Emerging Aspects of Natural Gas Demand Response Programs to Support Load Balancing and Avoid New Infrastructure

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ABSTRACT

Achieving carbon neutral future will require several tools, levers, technologies, and mechanisms in support of such a transition over the upcoming decades. While not new, gas demand response is one strategy of increasing interest to state policymakers and utility program administrators working to reduce greenhouse gas emissions. Decarbonization objectives and net zero carbon plans require reducing the quantity and role of natural gas for end-use equipment. Additionally, many jurisdictions are limiting or banning new natural gas infrastructure. Gas demand response is one approach among many that helps ensure customer needs are met while simultaneously balancing infrastructural priorities on the energy supply and distribution side.

Consortium for Energy Efficiency members have employed gas demand response with varying degrees of success yet are facing requirements to pursue gas demand response as a part of annual filings with local commissions. Historic challenges to gas demand response include 1) lack of comprehensive data regarding the duration and timing of gas usage, 2) uncertainty in determining the value of load shifting, 3) low volume and intermittent nature of gas demand response, and 4) unique characteristics of gas distribution presenting concerns around cost, serviceability, and potential negative impacts. CEE members and industry partners such as GTI Energy are working to elaborate on initial results, identify how new approaches may differ, and outline recommendations for designing gas demand response methodologies in the current landscape. This paper highlights gas demand response examples, focusing on regulatory and policy drivers, and how utilities and industry are working to develop successful gas DR approaches.

Introduction

The Consortium for Energy Efficiency membership consists of energy efficiency program administrators that are responsible for ratepayer-funded efficiency programs in 38 US states, the District of Columbia, and four Canadian provinces. The CEE Natural Gas Program Strategy Committee convenes a subset of these program administrators to work to support gas demand side management by ensuring availability and deployment of the most efficient gas equipment across residential, commercial, and industrial sectors, and exploring and demonstrating successful applications of new program approaches that reduce greenhouse gas emissions and avoid the need for investment in new gas infrastructure. This includes collaboratively exploring the challenges and opportunities associated with gas demand response (DR). Specifically, the CEE Committee is working to identify the main drivers of local and

binational gas DR, figure out the achievable and measurable goals for gas DR as an integrated demand side management strategy, and identify common issues that can be addressed together at the binational level. The CEE Committee continues to characterize the value proposition of gas DR, including uncertainties, implementation challenges, and lessons learned from early experience. In addition, the CEE Committee seeks to validate if and how gas DR can yield measurable benefits to customers or the distribution system, and the most promising targets within this framework.

The CEE Committee is also working to define gas DR terminology, help utilities and DR stakeholders understand the value of cost avoidance and the potential impact of gas DR, and to articulate the role of advanced metering infrastructure and the role of connected thermostats. Since some localities are requiring demand response program proposals, CEE members are weighing the upsides of DR program creation, including the avoidance of new gas infrastructure. However, more usage data is needed in many jurisdictions before assessing and determining gas DR program value.

This paper shares drivers, lessons, and future plans from four CEE member utilities and a fifth program from the perspective of GTI Energy. These examples provide a mix of experiences from different regions and regulatory environments and represent programs at various stages.

Table 1. Summary of Natural Gas Demand Response Programs

Utility Name	Program Scope	Program Phase	Service Territory	Program Participants
Xcel Energy	Smart Thermostat DLC offering for residential customers	Pilot launched in 2021 with the goal of ending in 2024	Summit County and Grand County, Colorado	148 participants and 253 thermostats enrolled
National Grid-NY	Load Shedding Program and Load Shifting Program for C&I customers, and the “BYOT” Program for residential and small business customers	Pilot program launched in 2017, and there is no current plan to end program	Downstate New York	C&I Program: 450 participants BYOT Program: 32,000 thermostats enrolled
Con Edison	Performance-based offering for C&I customers and multi-family units with centralized heat, and a Smart Thermostat DLC offering for	Four-year pilot completed between 2018/2019 and 2021/2022 winters	Manhattan, the Bronx, the First and Third Wards of Queens, and most of Westchester County	Performance-Based Gas DR Program: 606 participants Direct Load Control Program: 6,970 thermostats enrolled

	residential customers			
New Jersey Natural Gas	BYOT Program for residential customers and a separate smart thermostat offering for residential with use of Automated Meter Reading "AMR" technology	Pilot proposed to run from January 1, 2025, to June 30, 2027 pending approval from the New Jersey Board of Public Utilities	Portions of Monmouth, Ocean, Morris, Middlesex, Burlington and Sussex Counties, New Jersey for BYOT. AMR pathway limited to Monmouth County.	N/A- program is not approved yet.
GTI Energy (in collaboration with SoCalGas and Lumina Decision Systems	Smart Thermostat DLC of space heating offering for residential customers and a custom load reduction program, space heating program, and water heating program for C&I customers	The California Public Utilities Commission recently denied SoCalGas's request to implement DR Pilot Programs, so GTI and SoCalGas are currently evaluating alternative approaches to deliver all or parts of the proposed program	Los Angeles County, California	N/A

The following sections of the paper provide overviews of each program with a focus on the drivers for the program, lessons learned through implementation or the process of trying to launch the program and shares any identified future plans. The paper concludes with thoughts from the authors on what characteristics may make for successful natural gas demand response efforts, remaining knowledge gaps and program challenges, and plans for ongoing work to demonstrate the characteristics of successful gas DR program approaches.

Gas Demand Response Program Overviews

Con Edison: Smart Usage Rewards for Natural Gas Customers

Local Drivers. Con Edison delivers natural gas to approximately 1.1 million customers in Manhattan, the Bronx, the First and Third Wards of Queens, and most of Westchester County.

Natural gas is delivered by interstate pipelines to Con Edison at various points in or near its service territory and is distributed to customers through approximately 4,300 miles of mains and 370,000 service lines. The primary driver to implement a gas DR pilot in Con Edison's service territory is to better understand, develop and implement innovative programs that seek to manage demand among customers to provide innovative tools to manage peak gas demand through inducing customer behavior change.

As part of a portfolio of demand side management initiatives aimed at reducing overall demand across its service territory, Con Edison operated a two-pronged Gas DR Pilot for four years between the 2018/2019 and the 2021/2022 winters. The Pilot consisted of (1) a Performance-Based Gas DR Offering for commercial and industrial ("C&I") customers and multi-family buildings with centralized heating systems; and (2) a smart thermostat Direct Load Control ("DLC") offering for residential customers. The Pilot's objective was to understand the opportunity for customers to reduce usage over a peak gas demand day. The Pilot tested the feasibility of incentivizing customers to provide net reductions of natural gas demand during peak gas demand days (for a 24-hour period from 10:00 am to 10:00 am the following day) on the coldest winter days.

The overall goals of the Gas DR Pilot were to: understand the magnitude of net load reduction that customers can be compensated to provide over a 24-hour window from 10:00 am to 10:00 am the following day after receiving notification of an event, test customer engagement as measured by the number of customers enrolled and participant response, assess third-party participation as measured by number of aggregators enrolled and aggregator response; streamline event dispatch based on internal and external stakeholder response, test the participants' ability and willingness to participate in consecutive multi-day events and, if necessary, events on holidays, collect information on successful customer use reduction strategies, determine appropriate program incentive levels, test baseline methodologies, and provide data on reliability and repeatability of total reductions during events, as an input to Con Edison's peak day gas demand forecasting process.

Lessons Learned. Throughout the Performance-Based Gas DR Offering's term, Con Edison gathered load reduction data to assess participants' ability to provide consistent and predictable load reductions. Evaluations of program performance spanning four years indicated that load reductions achieved by the pilot were, statistically, not significant. In cases where there was evidence of positive load reductions, the reductions were not high enough to create a path to program cost effectiveness. Throughout the program's four-year duration, Con Edison did not observe weather temperatures close to its peak day system design criteria. After thorough analysis, Con Edison-was unable to provide insight into how customers could perform at temperatures approaching system design criteria. This means that the Gas DR Pilot at the time the pilot was implemented was not able to definitively determine whether gas demand response can be relied upon as an operational tool to reduce system-wide peak gas demand.

Throughout the Direct Load Control Gas DR Offering's term, Con Edison tested different combinations of thermostat reductions and event lengths to observe: 1) how various event parameters would affect the amount of load relief achieved during an event; 2) the amount of load reduction lost because of snapback within the same day after an event; and 3) the percentage of customers that chose to opt-out of an event. The events tested indicated that increasing the temperature setback (*i.e.*, decrease in the thermostat temperature setting) resulted in higher average load reductions, including after accounting for opt-outs and snapback. Con Edison also

tested various starting times and concluded that the optimal timeframe for implementing Direct Load Control Gas DR events to maximize load reduction is around the morning peak in gas consumption. However, while the average net removed load per device was increased over the years by utilizing this strategy, the benefits derived from load reduction per enrolled device were small compared to the costs incurred per enrolled device. As a result, the reductions at the time of the pilot implementation were not high enough to create a path to program cost effectiveness.

Future Plans. While demand response remains a valuable tool in managing peak electric demands, the results of this pilot demonstrate distinct challenges in bringing customer-driven peak reduction to the gas system. Given the Gas DR Pilot's performance and the insights gained from both internal and third-party evaluation, Con Edison has concluded that the Pilot was not a viable option for load relief and therefore ended the Pilot.

In the future, Con Edison plans to innovate and seek new opportunities that enable better management of gas use and consequently the ability to manage the gas system transition. Con Edison also plans to continue engaging with leading technology providers and stakeholders as well as peer utilities on gas DR strategies implemented across the industry. Con Edison will evaluate those strategies to assess their ability to deliver on state policy goals, as adopted in the Climate Leadership and Community Protection Act, including environmental and economic benefits.

Xcel Energy: Heat Savers

Local Drivers. A gas demand response pilot was launched by Xcel Energy in 2021 and completed in March 2024. Heat Savers is a smart thermostat, direct load control program for residential customers that emerged from three main drivers, each with a different motivation for using gas DR as a tool to address a challenge. The first driver began as an issue that developed in the mountains of Colorado due to population growth straining the existing infrastructure that was installed in the region. It became evident that reliability could be compromised in specific locations during cold mornings in the winter and a solution to reduce demand during the 6:00 am to 9:00 am window had to be studied. The second driver came from Colorado policymakers interested in exploring opportunities to limit or mitigate the need for infrastructure investments considering state policy goals. The last driver is an exploratory pressure to research heating demand response as a flexible utility asset. This effort encompasses the value of a mass market offering compared to a targeted approach, as well as the differences between gas and electric winter DR.

Lessons Learned. Each year the pilot supplied knowledge for Xcel Energy to incorporate into the subsequent years of program design. The pilot allowed the opportunity to evaluate and try innovative ideas around smart thermostat adjustments for natural gas DR. Lessons learned are as follows:

- A 3° – 4°F setback on a smart thermostat will reduce gas during a four-hour event.
- Preheat and snapback influence overall gas reduction during an event day.
- The service territory in the Colorado mountains has cold winters and mild summers. Because of this, many customers do not have a central furnace (as there is no need for air

conditioning) and instead use a boiler system that may be incompatible with the way Xcel Energy currently use smart thermostats to curtail load.
- Several customers have multiple thermostats or multiple furnaces, making it challenging to use thermostat setback to curtail gas.
- Nuanced enrollment issues exist between some manufacturers where the device is unable to have multiple programs associated with a single device.
- Lack of granular gas usage data (e.g., 15-minute interval data) is a challenge for designing gas DR programs for the residential market.
- There is limited visibility into the thermostat and the ability for adjustments. Details like dead band setting and schedules are not readily available to the implementer.

Future Plans. The future of gas DR for Xcel Energy has two paths. The first path is continuation of Heat Savers, specifically pursuing areas of interest: combine Heat Savers into the existing residential smart thermostat program (AC Rewards) to form a Thermostat Rewards program, understand the value of targeted gas DR vs. mass market adoption, explore longer duration events that are greater than four hours, and the impact of shifting during an emergency weather event. The second path is a gas DR RFP that will allow a third party to demonstrate a gas DR pilot within the Xcel Energy territory, open to residential and commercial customers. The intent is to identify and explore new directions for gas DR to potentially incorporate into the demand management portfolio with a focus on limiting investments in natural gas infrastructure.

National Grid: Gas Demand Response Programs

Local Drivers. National Grid operates a portfolio of Gas Demand Response programs in its New York State territories. Three programs constitute the portfolio—a Commercial and Industrial ("C&I") Load Shedding program, a C&I Load Shifting program, and a Residential and Small Business Bring-Your-Own-Thermostat ("BYOT") program. All three programs have run in National Grid's Downstate New York gas services territories (compromising parts of New York City and Long Island) since 2020, with the programs expanding to National Grid's Upstate New York territories in 2022.

National Grid first began exploring the potential of Gas DR through an innovative 2017 pilot program launched in its Downstate New York service territories. The pilot was one of the first instances in the country of applying demand response program principles to firm service gas customers. The pilot tested whether reductions in gas usage during periods of peak gas consumption could provide pressure support to National Grid's gas distribution system. As that pilot was winding down in 2019, states, regulators and utilities in the Northeast were increasingly looking to limit the expansion of gas infrastructure by exploring non-pipeline alternatives. At the same time, however, customer requests to add *new* gas service continued to grow, in turn increasing the volume of peak day gas demand. Out of this was borne National Grid's Gas Demand Response portfolio, which at present represents one of the largest, if not the largest, and most comprehensive firm gas demand response programs in the United States. The potential reductions from National Grid's Gas DR programs are incorporated into annual gas load forecasts. This lowers the peak day requirements for gas supply around which gas infrastructure—both upstream sources of supply and distribution system upgrades—is planned.

Lessons Learned. For the most part, National Grid's development of Gas DR programs was able to borrow heavily from the well-established experience of electric DR programs. However, there

are enough significant differences in the commodities—including when and how frequently they see peak consumption, what end uses they serve, and how the respective utility systems are managed—that the gas DR programs could not mimic all aspects of electric programs. National Grid's experience with Gas DR programs has led to some major takeaways.

- **Reliability does not vary with temperature**. Gas DR has faced questions around the reliability of customer reductions, particularly during times of rare, extreme weather events. While National Grid has been limited to evaluating Gas DR only under the conditions experienced since the inception of the programs, customers have thus far delivered consistently during events ranging in temperatures of 5° to 25°F. In fact, National Grid's programs have shown that reductions—inclusive of opt-outs and non-performance—are greater during cold weather periods than in more mild conditions.
- **Different needs call for different program designs**. Unlike electric counterparts, gas utilities focus on two types of peaks—the peak day volume of gas needed to supply customers, and the peak hour gas volume needed to maintain adequate system pressure. Gas DR programs do help reduce both peak day and peak hour consumption but may be structured to surgically target one over the other. Generally, if a utility has a systemwide need to lower gas demand they should structure program designs and DR event windows around peak day reductions. While utilities focused on supporting pressures in one or more segments of their system can focus on peak hour-focused programs.
- **Snapbacks eliminate some, but not all, peak day savings**. Since electric DR program designs solely focus on the kW demand impacts, there has not been much study on the post-event snapback impacts as cooling systems recover from setbacks after electric DR events during cooling seasons. Gas DR programs, however, must measure post-event snapback effects that occur when heating systems recover from temperature setbacks to measure the peak day impacts of DR events. Through its BYOT, direct load control program, National Grid found that there are net daily reductions in gas consumption even after accounting for pre-conditioning and snapback increases.
- **Pre-conditioning may not be useful at low temperatures**. During an emergency gas DR event called during 2022's Winter Storm Elliot, National Grid dispatched gas thermostats without pre-heating customer homes. The expectation was that this lack of pre-conditioning would result in a greater level of opt-outs and lower the event impacts. On the contrary, National Grid noted that the share of opt-outs were relatively unchanged (35-40%) and the amount of peak day reduction was higher since there was no pre-conditioning offset. National Grid has since tested the per device impacts of pre-conditioned and non-pre-conditioned groups during the same event and found similar results. The value of pre-heating significantly diminishes as the temperature delta between indoor and outdoor air increases and may not be useful in winter DR programs.

Future Plans. National Grid's Gas DR programs fit into a broader demand-side management strategy within the company's Clean Energy Vision. Going forward, the company will continue to grow participation of its existing programs in its New York portfolio and look to expand into Massachusetts. Additionally, National Grid is exploring a few novel programs and pilots—a Full Day style thermostat program, a Behavioral DR neighborhood data collection device program, and a Gas DR Hybrid Electrification pilot. The Full Day thermostat design looks at maximizing peak day reductions by setting back customer temperatures by one or two degrees over a

prolonged, 24-hour period. While some thermostat manufacturers can implement this solution, not all can do so now. Further, customer opt outs may need to be reset on some recurring interval to extract the most value out of the full day style program. The Behavioral DR program leverages neighborhood collector devices capable of reading hourly customer data from existing meters, while providing that data to customers and notifying them of DR events through a mobile application. This iteration of the Behavioral DR program should allow the Company to evaluate program reductions more accurately in an area where Advanced Metering Infrastructure (AMI) is not available. The Company's Gas DR Hybrid Electrification Pilot was spurred on by a US Department of Energy funding solicitation for DR pilots, in which the Company received a $1 million award. The Pilot seeks to identify the potential of a Gas DR offering in which gas heating customers that own heat pumps, but do not utilize them in the winter for heating, are offered incentives in exchange for leveraging the heat pumps during periods of peak gas demand.

New Jersey Natural Gas: SAVEGREEN® Demand Response Program Proposal

Local Drivers. New Jersey Natural Gas's ("NJNG") Demand Response ("DR") program was proposed to the New Jersey Board of Public Utilities ("BPU") in December 2023 as part of NJNG's plan for the delivery of Energy Efficiency, Building Decarbonization Start-up and Demand Response programs for Triennium Two which will cover the two-and-a-half-year period from January 1, 2025 to June 30, 2027.[1] NJNG's demand response program would incentivize customers to reduce gas consumption during peak demand periods through a Bring Your Own Thermostat ("BYOT") solution and use of proprietary technology to help Monmouth County customers who have an Automated Meter Reading ("AMR") meter to monitor their usage through a smartphone application. NJNG believes these approaches would combine to deliver real, measurable benefits in the Second Triennium, and provide invaluable learning opportunities to inform program design for DR in future energy efficiency programs. NJNG's DR program marketing would target a wide range of potential participants, including residential customers moving into NJNG's service territory and qualified homes and buildings previously participating in other energy efficiency program offerings. NJNG would identify and engage customers for program participation via eligibility verification as well as equipment compatibility. NJNG would develop customer incentive offerings and design dispatch strategies that maximize load shed while maintaining customer comfort.

NJNG developed its Demand Response program proposal in response to July 26, 2023 Order from BPU, positioning Second Triennium DR programs as a learning opportunity for New Jersey, and part of a broader effort to "identify the priorities, experimentation, milestones, and timing required to achieve the mission outlined in the DR Guiding Principles."[2] Further, NJNG's

[1] In the Matter of the Implementation of P.L. 2018, C. 17 the New Jersey Clean Energy Act of 2018, Regarding the Second Triennium of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO23030150, Order dated October 25, 2023.

[2] In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018, Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO19010040; – In the Matter of the Implementation of P.L. 2018, c. 17, the New Jersey Clean Energy Act of 2018, Regarding the Second Triennium of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO23030150; and – In the Matter of Electric Public Utilities and Gas Utilities Offering Energy Efficiency and Conservation Programs, Investing in Class I Renewable Energy Resources and Offering Class I Renewable Energy Programs in Their Respective Service Territories on a Regulated Basis, Pursuant to N.J.S.A. 48:3-98.1 and N.J.S.A. 48:3-87.9 –

DR proposed program aligns with New Jersey's Next Generation Savings program proposal goals to help advance technologies that are ready for market adoption but need additional support for broader market acceptance. The investments made under this program proposal, such as gas DR, would be intended to implement technologies and strategies that may be able to play a bigger role in securing cost-effective energy savings in the future. NJNG took this guidance from BPU by including both a more mainstream solution in BYOT and an experimental opportunity in its AMR-enabled technology solution to help shape future opportunities. NJNG's proposed DR program would utilize Evaluation, Measurement & Verification ("EM&V") best practices, and will review and report on customer engagement, performance during events, and any unique findings between the workstreams. EM&V can help assess whether program objectives are being achieved, document energy and non-energy benefits, and inform both future program modifications and development.

Lessons Learned. If approved, NJNG plans to study the results of its DR program to help inform what strategies work best to reduce natural gas demand and provide opportunities to create load flexibility and carbon emission reductions through non-pipe alternatives. While there have been a few residential gas demand programs at other natural gas utilities, there is not yet a strong pool of independently verified data to help develop an informed estimate of the benefits. NJNG acknowledges the challenges in developing and deploying an effective energy efficiency program, specifically new programs that have not accurately valued gas capacity.

The New Jersey Cost Test ("NJCT") is the primary benefit-cost analysis and does not provide a specific value associated with peak demand savings. This has created a challenging environment to design and propose a program and adequately represent the benefits. Part of NJNG's proposal includes EM&V efforts to better quantify these benefits for inclusion in future iterations of the NJCT and recognize benefits to all customers from the operation of this program. NJNG anticipates learning from the evaluations of the program and its benefits which could inform future program design and modifications that can improve performance-related metrics. Additionally, NJNG would continue to gather information and field data about demand response programs from industry partners and peer utilities to best support and continue to improve our DR program. Along with NJNG's SAVEGREEN programs, customer communications and protection of customer data would follow industry standards, including encryption of sending and receiving data with vendors.

For the BYOT pathway, NJNG would contract with an industry leading software platform to aggregate smart thermostats that have already been installed in NJNG's service territory (regardless of where the equipment was initially purchased). It would also offer enrollment opportunities for NJNG customers who purchase new thermostats from approved operating equipment manufacturers ("OEMs") such as Nest, ecobee, Honeywell, Emerson, Amazon, Alarm.com, and Lux through its online marketplace as part of NJNG's EE Products program. Eligible customers may also purchase in-home hardware from the OEMs to be shipped directly for self-installation. The marketplace would allow NJNG to partner with customers who have several different types of smart thermostats to grow an ecosystem that can be utilized for effective demand response. NJNG would maximize integration with many of the leading connected device brands to aggregate, monitor, and dispatch devices.

Minimum Filing Requirements, BPU Docket No. QO17091004; Order Directing the Utilities to Propose Second Triennium Energy Efficiency and Peak Demand Reduction Programs, Order dated July 26, 2023.

For the AMR pathway, NJNG would partner with Copper Labs to install a combination of in-home devices and neighborhood-level data collectors to enable customers to access a mobile application that provides insight into usage patterns. This also allows NJNG to contact customers to encourage them to reduce their energy usage during a particular period. Since the underlying meters require AMR technology, this workstream will be limited to metered residential customers in Monmouth County, New Jersey with a compliant and approved gas heating system and smart thermostat. NJNG would work with Copper Labs to prioritize the deployment of the neighborhood level collectors in either low- and moderate-income census tracts or overburdened community areas. NJNG proposes to provide in-home devices to customers at no additional cost and offer an initial incentive to customers who fully set up the mobile application, regardless of whether they are served through an in-home device or a neighborhood level collector. Through this program, NJNG would gain detailed insight into event performance and device data, as well as non-pipeline alternative performance, to accurately determine program effectiveness and consider broader strategies for the future. NJNG would also implement and manage curtailment events using secure Application Programming Interface ("API") connections with enrolled thermostats. The selected contractor's scope of work will also include partner device management, marketing and enrollment, event dispatch, and performance management.

Curtailment events would be authorized and triggered by NJNG, based on gas demand forecast, system operations information, and weather reports, all assisting in isolating geographic areas of gas capacity constraints that may be addressed. NJNG defines demand response as a specified time period where NJNG customers will have their thermostats adjusted by no more than four degrees during peak gas demand periods. These events would typically occur during specified winter morning and evening peaks and last one to four hours. Incentives would be provided both for enrollment in the program and ongoing participation in demand response events. For NJNG customers who purchase a thermostat from the marketplace and participate in this program, an installation would be performed at no cost to the customer. Primary event triggers would be related to weather conditions. Demand reduction during event hours would be measured using available data (e.g., meter, smart thermostat), to establish baseline performance and calculate customer level, targeted geographical area, and system-wide reductions and capacity savings. Additionally, NJNG would potentially trigger events to test customer responsiveness and meet other needs of the program. NJNG customers would be permitted at any time to override an event or opt-out from event and/or participate in program, to support customer satisfaction.

To minimize snapback effects after a turndown, the program would test the dispatch of thermostats using temperature offsets with pre-conditioning, where start and stop times may be staggered to gradually bring customer thermostats down and back up. Thermostats may be adjusted back up to normal setpoints in increments and pre-heating before an event will minimize impacts to customer comfort, reduce opt outs during the event, and snap-back after the event. NJNG customers would receive an initial enrollment incentive and be eligible for ongoing participation incentives if they remain in the program over the year. Additionally, NJNG customers would be eligible to receive both an energy efficiency rebate, when purchasing a thermostat through the marketplace, and the demand response incentives for each year they participate in the program.

Future Plans. Pending approval from the BPU, NJNG's DR program would commence January 1, 2025, at the beginning of Second Triennium.[3] Qualified third-party implementers and contractors would be evaluated and selected based on their experience effectively delivering demand response programs or initiatives. Additional implementer requirements prioritized by NJNG include technology functionality and compatibility with existing NJNG systems, marketing resources for customer engagement and education, overall cost to implement, and amount of dedicated business/contracts with minority, women, veteran and service-disabled veteran ("MWVBE") businesses. Additional responsibilities for third-party implementer(s) would include tracking enrollments, event management at direction of NJNG, customer communications regarding equipment functionality and maintenance, assistance with opt-out cycling, and event results tracking. Given the limited experience with gas DR programs across the country, maximum event counts, as well as proper methodology for measuring demand reduction performance, including data sources to calculate baseline and capacity savings, would be determined in consultation with implementation vendors, with additional consideration of impact to NJNG customers, and program needs.

GTI Energy: Natural Gas Demand Response Program for SoCalGas Residential, Commercial, and Industrial Customers

Local Drivers. In 2022, the Department of Energy awarded a grant to GTI Energy for a Gas Demand Response (DR) Program for Residential, Commercial, and Industrial Customers (DOE 2022). SoCalGas and Lumina Decision Systems are partners in the program and instrumental in the design and evaluation strategies. SoCalGas previously implemented DR pilots for the 2017-2018 and 2018-2019 winter seasons due to storage capacity at the Aliso Canyon natural gas storage facility and on-going maintenance on transmission pipelines. The programs for these winter seasons consisted solely of a residential thermostat controls program which lowered the temperature setpoint for four hours of participating customers during a demand response event. The 2017-2018 pilot showed peak savings ranging from 10-25% across morning and evening events for two thermostat vendors (Bell and Bieler 2018). The two proposed pilot programs build on SoCalGas experience in the narrowly defined residential thermostat program and a new offering to the C&I sector. The interest in expanded DR arises, in part, from studies examining the feasibility of minimizing or eliminating the use of Aliso Canyon, while still maintaining energy and electric reliability.

Lessons Learned: The Residential Thermostat Controls (RTC) program will be aimed at connecting with open automated demand response (OpenADR) enabled equipment connected to space heating equipment and calling on those capabilities to reduce gas usage during periods when there is anticipated stress on the gas system. The RTC program will be structured based on lessons learned from SoCalGas' prior winter gas DR programs. Building upon the impact evaluation and findings from previous winter seasons, the RTC program will develop new control and event strategies to increase the energy reduction and to reduce snapback[4]. An hour

[3] In the Matter of the Implementation of P.L. 2018, C. 17 the New Jersey Clean Energy Act of 2018, Regarding the Second Triennium of Energy Efficiency and Peak Demand Reduction Programs, BPU Docket No. QO23030150, Order dated October 25, 2023.

[4] Demand response snapback occurs post-event, when control is returned to the building operator and the heating system attempts to return to its pre-event setpoint. This phenomenon occurs in electric DR but can be more significant with gas given longer event periods.

before the DR event occurs, the thermostat and water heating equipment will pre-heat the home and water heating equipment, respectively, then automatically adjust the temperature setting based on the rules of the program. This redesigned program will use different groups of participants at two-to-four-hour event periods that are called on a rolling schedule. This design will maximize the sustained DR reductions over the target event period. For residential customer participants, the program will offer incentives for deferring their energy usage during scheduled DR event periods during the winter season by lowering their thermostat temperature between one to four degrees. DR events under the RTC will be structured around gas system morning or evening peak periods and customers will be notified beforehand when the DR event will be occurring. An hour before the DR event occurs, the thermostat will pre-heat the home, then automatically adjust the temperature setting based on the rules of the program. Once the DR event is over, the temperature settings will be restored to their initial setpoints.

The C&I program will have three components: 1) a custom load reduction program (LRP), 2) a space heating program, and 3) a water heating program. The LRP will be a stand-alone program focused on larger C&I customers. The space and water heating programs will be targeted at smaller C&I customers who have DR enabled equipment utilizing OpenADR that can be called upon during DR events.

The LRP will be a voluntary program targeted at C&I customers who are able to reduce their natural gas consumption during DR events. For C&I customers, natural gas is used in a variety of ways, including water heating, space heating, cooking, manufacturing, and feedstock for the production of industrial gases. With adequate economic incentives, customers may be able to reduce gas load by shifting or delaying processes to off-peak time. LRP is expected to concentrate its outreach efforts on its largest gas users to achieve the most load reduction during DR events. At the application stage, applicants will indicate how they plan on reducing load and will be required to estimate how much load can be reduced for each DR event day. DR events will be initiated by SoCalGas during periods of anticipated system stress. DR events (including test events) for LRP will, at a minimum, last for 24 hours. The LRP incentive structure consists of three main components – base usage, reservation, and performance incentives. For each DR event, the program will establish a customer base usage value against which will measure gas savings. When a customer enrolls in LRP, they will specify how much gas demand they plan to reduce per DR event day. This will be used to calculate the reservation portion of the incentive payments that will be based on stated gas demand reduction against their actual demand reduction. Additionally, for each DR event day, actual usage reduction will be incentivized for each therm reduction achieved in the form of the performance incentives.

The space heating program and water heating programs will focus on C&I customers with load control devices on space heating and water heating equipment such as furnaces, boilers, thermostats, and energy management systems may participate in the focused direct load control C&I space heating and water heating program. The programs may also explore the inclusion of controls that will signal direct load control devices to shut down the electric components of the equipment rather than shutting off the pilot light on furnaces, boilers, or other natural gas-fired equipment. Similar to residential thermostats, non-residential customers will receive an OpenADR signal when there is a pending DR event and will lower temperature setpoints during this time. DR events may be activated during times of system stress for both the morning and evening periods. C&I customers participating in these programs will receive performance incentives based on established baselines. Like the residential program, the space and water heating segments will also need to address snapback. It is expected the control

strategies will use tiered event calls to minimize the impact of snapback on the overall sustained DR reductions.

In addition to intensive evaluation of each subprogram, the evaluation includes gas hydraulic modeling to simulate natural gas transmission and local distribution systems to identify or predict operational challenges, enable operational efficiency, and perform pressure and flow calculations. . Gas hydraulic modeling will provide operating decision support for load approval, size main extensions and replacements, or lack thereof, for economy and performance. This subtask will evaluate the SoCalGas natural gas system including upstream pipeline capacity, distribution capacity, storage capacity, and the need for additional city-gate supply. It will determine the impacts of isolating selected regions of the natural gas system for the two-to-four-hour event periods on remaining network pressures and flow, determine optimal compressor and regulator operations to minimize fuel costs and maximize system capacity, and review the mechanisms used to schedule production and consumption of natural gas systems to maximize return from the pilot. The analysis also includes the impacts of the DR program on existing distribution systems (e.g., expansion), the role of interruptible service contracts in the success of demand response, the role of the power generation sector (fossil and non-fossil based) has on the DR program, and the potential benefits of the DR program on the growth of renewable energy. This work will help inform the value of DR in the face of new drivers such as limitations on new transmission and distribution pipeline investment, gas system pruning, reduced gas storage capacity, increasing gas power generation, and electrification.

Future Plans. The California Public Utilities Commission recently denied SoCalGas's request to implement DR Pilot Programs (Bemesderfer 2023). GTI and SoCalGas are currently evaluating alternative approaches to deliver all or parts of the proposed program. The US DOE project is pending until the issue is resolved.

Gas Demand Response Knowledge Gaps and Future Work

Policy drivers and system constraints are increasingly leading natural gas utilities to develop new methods for managing peak gas load while ensuring reliability and providing gas service while potentially avoiding significant infrastructure expansions. While gas demand response programs are actively offered and proposed by some North American utilities, as can be seen from the above examples, barriers and knowledge gaps to support broader program adoption remain.

In a Financial Assistance Funding Opportunity Announcement, the US Department of Energy's Office of Fossil Energy and Carbon Management suggests the following gaps need to be addressed to potentially design well-functioning gas DR programs (DOE 2021):

- Inadequate understanding of cost savings per participant across multiple sectors,
- Inadequate understanding and quantification of environmental benefits,
- Utility-dependent alleviation effects on local distribution system and customer response,
- Influence of "snapback" effects on smart thermostat programs, and
- Scalability issues and opportunities for technology innovation for automation, successful signal transmission, data analysis, and data management.

In addition, the industry would collectively benefit from a better understanding of time-of-day load shedding, cost of service, avoided or potential pipeline build-out costs, the resiliency

of the pipeline to offset potential cyber-attacks; and, the storage distance limitation and reliability of natural gas compressor stations (Tran 2023).

The five examples in this paper demonstrate knowledge gaps and challenges consistent with those previously identified, while also providing data to help close the gaps and overcome the barriers to gas DR program development. The proposed program from New Jersey Natural Gas acknowledges the lack of robust data about gas DR program impacts and how program design may affect outcomes and suggests its program will contribute to ongoing learning. The examples from Con Edison, National Grid, and Xcel Energy are already providing feedback on some of the common challenges, which can be used to iterate existing programs and shape the development of future programs. Key lessons learned that will help shape ongoing development include:

- While Con Edison and Xcel Energy ran into several significant challenges while conducting their pilot programs, and Con Edison found the programs not cost-effective, National Grid has found success with their program and plans to expand the program into Massachusetts.
- Most programs start with the assumption preconditioning will be necessary, however data shows this approach is less effective as the inside/outside temperature delta increases.
- Further, National Grid noted that the lack of pre-conditioning did not affect program participation significantly and thus led to higher gas reductions.
- Peak day and peak hour impacts can both be addressed by gas DR, but programs must be deliberately designed to do so. More broadly, peak day and hour are different concepts versus electric DR, and the need to maintain gas system pressure is critical.

The lessons learned from the examples in this paper will add to the growing body of knowledge about the circumstances under which gas DR can be successful, and the conditions under which it may not achieve intended objectives. By providing a forum for gas and dual fuel utilities to share learnings and discuss common challenges, the CEE Natural Gas Program Strategy Committee will continue to serve as a venue to explore and identify successful gas DR program models, engage the aggregator community, and promote knowledge and resources to support adoption of gas DR where it is likely to provide customer and grid benefits. The outcomes of this ongoing work will accelerate shared learning about successful gas DR program approaches and enable broader collective understanding of program design considerations, while also demonstrating a market for aggregation services and technologies to encourage competition and availably.

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