price Hub.

Prices were predicted using a linear regression between wholesale gas price and gas LDC demand for winter days between 2013 and 2018, excluding the winter days when oil was the marginal fuel

Illustrative Results

Wholesale Electricity Prices as a Function of Natural Gas LDC Demand
Winter 2017-18



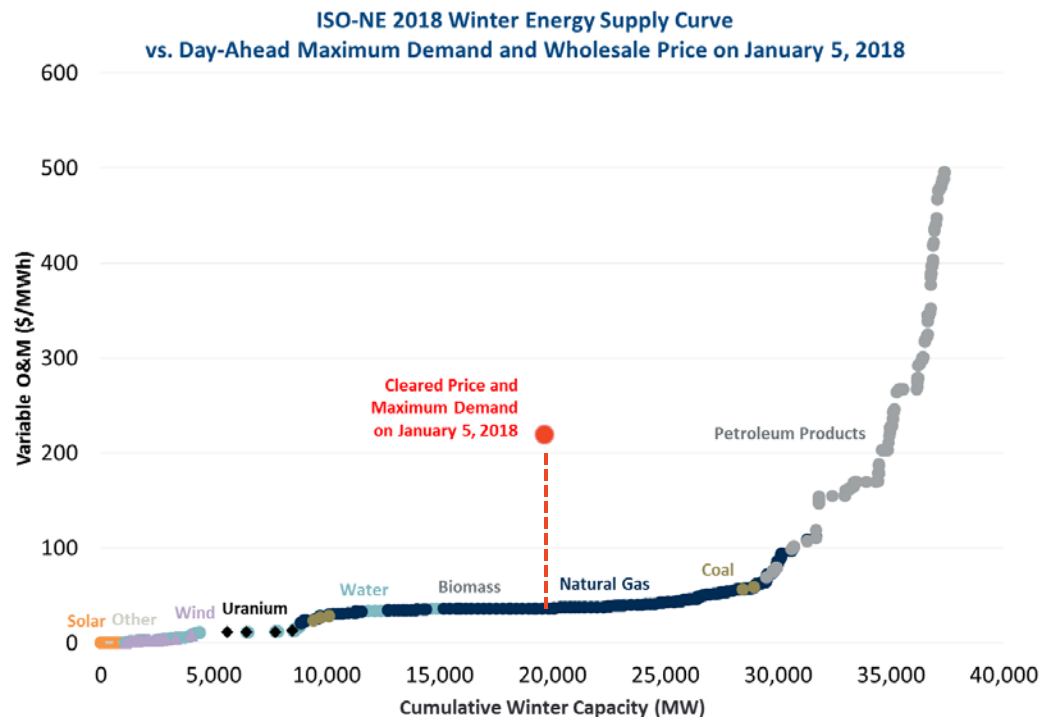
Source: S&P Global (actual price) and Brattle analysis (predicted prices).

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Prices were predicted using a linear regression between wholesale electricity price and gas LDC demand for winter days between 2013 and 2018, excluding the winter days when oil was the marginal fuel

During high natural gas demand periods, gas-fueled generation is not used to its full potential

Example for Jan 5, 2018: the day of winter 2017-18 which has the highest on-peak electricity price, due to a shift to oil as the marginal fuel while natural gas-fired plants could have been used



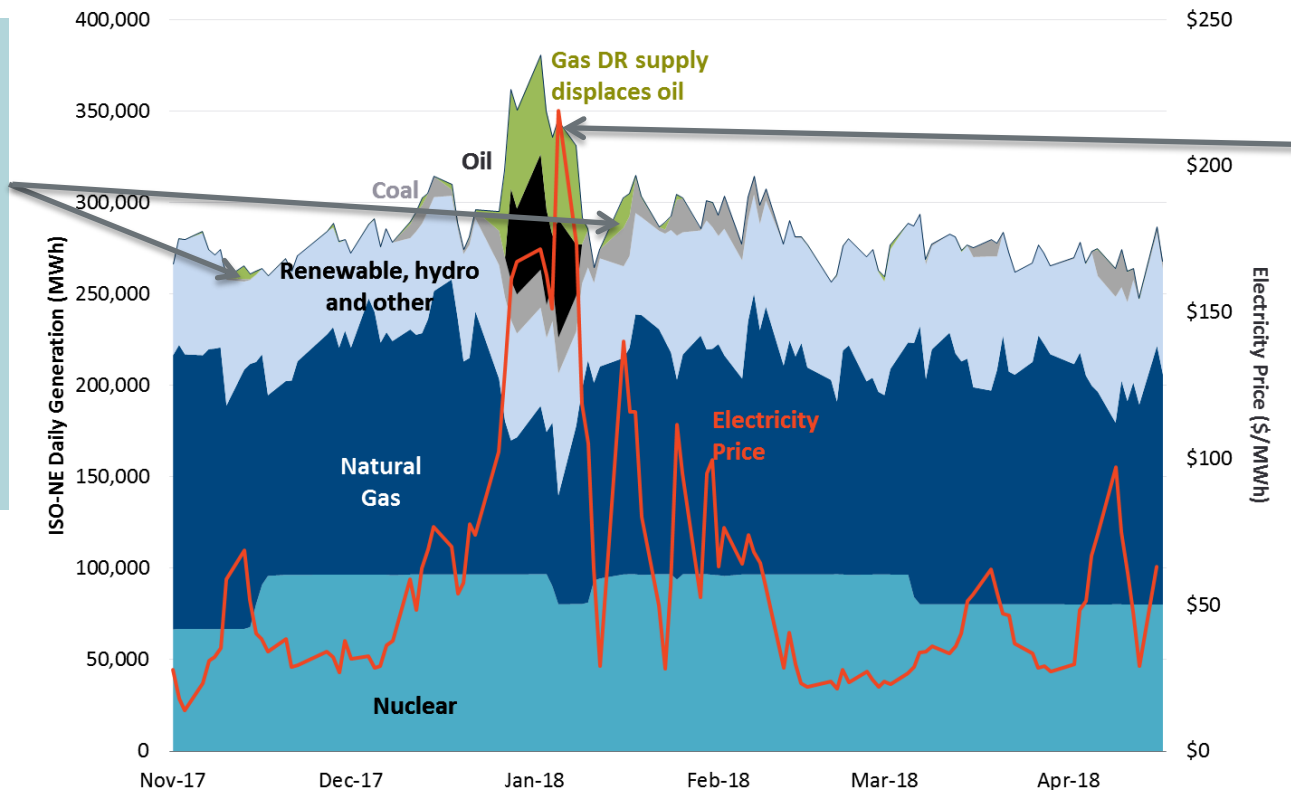
Sources: S&P Global Market Intelligence LLC (supply and price) and ISO-NE (demand).

Electricity market clearing price far above cost of natural gas fired generation implies that petroleum products were setting the market price and significant natural gas fired generating capacity was unused

Natural gas DR could entirely avoid some price spikes and help improve reliability

For instance, with up to 10% decrease in gas LDC demand on a peak day (~413 MMcf/d), up to 54,000 MWh/d additional electricity could be generated with gas (instead of oil)

ISO-NE Generation Mix vs. Wholesale Electricity Price, Winter 2017-18



Gas DR has the potential to solve the entire problem
(gas generation sets the marginal price instead of oil)

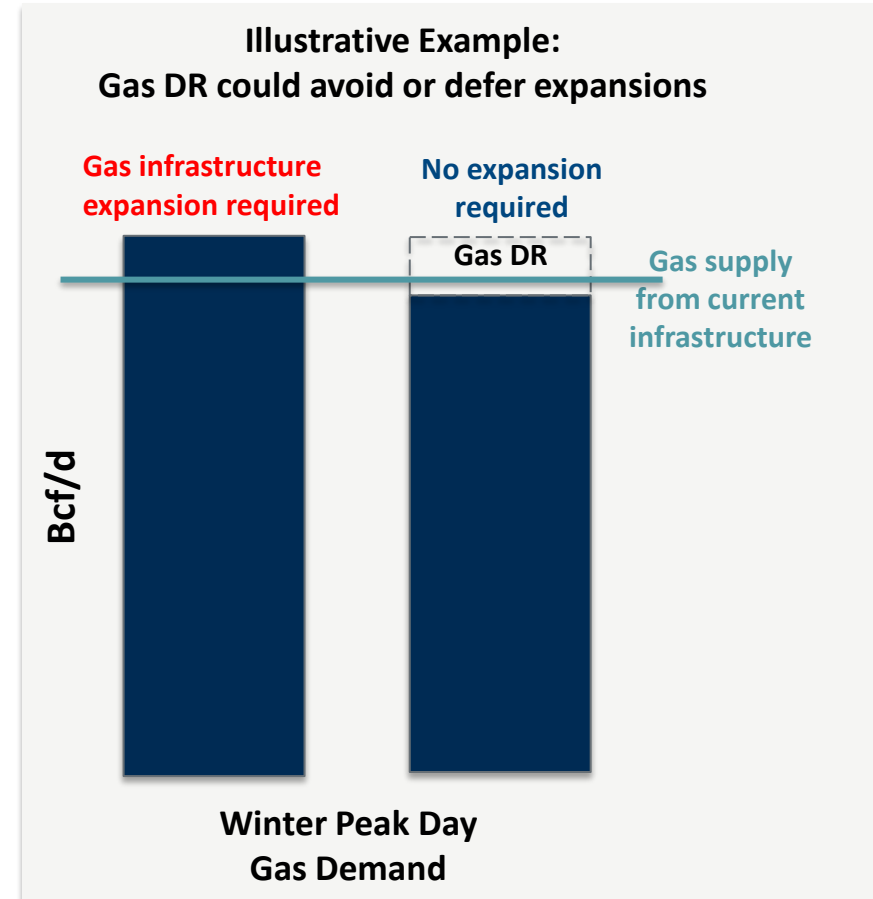
Gas DR solves part of the problem
(oil still on the margin, but additional gas generation provides reliability benefits)

Sources: ISO-NE Daily Generation By Fuel (generation mix): <https://www.iso-ne.com/isoexpress/web/reports/operations/-/tree/daily-gen-fuel-type>; S&P Global Market Intelligence LLC

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Natural gas DR could also provide value by deferring or avoiding investments in the longer run

- Deferral of a \$100-\$500 million gas pipeline or LNG peak-shaving investment could save \$10-\$70 million/year (assuming 5-10% cost-of-capital and 30-year depreciation)
- Reduction in the size/scope of the required infrastructure project could also provide savings
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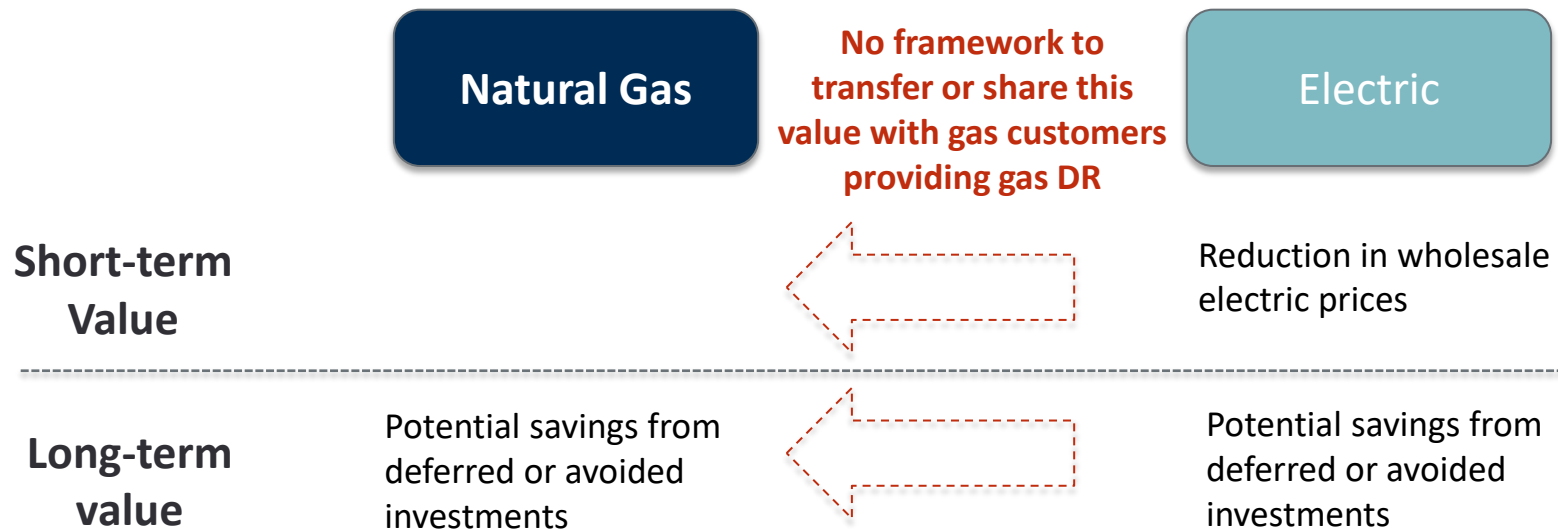


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Current regulatory and market structure is inadequate to activate natural gas DR potential

- Current regulatory and market framework does not allow natural gas customers to easily monetize value of providing gas DR
 - Natural gas DR currently does not participate in the electric market and therefore cannot benefit from value it creates in that market; e.g., benefits of reduced electric prices primarily accrue to electric customers
 - Price signals and potential natural gas demand response could be stronger if such value transfer was possible
 - Current regulatory framework also makes realizing full potential of natural gas DR challenging (e.g., natural gas/pipeline capacity made available due to natural gas DR may not be dedicated to gas-fired generators due to FERC rules)



Natural gas DR may also face other challenges

- **Lack of diversity in natural gas uses:** in comparison to electric DR, customers (particularly residential) have less flexibility because less natural gas-fueled appliances to manage. However, this may also lead to a high impact from decreasing thermostat temperature
- **Natural gas metering capabilities are limited:** the deployment of advanced gas meters (for daily measurement) for small and medium size customers is relatively limited, while it is widespread for electricity; but several combination utilities are updating both electric and gas meters with smart meters
- **Low customer engagement so far:** first natural gas DR programs for small customers have show low customer responsiveness (participation could improve if customers are adequately compensated and targeted)

Technology may not be a significant deterrent for at least some gas DR

DR programs **can be implemented without “smart devices”**

Can expect even better results when coupled with “smart” devices and/or when customers have access to more timely and precise usage data, such as

- **Smart thermostats** which allow remote control of gas furnaces (remote direct load control)
- **AMI** (and smart thermostats in some cases) which is used to collect usage data in a timely manner allowing for customers to be better informed, for programs to be more sophisticated programs, and for the utility to better evaluate the impact of DR programs

The **existing infrastructure** can be leveraged:

- Gas AMI is modestly deployed in the US (mostly for dual fuel utilities)
- Some smart thermostats have already been installed through electric EE and DR utility programs – joint gas and electric incentive programs could be designed

Smart thermostat



Smart meter



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A handful of utilities have already deployed natural gas DR programs

- **SoCalGas** launched the **first residential natural gas DR pilot** in the winter 2016-17 notifying customers on event days (without smart thermostats)
 - SoCalGas 2016-17 Winter DR rebate pilot resulted in a **3.7% average reduction in demand** on 3 of the 7 event days for residential My Account customers enrolled – other subsets of customers and other programs analyzed did not demonstrate any statistically significant results
 - CPUC approved the deployment of several natural gas DR programs **with smart thermostats** for the two following winters – including a joint program with SoCal Edison incentivizing customers to purchase a smart thermostat to adjust both their natural gas and electric demand
- **National Grid** deployed a **direct load control** program for **large C&I** customers in NY emitting signals to switch on and off furnaces, boilers and other natural gas-fired equipment on event days
- Multiple natural gas utilities offer **interruptible rates** for large C&I customers
- **ConEd** proposed a **natural gas DR program** for firm customers (C&I are targeted) and aggregators for winter 2018-19, based on 24-hr event windows
 - Commission action is expected during Summer 2018

There are several questions remaining to be answered

- What are the primary sources of natural gas DR (technology enabled or not)?
- What is the (regional) technical/economic potential for natural gas DR?
- What is the value of natural gas DR in the short and long run?
- What are the environmental impacts of the various flavors of natural gas DR?
- How responsive/aware are small / large, residential / commercial / industrial customers ?
- What are the regulatory barriers to natural gas DR and how can they be addressed?

Legislation to encourage natural gas DR was recently proposed

Senator Sheldon Whitehouse introduced a bill on April 11, 2018 directing the Dept. of Energy (DOE) to:

- **Study the potential** for natural gas demand response (DR) in the US
- **Establish a pilot program** allowing participants to develop natural gas DR programs – potential participants include
 - Utilities, including local distribution companies (LDCs)
 - State public utilities commissions (PUCs)
 - Municipalities
 - Large commercial or industrial (C&I) customers and gas retailers
 - 3rd party energy efficiency program provider

The Whitehouse bill would help provide preliminary answers and frame potential next steps

Where do we go from here?

- How much gas DR could contribute to solving “polar vortex” type events requires an assessment of the technical, economic and achievable potential on a regional basis
 - Gas DR supply curves by region would help assess both the quantity of gas DR available and the cost of activating gas DR
 - Would provide a basis for evaluating the value of gas DR as an alternative to other proposed solutions
- Gas DR is a relatively unproven concept and therefore likely faces various challenges
 - It is unclear how much gas DR can be activated with existing technology
 - Market timing for electricity and gas is not aligned
 - Benefits are most likely to accrue to electric customers, but action is required by gas customers, which creates significant regulatory issues
- Gas DR potential studies could be useful to assess potential and identify various barriers for implementation

References

The potential of gas DR:

- “Gas Demand Response,” Ahmad Faruqui and Jurgen Weiss, Published in *Public Utilities Fortnightly's Spark*, 2011.
- “SoCalGas 2016-2017 Winter Demand Response Load Impact Evaluation,” prepared by Josh Schellenberg, Aimee Savage, and Adriana Ciccone of Nexant, Inc for Southern California Gas Company, September 1, 2017.
- “Initial Report on Scope, Tasks, and Timelines for the Demand Savings Group,” Massachusetts Energy Efficiency Advisory Council, March 31, 2016.
- “Gas Demand Response, A Solution to the Electricity/Gas Interface Issue?” The Brattle Group and Brown Rudnick LLP, June 4, 2014.
- “Natural Gas Price Elasticities and Optimal Cost Recovery Under Consumer Heterogeneity: Evidence from 300 Million Natural Gas Bills,” Maximilian Auffhammer and Edward Rubin, Energy Institute at Haas working paper, January 2018.
- “Regional Gas Market Update,” presented by Northeast Gas Association to ISO-NE Planning Advisory Committee, April 26, 2018, https://www.iso-ne.com/static-assets/documents/2018/04/a4_regional_gas_market_update.pdf.

Existing gas DR programs:

- SoCalGas Joins Nest to Announce Results of Winter Seasonal Savings Energy Efficiency Program
<https://www.prnewswire.com/news-releases/socalgas-joins-nest-to-announce-results-of-winter-seasonal-savings-energy-efficiency-program-300482114.html>
- SoCalGas Launches Winter Rebate Program for ecobee Smart Thermostat Users
<https://www.sempira.com/newsroom/press-releases/socalgas-launches-winter-rebate-program-ecobee-smart-thermostat-users>
- National Grid and AutoGrid Test Demand Response for Natural Gas in New York
<https://www.greentechmedia.com/articles/read/national-grid-autogrid-test-demand-response-for-natural-gas-in-nyc#gs.AWm6cy0>
- Baker-Polito Administration Announces Over \$4.6 Million in Grants for Peak Demand Reduction Projects
<https://www.mass.gov/news/baker-polito-administration-announces-over-46-million-in-grants-for-peak-demand-reduction>
- Senator Whitehouse Introduces Innovative Natural Gas Demand Response Legislation
<https://www.whitehouse.senate.gov/news/release/whitehouse-introduces-innovative-natural-gas-demand-response-legislation>

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