ENVIRONMENTAL & ENERGY LITIGATION

Winter 2019, Vol. 3 No. 2

March 01, 2019

Extending Demand Response to the Natural Gas Industry

Demand response programs promote better pricing signals to consumers of the resource costs of energy consumption.

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Demand response programs, which have become commonplace in retail electricity markets, promote better pricing signals to consumers of the resource costs of energy consumption. These price signals encourage consumers to change consumption behavior during peak usage time periods, when costs are highest.

Though demand response has been widely applied in electricity markets, interest in promoting demand response programs for natural gas recently gained national attention with a bill sponsored by Senator Sheldon Whitehouse (D-RI) to "establish a natural gas demand response pilot program to use the latest demand response technology from the energy sector for natural gas." Energy Infrastructure Demand Response Act of 2018, S. 2649, 115th Congress (introduced Apr. 11, 2018). A study currently underway at the Department of Energy (DOE) will address "the costs and benefits associated with those savings, including avoided energy costs, reduced market price volatility, improved electric and gas system reliability, deferred or avoided pipeline or utility capital investment, and air emissions reductions." Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, H.R. 5895, 115th Congress (Sept. 21, 2018).

Demand Response and Electricity Markets: An Overview

For electricity markets, demand response programs provide mechanisms to enable retail customers to adjust consumption according to real-time wholesale electricity prices. Advanced metering infrastructure permits consumers to reduce demand during peak periods (when electricity prices are higher) and consume during off-peak periods (when prices are lower). Fed. Energy Regulatory Comm'n (FERC), 2018 Assessment of Demand Response and Advanced Metering (Nov. 7, 2018). By way of example, consumers can charge their electric vehicle batteries overnight during off-peak hours.

Demand Response and Natural Gas Markets: An Overview

Gas demand response programs face a different supply infrastructure from electricity—for a different type of commodity. The goals of reducing energy usage and reducing infrastructure investment apply to both electricity and gas. However, rather than planning for peak hours (as in electricity), the relevant planning period for gas usage and infrastructure investment is a year—peak usage occurs during the cold winter months. A rate structure that better allocates the fixed costs that drive infrastructure investment to those peak months can support the goals of gas demand response.

By applying "marginal-cost pricing," a term in economics that reflects the costs of consuming an additional unit of a good, a gas demand response program can use prices that better reflect the forward-looking costs of investing in infrastructure to meet the winter peak. Consumers will be able to react and reduce peak consumption, facilitating a delay in infrastructure investment decisions. J. D. Makholm, *Gas Industry's Version of Demand Response Cures Its 'Duck Curve,'* Nat. Gas & Electricity, Feb. 2019. Gas utilities and state regulators—with whom planning and public interest responsibilities reside—can modify the rate structure such that it incentivizes customers to reduce peak consumption, leading to less infrastructure investment and fossil fuel use.

Gas Utilities' Yearly Planning Cycle

Peak gas consumption, predominantly for space heating, occurs during the winter months. Natural gas utilities plan for gas demand over the course of the year based on the relationship between historical "sendout" (gas purchased) and weather.

Gas demand response programs seek to incentivize consumers to use less gas; if adopted, such programs may reduce the need for additional infrastructure that might otherwise be required to serve winter peak demand. Changing the relationship between sendout and weather, by modifying rate design to recognize the costs of serving the peak, can potentially achieve those goals.

Wholesale and retail electricity markets have successfully used demand response programs for decades with price signals to consumers that better reveal the costs associated with peak consumption. Prices incentivize consumers to lessen or shift consumption from those peak periods that drive electricity markets and infrastructure investment. A FERC report shows that demand resource participation in regional transmission organizations / independent system operators (RTOs/ISOs) grew more than 3 percent between 2016 and 2017, and customer enrollment in retail demand response programs grew more than 8 percent between 2015 and 2016. FERC, *supra*, at 12, 15, 22.

Figure 1, below, shows the now-infamous California duck curve, where increased solar generation over the years lowers the belly of the duck but usage increases at the peak once the sun sets. As illustrated, load-shifting demand response encourages usage during off-peak hours. Lower peaks indicate success in electric demand response programs. C. Eid et al., *Time-Based Pricing and Electricity Demand Response: Existing Barriers and Next Steps*, 40 Util. Pol'y 15–25 (2016). Such programs can reduce power plant investment and, by mitigating network congestion, reduce electric transmission and distribution investment. P. Bradley et al., *A Review of the Costs and Benefits of Demand Response for Electricity in the UK*, 52 Energy Pol'y 312–27 (2013).

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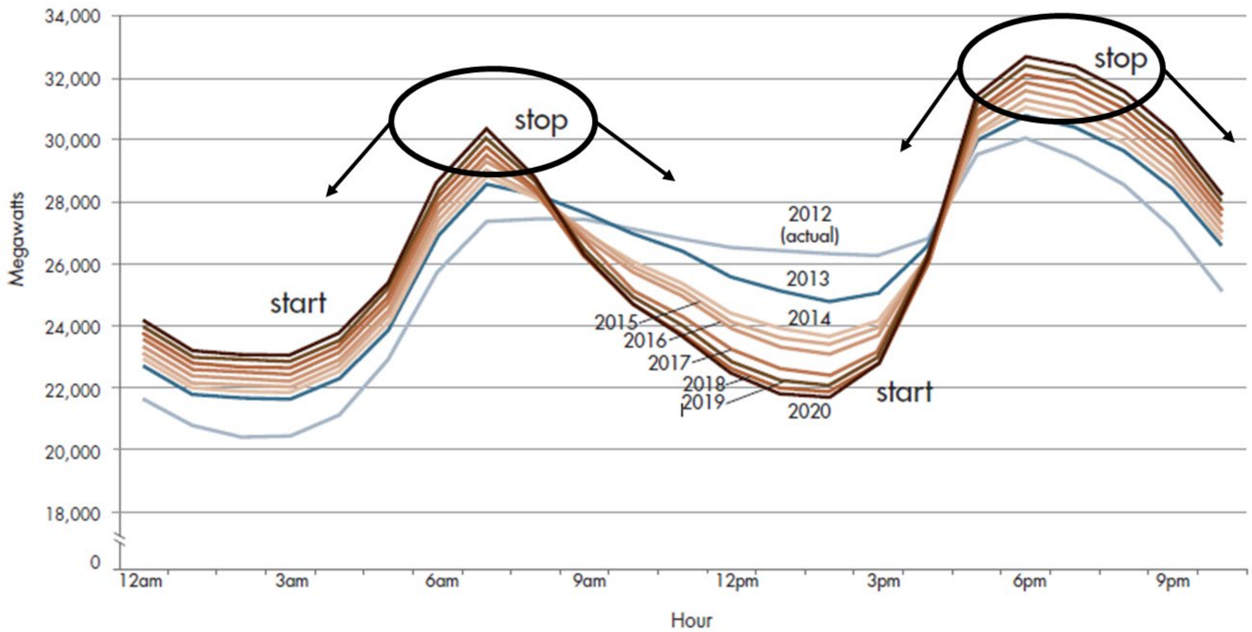
Figure 1: Demand Response Encourages Consumers to Reduce Hourly Peak Demand



Source: California Independent System Operator. Illustration by author.

In contrast, gas demand response concerns only transport and storage infrastructure. The time horizon that drives infrastructure investment for gas is annual, as shown below in Figure 2. The focus of gas demand response programs will need to encourage a change in behavior through prices that more accurately reflect the relevant peak period—that is, the winter months. Consumers cannot shift home heating to the summer months.

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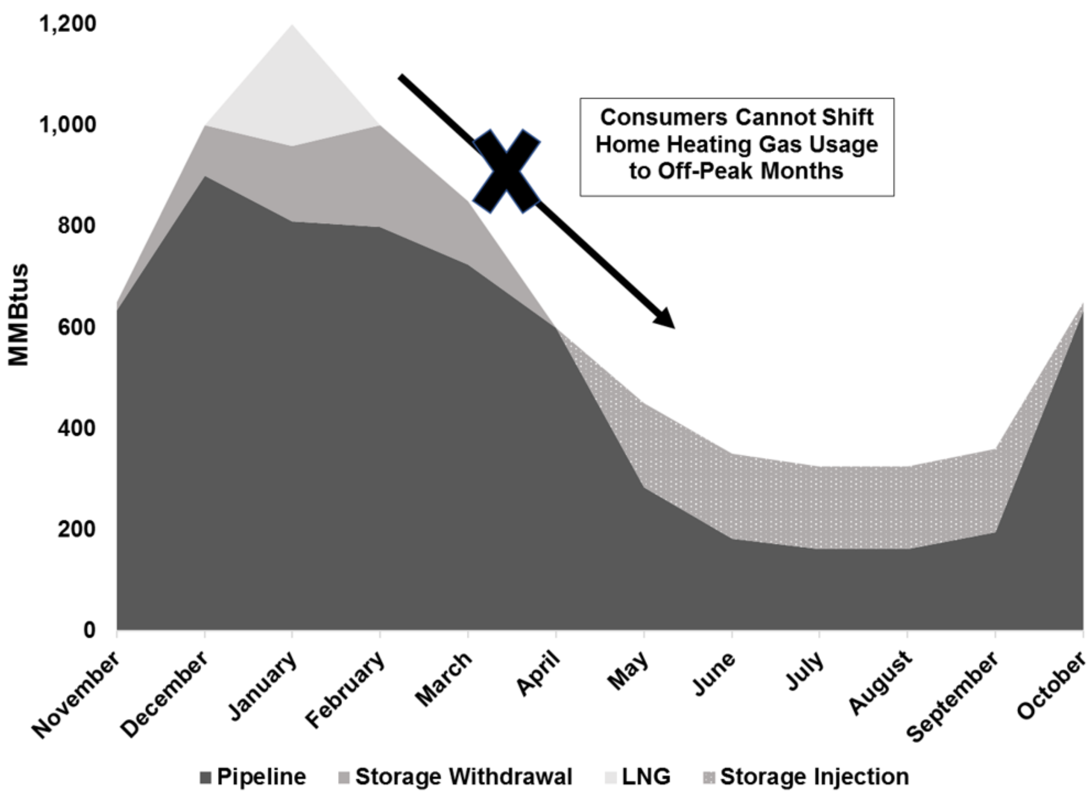
Figure 2: Consumers Cannot Sacrifice Heat During Peak Winter Months



Source: NERA Economic Consulting

During the off-peak months of the year (April through October, depending on the location), utilities serve customers' needs (largely water heating, cooking, and gas clothes dryers) using ample pipeline throughput capacity and inject some natural gas into storage to save for the winter. During the winter months, distributors use all of the resources available (pipeline, stored gas, and LNG) to serve consumers' heating demands.

Gas Demand Response and Consumer Behavior

Gas demand response programs can act as a novel form of marginal-cost pricing by better communicating the costs of serving the winter peak months. Modifying rate design to better reflect the costs that drive investment in infrastructure does not necessarily require advanced metering technology. Rather, it requires adjusting rate design to collect a greater proportion of the fixed costs during peak months. In doing so, utilities can reduce gas usage and infrastructure investment going forward.

Natural gas utility costs generally fall into four major categories: gas supply, interstate pipeline transmission, storage, and distribution. Gas supply depends on contracts signed between producers and local distribution companies, which have a portfolio of long- and short-term gas supply contracts and some spot market, storage, and LNG purchases. Am. Gas Ass'n, LDC Supply Portfolio Management During the 2014–2015 Winter Season (June 5, 2016). Those local gas distributors also sign contracts with pipelines and storage facilities. Distribution costs include the infrastructure to transport gas to homes and businesses. Local distribution companies file gas supply plans with state regulators, who approve those plans and uphold the public interest by ensuring that the companies procure sufficient gas supply and pipeline and storage capacity to meet peak usage. *See, e.g.*, Cal. Pub. Util. Code § 454.52; Mass. Gen. Laws ch. 164, § 69I; 39 R.I. Gen. Laws ch. 39-24, § 39-24-2.

The impact of electric demand response can be seen within a day. For gas, changes in gas supply and infrastructure investment can only be measured by looking at how a change in consumer behavior affects the gas distribution utility planning process. Figure 3, below, shows the steps through which demand response programs must travel to impact electricity and gas resource costs (fuel and infrastructure).

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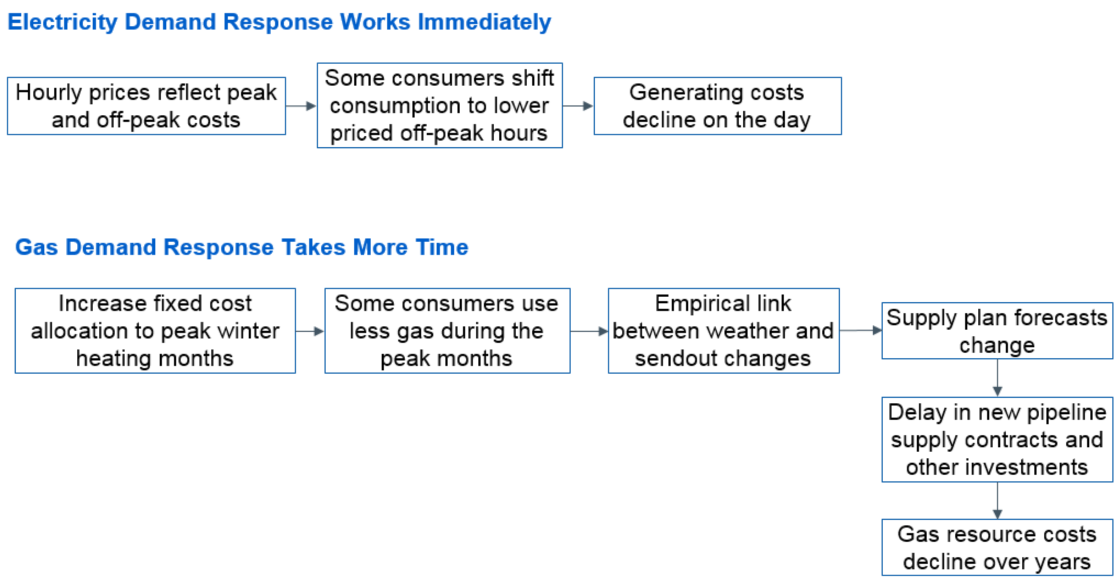
Figure 3: How Demand Response Programs Impact Energy Resource Costs



Source: NERA Economic Consulting

Demand response programs can impact gas resource costs, but the effect takes longer to observe than it does for electric demand response programs because of the gas supply planning process. Each step of the gas distribution utility planning process has the capacity to absorb a change from a demand response program that better signals peak costs to consumers. While it is a longer path, and it requires some work to reflect changes in behavior and empirical relationships between the variables that traditional models use, signaling to consumers the higher costs of serving peak winter months is a worthwhile endeavor.

Gas distribution utilities file gas supply plans with state regulators every few years. Those gas supply plans use weather and other variables to predict sendout required to meet demand during certain peak periods. Regulators ensure that distributors can serve customers, and they approve new investments in gas supply or infrastructure contracts. Gas utilities design their distribution systems based on the probability of extreme weather conditions.

Gas utilities with weather-sensitive customer loads also use weather data to help predict future peak sendout by examining the relationship between weather, wind speed, and customer load. A wide variety of possible weather characteristics might affect heating requirements. These include temperature pattern during the day, angle and intensity of sunlight, humidity, and wind speed. Utilities also forecast future sendout needs by considering variables such as expected consumer growth, oil and gas prices, retail gas supply, and energy-efficiency programs.

Gas utilities can use marginal-cost pricing, a rate-making tool that gained attention in the United States in the 1970s, to signal gas resource costs to consumers. Marginal-cost pricing recognizes that, for consumers to make efficient choices, they must know the cost of the product they plan to purchase so that they can make the decision of whether the satisfaction they gain from consuming that product is worth the cost. Off-peak usage does not impose capacity constraints on the system. 1 A. E. Kahn, The Economics of Regulation: Principles and Institutions 66, 89 (John Wiley & Sons 1970).

Allocating fixed costs during those peak winter months that drive infrastructure investment will better reflect actual costs to consumers. Consumers will have the ability to react better to this price and change behavior by reducing gas usage. The ultimate effect of this change is a reduction in natural gas resource costs (fuel and infrastructure) through the effect on the gas utility planning process.

The relationship between weather and sendout will change as consumers will have a better idea of the costs of using gas during peak (and off-peak) periods. Distributors can take this changed relationship into account when developing supply plan forecasts. Less gas usage at the peak may mean delaying new supply contracts with pipelines and other sources of supply—and, therefore, delaying infrastructure investment. Delayed investment results in a decline in gas resource costs.

Given design standards and expected future demand, gas distributors develop a portfolio of least-cost resources to serve consumers. With a demand response program, all else being equal, a changed relationship between weather and sendout may mean that the point at which the utility will need to invest more (i.e., expand distribution capacity or sign incremental contracts for gas supply) will change. A demand response program as defined here—allocating fixed costs to peak winter months—will cause consumers at the margin to use less gas during peak winter months by turning down thermostats or buying more efficient heating equipment. Changed consumer behavior will change the relationship traditionally used to develop system design standards. Moving forward, future needs will change as consumers adjust to this new cost allocation.

Conclusion

It would be relatively straightforward to adjust rate design to reflect interstate pipeline and fixed infrastructure costs by collecting more during the winter billing cycles for all customer classes. Marginal-cost pricing may prompt consumers to reduce gas demand during peak winter months. This changed behavior would inform the planning models described above that drive future investment. Demand response programs that more effectively transmit resource costs to consumers and incentivize efficient energy usage will support the goals of avoiding costly infrastructure investment and reliance on fossil fuels.

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