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Gas Demand Response

2020-21 Annual Report

Brooklyn Union Gas Company d/b/a National Grid NY and
Keyspan Gas East Corp. d/b/a National Grid
Case 20-G-0086 and Case 20-G-0087
June 14, 2021

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Executive Summary

Pursuant to the New York Public Service Commission's "Order Directing Implementation Plan Filing, Annual Reporting and Tariff Modifications" dated October 15, 2020 in Case 20-G-0086 and Case 20-G-0087, The Brooklyn Union Gas Company d/b/a National Grid NY and Keyspan Gas East Corp. d/b/a National Grid (collectively, "National Grid" or "the Companies") submit the first Annual Report of their Gas Demand Response ("Gas DR" or "DR") programs for the 2020-21 season.

From November 1, 2020 through March 31, 2021, the Companies ran a portfolio of gas demand response programs aimed at reducing customer gas demand during peak winter days with extreme cold temperatures. These programs were an extension of programs developed during the 2019-20 winter heating season and described in the Companies' "2020-2021 Expanded Gas Demand Response Implementation Plan" filed on October 22, 2020 in Case 20-G-0086 and Case 20-G-0087. The DR portfolio consisted of 3 specific programs:

- i. Daily Demand Response - A program for large commercial, industrial and multi-family firm service customers capable of reducing peak day gas loads over a 6 or 8-hour period on event days.
- ii. Bring-Your-Own-Thermostat ("BYOT") Demand Response - A residential and small commercial customer-focused program which utilizes Wi-Fi connected thermostats to remotely lower temperature set points and shift peak hour gas loads on event days.
- iii. Behavioral Demand Response ("BDR") - A non-incentivized program which uses e-mail messaging to notify customers of impending cold weather and suggests methods to lower gas consumption during peak hours.

The goals of the program were twofold. First and foremost, the Companies system-wide gas supply constraints required the reduction in peak-day gas usage from existing customers in order to continue to serve additional customer connection requests following the "Order Adopting and Approving Settlement" in Case 19-G-0678. Secondly, the Companies recognized the need to develop new and innovative demand management programs to meet future needs and encourage DR program participation from all customer segments.

Summary results for each program are listed below, with additional details provided in subsequent sections of the document.

- i. Daily Demand Response
National Grid enrolled 156 customers that committed to reducing design day¹ gas consumption of 17,790 dekatherms (dth) in total per day in its Daily Demand Response program². Over 90% of customer accounts that had participated in the 2019-20 season returned for the 2020-21 program. Eighty percent of customer enrolled volumes were located in the KEDNY service territory of Brooklyn and Queens, with the remaining 20% spread across KEDLI's Long Island territory. Customers were offered a range of program options, with approximately two-thirds of customers electing an option with Direct Load Control ("DLC"), that accounted for 24% of load curtailment commitments. Customer consumption was measured using existing Companies-

¹ The Companies define a Design Day as a 24-hour period with an average temperature of 0 degrees Fahrenheit.

² 159 customers began the 2020-21 season in the program, with 3 dropping out of the program following the test events. The 17,790 dth commitment excludes those accounts.

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owned hourly metering devices (“M2Ms”). Due to a mild winter, no Demand Response Events were called for the 2020-21 season. However, most customers participated in a limited, 3-hour test event that was conducted on 12/2/2020, with a subsequent 3-hour test event occurring on 12/22/2020 for the remaining, untested participants³. The average Heating Degree Day (“HDD”) measures were 26 HDD for the 12/2/2020 test, and 25 HDD for the 12/22/2020 test. In aggregate, customers reduced daily load by 2,568 dths for the sum total of both the events and the entirety of the three hours⁴, with the portfolio performing at 83% of the weather-adjusted baseline⁵.

ii. BYOT Demand Response

As of the close of the 2020-21 winter heating season, 2,251 thermostat devices were enrolled in the BYOT DR program. To accurately measure the impacts of this program, the Companies randomly divided its portfolio of enrolled devices into 3 groups for these events, dispatching one or two groups and leaving the other(s) unchanged to serve as the control group(s). There were four separate 4-hour events over the course of the 2020-21 winter; three morning events, and one evening event. Across the four events, event window usage reductions were observed as well as net event usage reductions. While the former metric is calculated only for the four-hours long event period beginning at either 6 AM or 5 PM, the latter also accounts for the pre-heat and snapback usage, which are calculated at 90 minutes before and after an event. The average per customer event window usage savings ranged from 0.061-0.066 dth per event, while the net event usage savings ranged from 0.019 – 0.034 dth per event⁶. These estimates are statistically significant at the 95% level.

iii. Behavioral Demand Response

National Grid conducted two Behavioral Demand Response events for the 2020-21 season. The first event was conducted on the coldest day of the winter season (1/29/20) and involved cold weather email alerts to 489,969 Residential and Small Commercial customers. These emails included a call to action for customers, with 2,894 customers committing to reduce load as directed. The second utilized a customer installed metering device and mobile application to run a BDR event for 269 customers split between two groups in a randomized controlled trial. The

³ Due to delays in installing metering and the unexpected enrollment of a large portfolio customer just prior to the season, the Companies found it necessary to conduct two separate test events for participating customers, with no overlapping participation.

⁴ Mild temperatures during test event days, combined with a limited test event length (3 hours), contribute to the disparity between dekatherms reductions reported here and the design day-based enrollment quantities.

⁵ The Companies were unable to verify the participation of 15 customers due to issues with meter data collection. These participants have been excluded from the performance metrics reported here.

⁶ Aggregate level event window usage reductions ranged from 42.4 – 84.7 dth/event, while the net event usage savings ranged from 13.1 – 37.6 dth/event. However, the four events are not equivalent scenarios and had a wide difference in participant counts. Event participation, while randomized, ranged from 682 to 1,371 participants across the four events; hence the aggregate level reductions are largely driven by customer counts, in addition to the variability in reductions at the event level. Table 2-1 and Table 3-4 in Appendix A report device participation counts and aggregate level metrics respectively.

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results of this event have proved inconclusive to date, as the low sample size impaired the randomized controlled trial from producing conclusive results.

The DR programs operated for the 2020-21 season were successful relative to the customer enrollment, program operation and performance goals. The Daily DR program exceeded the target daily consumption reduction enrollment goal by 6.7%⁷, while the BYOT program fell shy of its 2,500 device enrollment goal by 10%. At the same time, the 2020-21 winter saw limited instances of colder than normal temperatures, and no periods of severe cold snaps around which Gas DR programs are designed. This limited the Companies' ability to observe the performance of the DR resources under near-Design Day conditions. On the other hand, the winter did provide a good opportunity to engage customers, test the capabilities of the early stage Residential programs and refine program operations and administration. Several key takeaways from the past year are detailed below:

- For the second year in a row, limited instances of severe cold weather inhibited the evaluation of DR resources under true event conditions
- Customers responded positively to increased incentive offers associated with the DLC option of the Daily DR program, exceeding expectations regarding customer commitments.
- Getting access to, analyzing and evaluating hourly metering data for gas customers is a critical component of running a gas DR program.
- Higher incentives and more targeted sales efforts may be necessary to encourage participation of non-heating dependent loads in the Daily DR program and reduce reliance on back-up fossil heating systems.

Residential thermostat programs showed the potential for addressing peak hour needs, with some measurable impact to peak day demand as well.

⁷ This figure is based on commitments from the final 156 enrolled customer facilities, which is 17,790 dth

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Gas Demand Response Background

National Grid first initiated Gas Demand Response programs through a pilot program launched in 2017 in the KEDNY and KEDLI service territories. This program, which concluded its three-year run on March 31, 2020, was one of the first introductions of applying traditionally electric focused demand response programs to gas utilities.

The demonstration project provided useful data regarding the value of DR programs for gas utilities. Most importantly, the pilot demonstrated that customers were eager to participate in gas DR programs, that access to usage data was a valuable resource for customers and that DR programs could be used to support areas of low pressure on the distribution system. The pilot was focused on reducing load during the peak hour and, at its peak, was reducing demand by 241 dth/hr.

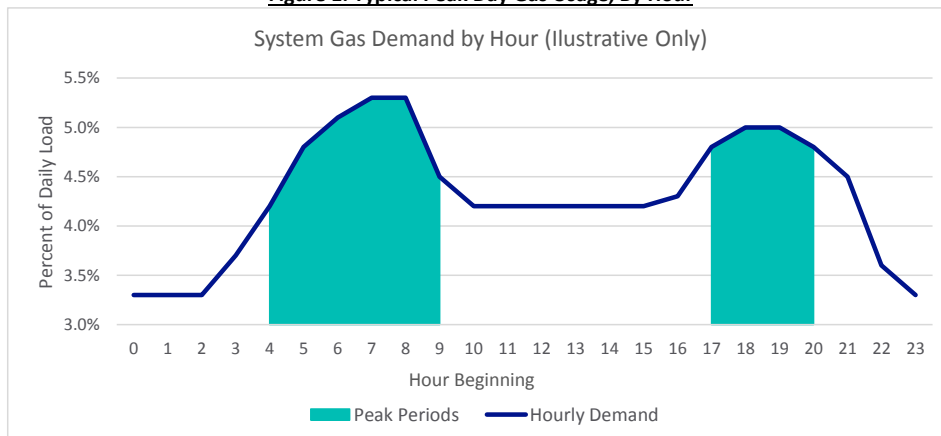
As the pilot program was winding down in 2019-20, National Grid launched additional DR programs aimed at reducing Design Day gas demand to help allow the connection of additional firm service customers to the Companies' gas system beginning in the fall of 2019. Three DR programs were deployed by the Companies in Winter 2019-2020 as part of the November 24, 2019 Settlement agreement and described in the Companies' Implementation and Contingency Plan filed on October 21, 2019 in Case 19-G-0678.

The programs for the 2020-21 winter season built on the knowledge gained from both the DR pilot program and the 2019-20 programs. With current supply constraints in downstate New York and significant stakeholder interest in non-pipeline alternatives, these programs represent a critical component of meeting future gas system needs.

Daily Demand Response

a. Program Design

Figure 1: Typical Peak Day Gas Usage, By Hour



The primary goal of the Daily Demand Response program is to provide load relief in the form of demand destruction that can be measured over the full gas day. Customers were asked to reduce gas

Commented [XM1]: Shall we add KEDLI and KEDNY to the chart title?

Commented [BO2R1]: Good question but no. This is illustrative so we don't want to introduce any confusion that it refers to a specific system.

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consumption during pre-determined hours, which also corresponded to the hours in which National Grid's system typically experiences the highest customer demand. The Companies typical peak day hourly consumption pattern is illustrated in the chart above.

Though the program is focused on daily load reductions, the Companies aligned their program event windows to correspond to the typical system peaks. This was done to ensure that the daily load reductions were occurring during the gas system's most critical periods. A program which requested or encouraged load shedding outside of these hours would run the risk of solving a peak day system need while ignoring the peak hour, which becomes an increasingly critical figure in operational planning in a supply constrained gas system.

Customers were provided with a menu of 4 Daily DR program options, differentiated by the times in which they would participate and the level of control the Companies retained over customer equipment (Direct Load Control, or DLC). Those 4 options are listed below.

Table 1: Daily DR Program Options

2020-2021 Daily DR Options	No DLC	With DLC
4AM-10AM	Option 1	Option 2
6AM-10AM AND 5PM-9PM	Option 3	Option 4

Customers were offered two types of performance-based incentives for enrolling and participating in the program. The first, a Reservation Payment, is paid in exchange for the commitment to reduce a pre-set quantity of gas during events (in dekatherms per day, or dth/d), with incentives scaling up over each of the successive levels from Option 1 to Option 4. These incentives follow structures similar to the electric demand response programs in New York. . Reservation payments are subject to an adjustment based on the customers' average performance rating ("Performance Factor")⁸, with the payments being processed and paid out at the end of the season. In addition to this, Customers would also receive smaller event-based Performance Payments for each dth reduced during events or test events.

The program Incentive Rates for the 2020-2021 season are shown below.

Table 2: Daily DR Program Incentive Rates, By Program Option

Program Option	Event Window(s)	DLC	Reservation Payment	Performance Payment
Option 1	4-10AM	No	\$38/dth/Month	\$7/dth
Option 2	4-10AM	Yes	\$44/dth/Month	\$7/dth
Option 3	6-10AM & 5-9PM	No	\$45/dth/Month	\$7/dth
Option 4	6-10AM & 5-9PM	Yes	\$52/dth/Month	\$7/dth

⁸ The Performance Factor is a rolling average, calculated as the average of the last three Event Performances. The Event Performance is a percentage value based on an account's actual event consumption when compared to a Baseline usage amount. For returning customer accounts, the starting Performance Factor will be equal to the calculated Performance Factor as of the close of the prior season. Each subsequent event during the season will adjust the Performance Factor used in monthly Reservation Payment settlements. New customers will begin the season with an assumed Performance Factor of 100%, but the Event Performance during the first event or test event will retroactively apply to any months where no events occurred.

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b. Marketing and Enrollments

In designing the program, it was understood and expected that only a limited pool of large Commercial, Industrial and Multi-Family would have the means, equipment and consumption profiles to participate in a load shedding program. Additionally, the Companies have previously found broader marketing efforts (ex. e-mail campaigns) for DR programs to fall short of reaching desired goals, largely due to the novelty of gas demand response programs. The Companies' expect this to change as customers become more familiar with no-infrastructure solutions and distributed energy resources, including demand response programs.

As a result, the Companies' marketing efforts were highly targeted. The Companies mostly relied on direct outreach through its large customer account managers. The Companies provided potential customers with:

- A one-page Flyer summarizing the program details
- Customized enrollment incentive estimates (in the absence of hourly metering data)
- An FAQ document addressing the most typical customer concerns
- As-needed virtual meetings between customers, sales reps and the DR program team

Commercial, Industrial and Multi-family customers were eligible to participate in the program if they received firm natural gas service from the Companies in either the KEDNY or KEDLI service territories, with one geographic exclusion. Due to an existing on-system distribution constraint, load relief on Staten Island has little impact on the supply of gas needed at points further east. Customers located on Staten Island are, therefore, ineligible to participate in this program. Participating customers were required to have the ability to reduce daily gas consumption by shutting off non-heating gas equipment or switching to a backup, non-gas heating fuel source. Customers with heating dependent loads that could only be "shifted" to other times during the gas day were not encouraged to participate.

Customers were generally very receptive to the program's offering. Many customers National Grid approached had at least some knowledge of demand response from their participation in the electric demand response programs. This proved useful in educating customers about the program, as the changes for the 2020-21 season were intended to mirror electric DR program structures to the extent possible.

One challenge, as discussed later in this document, is that unlike the metering used for large customer billing for electric utilities, most National Grid gas meters in downstate New York are read on a monthly basis. As was found in the original DR Pilot demonstration project, most customers who were approached for the gas DR programs had little insight into their daily or hourly gas use. As a result,, National Grid sales staff were heavily involved in conversations with customers to discuss potential enrollment volumes of eligible customers. As the program grows, National Grid will continue to work with new prospective customers to develop estimates on hourly load consumption in lieu of actual metered data.

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The Companies set out to enroll a total of 16,667 dth/d of design day customer commitments for the 2020-21 season. This target was set based on an operational need of 10,000 dth/d, grossed up by an assumed reliability factor of 60%⁹.

The program reached a total of 17,970 dth/d in design day enrollments for the 2020-21 season, consisting of 156 individual facilities. Over 90% of customer accounts that had participated in the 2019-20 season returned for the 2020-21 program.

A table displaying the mix of customer accounts enrolled by facility type is shown below. As was the case in 2019-20, most customers participated through the use of back-up heating systems.

Table 3: Daily DR Program Enrollment, By Customer Facility Type

Facility Type	Number of Facilities	Percentage
Healthcare	8	5.1%
Mixed Commercial	3	1.9%
Multi-Family	82	52.6%
Dept. of Education	53	34.0%
Higher Education	6	3.8%
Industrial	1	0.6%
Government	3	1.9%
Total	156	100%

80% of customer enrolled volumes were located in the KEDNY service territory of Brooklyn and Queens, with the remaining 20% spread across KEDLI's Long Island territory. Most customers enrolled directly with National Grid, though select portfolio customers aggregated their accounts into one enrollment submission with the assistance of a third party. Customers overwhelmingly opted for the higher-incentive program Options as shown in the table below.

Table 4: Daily DR Program Enrollment, By Program Option Chosen

Program Option	Option Detail	Customers	dth/d Enrolled
Option 1	4AM-10AM, No DLC	5	196
Option 2	4AM-10AM, DLC	1	42
Option 3	6AM-10AM & 5PM-9PM, No DLC	44	13,435
Option 4	6AM-10AM & 5PM-9PM, DLC	106	4,296

c. Metering

Following a customer's enrollment in the program (and depending on the option selected), the Companies engaged its metering groups to prepare customer facilities for the installation of hourly metering devices. While the Companies were successful in enabling the recording, collection and communication of hourly gas meter reads for all program customers, this was a not an insignificant challenge for the Companies.

⁹ As a largely untested resource—particularly with respect to operations under design day conditions—the Companies use this assumed reliability factor to discount the deliverability of DR resources. This value will change over time as more performance data is collected on DR accuracy and reliability.

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The Companies uses devices known as “M2Ms”, an acronym describing that they are “machine to machine” communication devices to measure the hourly consumption of customers in the Daily DR program. These devices have historically been used for the Companies’ Non-Firm Demand Response rate classifications (formerly known as Temperature Controlled customers). As the population of that rate classification has declined over the last several years, the Companies were able to repurpose the devices that were currently in inventory to be used in the Firm DR program. M2Ms can either be used to solely read hourly consumption, or they can both read hourly consumption and enable the remote switchover to a back-up heating system (Direct Load Control).

The level of work required to install these devices for ‘read-only’ purposes is dependent on the existing customer’s meter, including:

- Current meter (pulsing vs. non-pulsing)
- Presence of a pulse corrector or pulse adaptor (IMAC Blue Box)
- Availability of wireless communications signal
- Availability of nearby 120-volt power outlet

Of these items, the first three may require the Companies to perform work at the customer’s facility¹⁰ prior to installing the M2M devices. The Companies encountered many of these needs when attempting to install the M2Ms, requiring multiple site visits to fully install the equipment. Additionally, the inclusion of the DLC option for customers added more complexities, as customer delays in making site equipment ready for DLC connection required several site visits from the Companies metering technicians.

While the Companies saw a high percentage of customers who returned to the program from the prior year, many of those customers upgraded their M2Ms to enable DLC connectivity. A summary of the installations completed in advance of the 2020-21 season is shown below¹¹.

Table 5: Daily DR Program Enrollment, By Metering Job Type

Job Type	Customers	Enrolled Load (dth/d)
New M2M & DLC	24	773
New M2M	21	5,459
DLC Upgrade	83	3,566
No Work Needed	28	8,172
Total	156	17,790

As evidenced by the above table, a large number of smaller customers elected the DLC option. A contributing factor is that for most large users with complex facilities, DLC connection would prove costly to the customer.

¹⁰ Customers are responsible for any work and associated costs for installing power near the gas meter. However, the Companies do provide customers with a long-range voltage adapter to connect to power not immediately near the meter.

¹¹ Additional site visits and installs were completed that are not reflected in those totals. Those occurred on customer accounts who either dropped out of the program mid-season or were found to not have sufficient metering and equipment needs and did not wish to pay for contractor upgrades.

Commented [XM3]: Did you mean making site equipment available

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Metering for the gas demand response program is expected to continue to be a critical component of program administration in the years to come. This is particularly true as the programs grow and continue to add a large number of new customers in the upcoming season. National Grid is taking several steps to improve this process, as detailed in a later section of this document.

d. Event Performance

Due to the absence of severe cold weather, the Companies did not call for any Daily Demand Response events based on temperature for the 2020-21 season. However, the Companies did institute a mandatory test event for participating customers which impacted their potential incentives just as an actual event would. The test event was designed to collect data on customer performance for at least one event, serve as a 'dry run' for actual events, and adjust customer incentives for those that did not perform up to their committed enrollments.

Due to the large number of metering jobs that were required to be performed in a short window and the unexpected enrollment of a large portfolio customer just prior to the season, the Companies found it necessary to conduct two separate test events for participating customers, with no overlapping participation. The first was held on 12/2/2020 from 6AM-9AM, with 133 customer accounts participating. The second event occurred on 12/22/2020, during the same window, and had 26 participating accounts¹². Both events occurred under the same weather conditions, with an average Heating Degree Day ("HDD") measure for the event hours of 26 HDD for the 12/2/2020 test and 25 HDD for the 12/22/2020 test.

A total of 15 accounts did not have functional or accurate hourly usage data at the time of the events. Those customers were still asked to curtail usage during the test events, but their performance could not be calculated or validated.

Of the accounts with functional active hourly metering, the Companies measured a total customer performance of 83% for the test events¹³ relative to the weather-adjusted baseline. The Companies calculated a weather-adjusted load drop of 2,568 dth¹⁴ over the course of the 3-hour test events, or an average of 856 dth/hr.

Notable takeaways from the test event are listed below.

- The odd post-event load shape in Hours Beginning 9 and 10 is due to several accounts which continued to utilize a back-up heating system past the DR test event windows.
- A single, large portfolio customer negatively impacted the overall performance of the DR resources. Excluding that portfolio customer's accounts from the calculations would raise the remaining customers' performance to 95%.

¹² Three accounts that participated in the 12/22/2020 event discovered that they did not possess working back-up heating equipment and subsequently dropped from the program. Their non-performance is included in the event performance totals.

¹³ Due to the similar HDD levels at the time of the two events, the Companies will show all performance figures as the total across the two events.

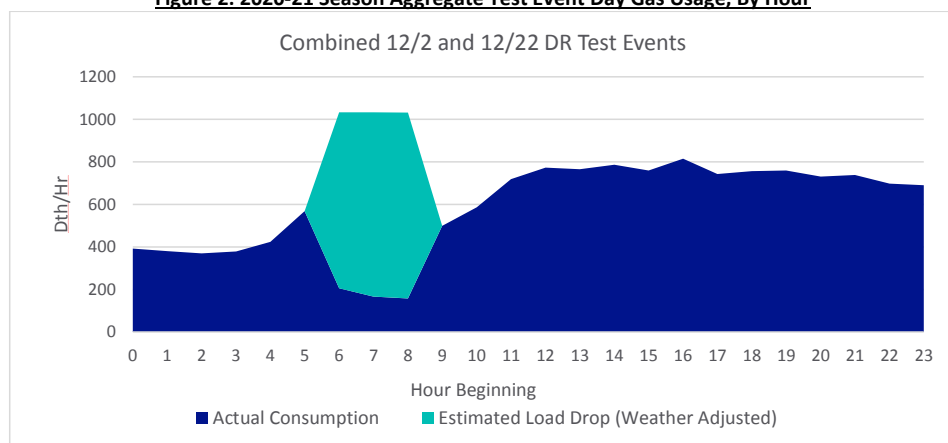
¹⁴ This figure is the sum of the load drops across all three hours from the two events which were conducted on 12/2/2020 and 12/22/2021 respectively

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- Customer accounts with DLC enabled performed at 99% reliability, versus 73% for manual accounts. DLC performance is slightly below 100% due to delays in transmitting communication signals from the Companies to the M2M controller.
- Accounts that were in the program last season and returned for 2020-21 performed at 96% reliability, versus 52% for new accounts.

The below chart reflects the measured customer load drop and baseline for the aggregate of the two test events.

Figure 2: 2020-21 Season Aggregate Test Event Day Gas Usage, By Hour



It's also worth noting that the measured load drop and associated performance percentage on a 25 HDD day will not tie back to the enrolled volumes since customers enrollment is based on expected design day loads (65 HDD). However, since an event may be called on a day that does not meet design day temperatures, a customer's baseline usage needs to be estimated for such a day (the counterfactual). Since Customers may only reduce loads that they would have used otherwise on such a day, under non-design day conditions, a weather-adjusted baseline is used to calculate customer performance.

Though there were no actual events in which to measure customer performance under near-design day conditions, the Companies were able to, for the first time, collect a full season of hourly usage data for the customers in the program. Based on analysis of that customer data, the Companies will be adjusting the event baseline calculations for the 2021-22 season. The method used for the 2020-21 season relied too heavily on the prior day's consumption, which had significant variation based on weather, day of the week, and customer operation schedules.¹⁵ The new method will take a longer view of customer consumption, employing a 'high 5 of 10' baseline calculation with a weather adjustment.

The Companies will also be adjusting their method for estimating customer design day potential in some cases. The Companies found that some customer accounts—particularly those with high summer gas

¹⁵ Some of this variation can be attributed to the unique year in which many customer facility operation schedules may have been impacted by the COVID-19 pandemic. Schools, in particular, saw odd consumption patterns due to frequent closings.

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consumption—appeared to have overstated design day estimates relative to observed hourly metering data. To counter this, the Companies will be utilizing the hourly data for returning customers to revise those design day estimates.

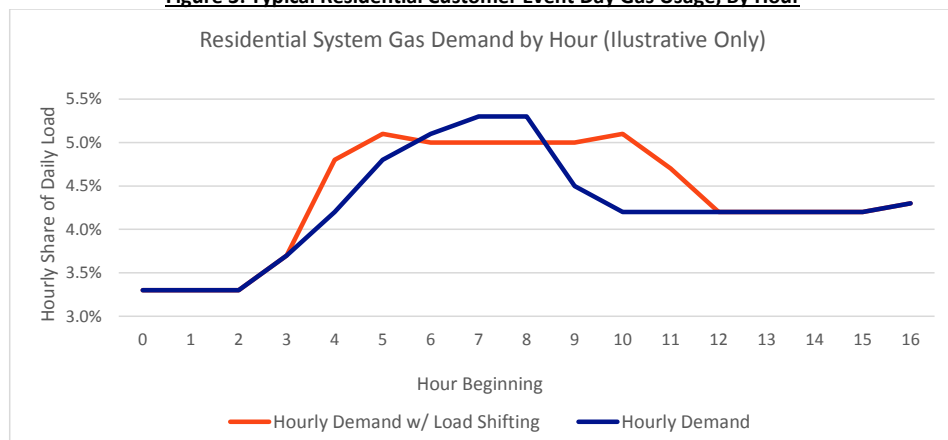
Bring-Your-Own-Thermostat Demand Response

a. Program Design

The Companies' Bring-Your-Own-Thermostat program offers the opportunity for residential customers to provide hourly load reductions in exchange for annual incentives. The program utilizes customers' existing Wi-Fi-enabled thermostats to remotely control connected heating equipment during periods of peak gas demand.

While the Daily DR program focuses on customers who can eliminate a portion of peak day gas loads, residential customers do not have that capability due to their sole reliance on gas for space heating purposes. Rather than shedding gas use over a 6 or 8-hour period, customers in the BYOT program were asked to shift some of their gas use out of the peak morning period into other times of the gas day. At a large scale, this "load shifting" technique may offer better utilization of the gas system by flattening the shape of daily demand curve and limiting the peak volume of supply needed to serve customer loads. An illustrative example of this is shown below.

Figure 3: Typical Residential Customer Event Day Gas Usage, By Hour



In order to effectuate this load shifting pattern and retain customer comfort, the BYOT program would pre-heat customer homes in advance of an event, then reduce the thermostat setpoint temperature during events, finally returning the thermostat back to normal operations at the conclusion of events. Customers maintained the ability to override adjustments to their thermostats at all times.

The program established fixed event windows for customers, running events either from 6AM-10AM or from 5PM-9PM to align with peak windows. A timeline for events, along with the respective temperature adjustments, is shown below.

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- Starting 90 minutes prior to the start of an event, thermostat setpoint temperatures would increase by 3 degrees relative to their normal, non-event schedules.
- At the start of the event, the thermostat setpoints would be lowered to 4 degrees below their normal, non-event schedules¹⁶.
- Following the conclusion of the event, which runs for 4 hours, the customer's thermostat setpoint would return to its normal, non-event schedule for that hour.

No strict temperature thresholds were established for the 2020-21 season. The Companies instead endeavored to call 3-5 events during the coldest days of the winter so that it could test the viability and impact of the program. Future program seasons will utilize an established temperature threshold that will align with the Daily DR program.

Customers were offered a \$25 instant incentive for signing up for the program and, starting with the second season in which they are enrolled, could earn an additional \$25 per year incentive if they participated in at least 70% of the that season's event hours.

b. Marketing and Enrollments

The Companies utilized a third-party Distributed Energy Resource Management System ("DERMS") provided by EnergyHub to aggregate the enrollments of participating thermostat manufacturers and customers. EnergyHub also provides this service to National Grid's affiliate electric service companies in New York, Massachusetts and Rhode Island.

The Companies primarily utilized the communication channels of its thermostat partners to reach potential customers. Customers received offers—either in the form of a mobile application notification or email—directly from their thermostat manufacturers with offers to enroll in the program. National Grid also incorporated the program sign-up into its larger ConnectedSolutions offerings, adding a program webpage for the downstate New York gas program¹⁷. Customers could access the sign-up pages, hosted by EnergyHub, through either method. Utilizing the thermostat manufacturers existing communication channels, the Companies were able to directly target customers with eligible smart thermostats.

For the 2020-21 season, the program was open to customers that met the following eligibility criteria. To qualify, customers must:

- Be an active National Grid natural gas customer
- Reside in either Brooklyn or Queens
- Own a qualifying smart thermostat from one of the following manufacturers:
 - Emerson (Sensi)
 - Honeywell
 - Lux

¹⁶ Note that in some cases this would be a net change of 7 degrees from the pre-heating period. Depending on the customer's typical schedule, the event temperature setpoint could fluctuate during the event, but would always remain 4 degrees below normal unless the customer overrides the controls.

¹⁷ <https://www.nationalgridus.com/NY-Home/Energy-Saving-Programs/ConnectedSolutions>

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- Radio Thermostat
- Google-Nest
- Have their qualified thermostat connected to a natural gas fired central heating system

Customers in Staten Island were ineligible to participate for the same reasons as listed in the Daily DR section earlier in this report. Customers on Long Island were not able to participate due to a technical limitation with overlapping electric DR programs in the PSEG Long Island territory.

As of the close of the 2020-21 winter season, the Companies had enrolled 2,251 devices in the program¹⁸, falling shy of its seasonal program goal of 2,500 devices.

c. Evaluation Plan and Event Performance

As a new program offering with limited customers expected in the first season, the BYOT program in 2020-21 was designed to be used as a test case for estimating program potential and capability. As mentioned previously, the Companies have limited hourly metering across their customer portfolio. This is particularly the case for the residential customer population.

To estimate statistically valid results, as well as considering this limitation, the Companies developed a 'treatment and control' design for the 2020-21 BYOT program. Customer devices were randomly assigned to 3 different treatment groups, of which 1-2 groups could be dispatched during an event (treatment), with the non-dispatched group(s) serving as the control groups.

The Companies conducted four events for the 2020-21 season, a summary of the event dates, times, temperature and groups dispatch are shown below.

Table 6: BYOT Event Dates and Device Counts¹⁹

Date	Event Window	Avg. Event Temperature (F)	Treatment Devices	Control Devices
12/18/2020	6AM-10AM	26 Degrees	1,083	535
1/29/2021	6AM-10AM	18 Degrees	1,334	678
1/29/2021	5PM-9PM	23 Degrees	688	1,358
1/30/2021	6AM-10AM	19 Degrees	678	1,368

Without access to interval metered data, the Companies utilized the 15-minute runtime data recorded from the participating thermostats. This runtime data was then transformed into dekatherms utilizing an estimated 80,000 BTU/Hour input assumption for the average customer heating equipment. The Companies are currently working to verify this input assumption using actual hourly data sampled from participating BYOT customers.

Once total runtime data was transformed into 15-minute gas consumption, the Companies were able to compare the per device consumption between the devices in the test and control groups. Across the four events (AM and PM), we observed event window usage reductions as well as net event usage

¹⁸ Enrollments have continued to grow since the close of the winter season, with total devices now over 2,700.

¹⁹ There is a minor discrepancy in aggregate level device counts reported in this table, and the customer-level runtime device data utilized for the evaluation and referenced elsewhere in this report. National Grid has reviewed this data with an external consultant and concluded that this does not present a concern for statistical validity and should not impact overall results of event performance.

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reductions. While the former metric is calculated only for the four hours long event period beginning at 6 AM or 5 PM, the latter also accounts for the pre-heat and snapback usage, which are calculated at 90 minutes before and after an event. Additionally, DNV GL, who have independently validated the Residential BYOT results have reported detailed results in the memorandum attached in Appendix A. The average per customer event window usage savings ranged from 0.061-0.066 dth while the net event usage savings ranged from 0.019 – 0.034 dth. These estimates are statistically significant at the 95% level. Please note that the savings metrics reported here are point estimates. DNV GL has also presented the relative precision of each of the event day estimates at the 95% confidence level, in the attached memo. A relative precision estimate of (95/x) is to be interpreted as follows; that we are 95% confident that the true value is within x% of the reported estimate.

Aggregate level event window usage reductions ranged from 44.2 – 84.7 dth/event, while the net event usage savings ranged from 13.1 – 37.6 dth/event. However, the four events are not equivalent scenarios and had a wide difference in participant counts. Event participation, while randomized, ranged from 682 to 1,371 participants across the four events; hence the aggregate level reductions are largely driven by customer counts, in addition to the variability in reductions at the event level. Table 2-1 and Table 3-4 in Appendix A report device participation counts and aggregate level metrics respectively.

A summary of the per device event reductions, increases from the pre-heating and snapback periods, and resulting net daily load reduced are shown in the table below. A graphical representation follows.

Table 7: BYOT Per Device Reductions, Inclusive of Opt-Outs (in Therms²⁰)

Event Date	Pre-Heat Delta	Relative Precision (95 / x)	Event Delta	Relative Precision (95 / x)	Snapback Delta	Relative Precision (95 / x)	Net Delta	Relative Precision (95 / x)
2020-12-18 (AM)	-0.18	14%	0.66	7%	-0.14	17%	0.34	20%
2021-01-29 (AM)	-0.22	10%	0.62	7%	-0.12	17%	0.27	26%
2021-01-29 (PM)	-0.27	7%	0.61	7%	-0.12	16%	0.21	33%
2021-01-30 (AM)	-0.29	7%	0.66	7%	-0.17	12%	0.19	38%

Table 8: BYOT Event Reductions, Inclusive of Opt-Outs (Percent Reductions)

Event	Percent Reduction (Event)	Percent Reduction (Net)
2020-12-18 (AM)	57%	18%
2021-01-29 (AM)	45%	12%
2021-01-29 (PM)	51%	10%
2021-01-30 (AM)	48%	9%

The events were able to demonstrate that despite the increases in consumption for the pre-heating and snapback periods, the BYOT program can achieve reductions in net daily gas consumption in addition to the hourly reductions. The total pre-heating and snapback effects offset a portion of the total event

²⁰ 1 therm is the equivalent of 0.1 dekatherms

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savings by a range of 48-71%. The ability of this to be sustained during periods of more extreme cold will depend on the level of customer participation and associated comfort with the program.

Figure 4: Residential BYOT Test vs. Control – AM Event Average

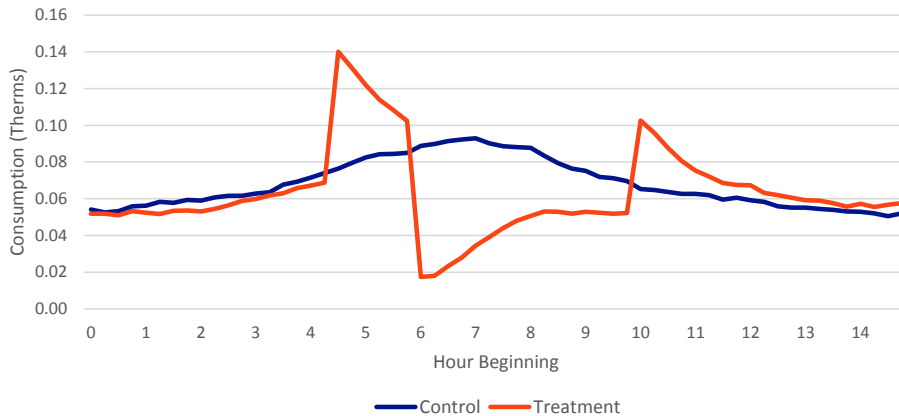
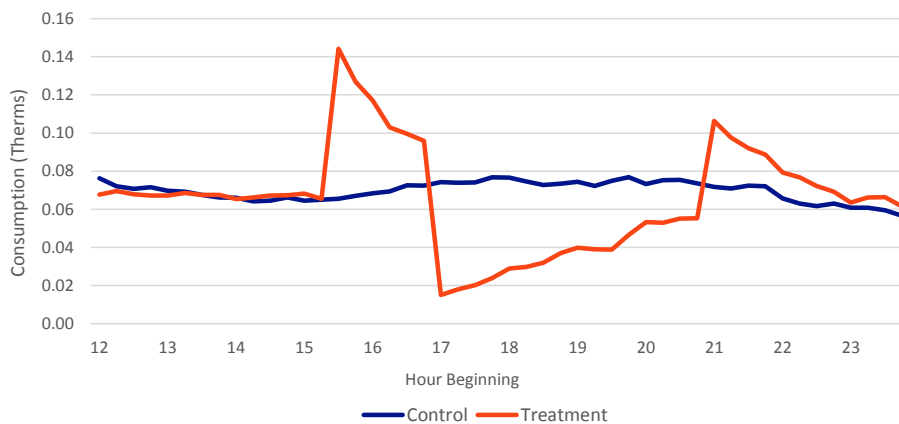


Figure 5: Residential BYOT Test vs. Control – PM Event



Though data is limited due to the low number of events, the Companies did observe that customers opted out more frequently during the colder events of 1/29/21 and 1/30/2021 (34%) than the milder event on 12/18/2020 (25%). Most customers opted out in the middle of the event, which partially explains the rise in the treatment groups consumption around the 7-8AM hours. Though the customers are listed as having opted out, they still were able to provide some measure of peak hour reduction during the few hours of the event. The Companies intend to use data on customer opt-outs to improve customer education, highlighting the ability to earn future incentives to improve participation levels.

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Behavioral Demand Response

a. Program Design and Events

In order to reach additional customers that did not participate in the Daily DR or BYOT programs, the Companies also ran a non-incentivized Behavioral Demand Response program for residential and small-commercial customers. Unlike the incentivized programs, customers did not enroll in this program but were instead targeted in a large marketing-like campaign during cold weather events.

The Companies conducted one large Behavioral DR ("BDR") event on 1/29/2021. For this event, the Companies sent email messages to 489,969 Residential and Small Commercial customers with tips on ways to temporarily reduce gas consumption in the early morning hours.

In addition to the recommendations on how to conserve gas, the message included a call to action for customers. Customers committed to participating in the event by selecting a link within the BDR e-mail. The link brought customers to a thank you page which also provided additional information on energy efficiency and the BYOT DR program. Those commitments were tallied with over 2,894 customers saying they would participate in the BDR event. Without hourly metering, the Companies can only estimate the volume of gas reduced.

In order to get accurate information on customer reductions during Behavioral DR events, National Grid partnered with Copper Labs to provide 900 select customers with devices capable of reading hourly gas consumption from traditional drive-by meters. Customers also received access to a mobile application through which they could receive push notifications and track their consumption. Due to delays in implementation, these devices were largely inactive during the 1/29 BDR event. The Companies did run a separate randomized control trial for 269 customers following this first event. Due to limitations in sample size, the Companies were not able to determine any impact from the mobile BDR message. The Companies will continue to work with customers to complete the connections of these devices, which will be utilized to measure impacts of BDR events in 2021-22.

Program Costs

a. Costs by Program and Type

All costs associated with the 2020-21 demand response program options were borne by National Grid shareholders as part of the Moratorium Settlement agreement. The Companies costs totaled \$3,865,162 to operate the programs in 2020-21, with the bulk of costs coming from customer incentives. Costs were less than the maximum projected totals laid out in the Companies' 2020-21 Demand Response Implementation plan due to the sub-100% performance of Daily DR resources, a low number of events and slightly less than expected enrollments in the BYOT program.

Table 9: 2020-21 Costs by Program

Program	Incentives	Vendors and Metering	Total
Daily DR	\$3,597,503	\$0	\$3,597,503
BYOT DR	\$57,733	\$92,250	\$149,983
Behavioral DR	\$0	\$105,676	\$105,676
Total			\$3,853,162

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Non-incentive expenses were driven by three factors—fees paid to the Companies’ BYOT vendor for operating the program and enrolling customers, one-time costs associated with the deployment of Copper Labs energy monitoring devices for evaluation of the BYOT and BDR programs, and per e-mail messaging fees associated with the BDR program.

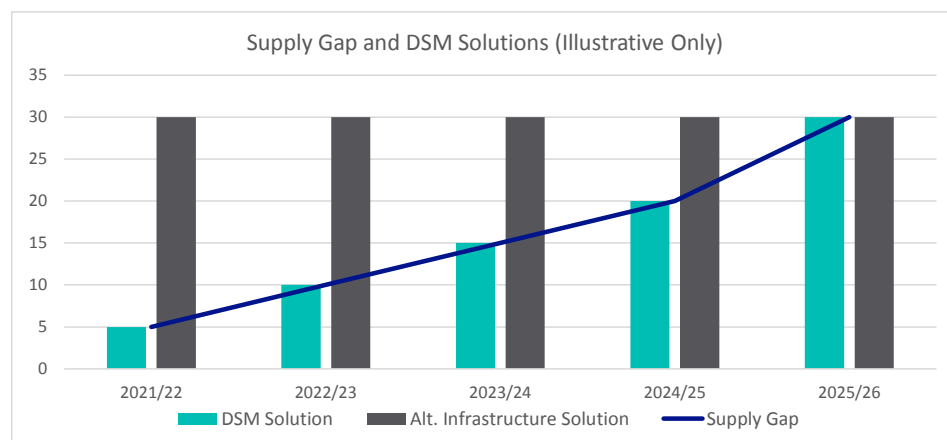
b. Benefit Cost Analysis

The Companies have developed a new Benefit Cost Analysis (“BCA”) tool for the purposes of evaluating both its gas demand response programs and any other non-pipeline alternatives implemented or considered in response to the system-wide supply constraints currently experienced by the Companies.

Since gas DR and other novel demand-side measures are being implemented in place of traditional pipeline infrastructure, the BCA tool captures the value of upstream supply capacity in the form of a modeled pipeline alternative sized to the DR program delivery.

In the context of the Companies’ Demand Side Management (“DSM”) strategies, the BCA tool will evaluate programs as a single portfolio offering over a multi-year period. It should be noted that DSM programs are found to be more valuable from a BCA perspective under a multi-year view since they can be sized to meet the exact system needs each year. In contrast, infrastructure solutions are built to meet needs 5, 10 or 15 years in the future.

Figure 6: Supply Gap and DSM Solutions (Illustrative Only)



For the purposes of this Annual Report, the BCA scores listed below account only for a single year of DR programs. The scores are calculated using a Societal Cost Test (“SCT”).

Table 10: 2020-21 Demand Response Benefit Cost Analysis Scores

Program	SCT Score
Daily DR	3.43
BYOT DR	1.65
Behavioral DR	1.19
DR Portfolio	3.35

Conclusion

a. Lessons Learned and Program Changes

Despite the mild winter temperatures and the lack of actual events, the 2020-21 DR season provided the Companies with several key learnings for the future. These learning have been used to alter DR program designs for the upcoming 2021-22 winter season. A list of those lessons learned, and the resulting programmatic changes are listed below. A full detail of the Companies plan for the 2021-22 DR season can be found in the 2021-2022 Gas demand Response Implementation Plan filed with this report.

1. In the case of a mild winter the early season test event may not provide enough useful data on customer performance.
 - In future years, the Companies will add the possibility of calling a mid-winter test event if no actual events have occurred. The Companies will retain the early season test event as a dry run for participating resources. In the face of limited information on customer reliability and the novel aspects of gas DR events, this early season test event is critical to increasing customer comfort with gas DR and improving performance in advance of actual events.
2. Customers in the Daily DR program showed a stronger than expected preference for DLC program options, due to the higher rates offered for those options and the operational relief provided to facility staff. However, the process to enable DLC proved cumbersome in some cases, with resources strained to enable DLC on lower priority accounts.
 - For 2021-22, the Companies will increase customer awareness around the requirements for DLC and encourage those customers to enroll in the program as early as possible. Unless due to negligence on the part of National Grid, customers that do not upgrade their heating equipment to receive a working DLC signal from the M2M device will not be eligible for DLC rates until the month following the completion of that upgrade.
3. Visibility into hourly gas consumption remains an obstacle during the enrollment period. In many cases both the Companies and the customers do not have access to hourly metering data until after a customer has enrolled in the program and an hourly metering device is installed. Estimating a customer's potential DR contribution is challenging without this information.
 - The Companies will utilize all available hourly metering data to refine estimates on customer consumption during peak days. This will ensure both that customer's enrollments accurately represent their capability of delivering gas load relief.
 - The Companies will also adjust its baseline calculation for Daily DR event, moving to a high 5 of 10 baseline (or high 4 of 6 for holidays and weekend days) with an optional weather adjustment for heating-dependent accounts.
4. Customer metering for the Daily DR program encountered several challenges related to the work required by National Grid at each site, resulting in several site visits to complete some hourly metering installations.

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- The DR team will coordinate with customers and internal metering staff to review customer needs prior to conducting initial site visits. This will cut down on the number of 'empty' customers visits.
- 5. Most of the participation in the Daily DR program came from resources participating through the use of a back-up fossil-based heating systems. Finding additional resources to diversify the Daily DR portfolio and limit emissions impacts will be critical for futures seasons.
 - Expanded sales and outreach efforts have begun to target non-heating dependent loads and customers relying on gas for on-site electric generation. Additional curtailment strategies, including the use of alternate electric heat pumps and biodiesel fuel, are being explored with customers.
- 6. Several customers unable to participate in the Daily DR program expressed interest in participating in an hourly, load-shifting program.
 - The Companies will be adding an hourly, load-shifting program for Commercial and Multifamily customer to its 2021-22 DR portfolio.
- 7. Limitations in the areas where the Companies could offer its BYOT program negatively impacted customer adoption.
 - The Companies, through its vendor EnergyHub, plan to expand eligibility to customers in Long Island for the 2022-22 season. EnergyHub has communicated with the Companies plans to update its platform to allow for a single device to be enrolled in separate utility programs.

**Memo to:**

Owen Tyrell
Merlyn Xavier
Alberto Edde

From:

Ken Agnew
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Riley James

Date:

May 10, 2021

Copied to:

Tom Ledyard

EnergyHub Event Analysis

1 Introduction

This memo offers an independent validation of the The Brooklyn Union Gas Company d/b/a National Grid ("National Grid") and Keyspan Gas East Corporation d/b/a National Grid BYOT gas demand response (DR) program event results for the 2020-21 winter season. There were four events: three in the morning and one in the evening.

2 Methodology

This section explains the counts of the experimental design groups, estimates of per-unit load reduction, and how they were combined to produce program-level event and daily load reduction estimates.

2.1 Treatment group counts

The primary source of data is the "Raw Data – All Groups" tab in the EnergyHub event summary data. The customer-level run-time data from which the results are estimated are in that tab and the counts from these data are used to expand per-unit load reduction estimates to the program results. There are a small number of customers for whom run-time data were not available and they are not included in these counts. The counts are shown in Table 0-1.

Table 0-1. Treatment and control group counts by event (Raw Data – All Groups)

Event Date	Treatment	Control
2020-12-18 (AM)	993	491
2021-01-29 (AM)	1371	698
2021-01-29 (PM)	698	1371
2021-01-30 (AM)	682	1383

2.2 Consumption calculation

The customer-level run time data mentioned in Section 0 was used to calculate the per-unit load reduction estimates. The steps include:

- To calculate savings by unit
 - Average treatment and control run time over each 15-minute period



- Transform to therm using assumed 80 MBtu furnace input. This assumption may be revised if data from the Copper Labs devices is deemed to be representative.
 - Identify peak, pre-heat, and snapback periods. Events start at 6 AM or 5 PM and are four hours long. Pre-heat and snapback are 90 minutes before and after, respectively. Actual snapback effects are likely longer than 90 minutes.
 - Subtract treatment group average consumption from the control group to calculate per customer savings
- Savings by AM and PM
 - Same as above for the three morning events combined and the one evening event
- Aggregate daily and event period savings
 - Use the Raw Data – All Groups counts for consistency
 - Multiply UES by treatment group counts

3 Results

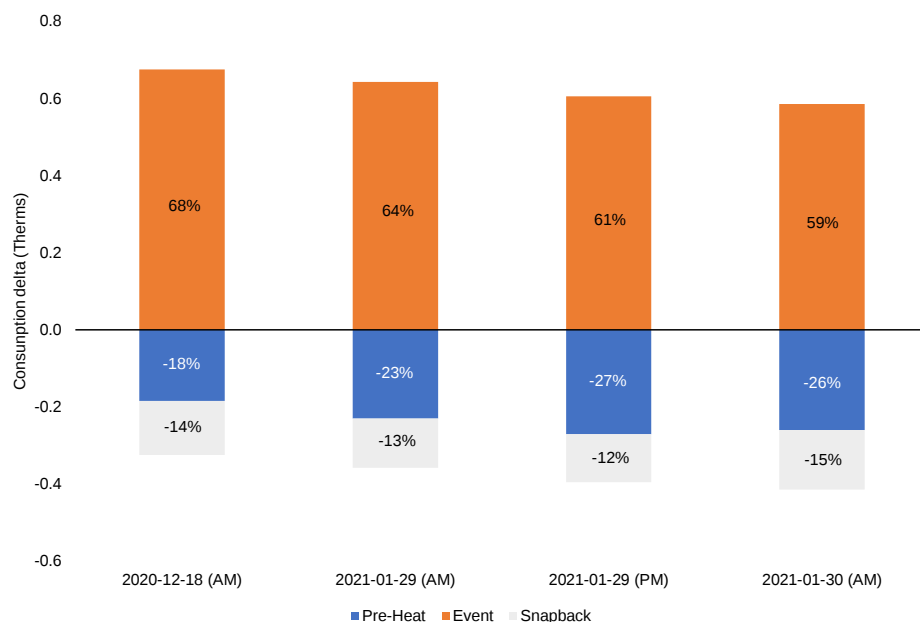
3.1 Unit consumption

Table 0-1. Per-unit event delta by window in therms with relative precision at 95% confidence

Event Date	Pre-Heat Delta	Relative Precision (95 / x)	Event Delta	Relative Precision (95 / x)	Snapback Delta	Relative Precision (95 / x)	Net Delta	Relative Precision (95 / x)
2020-12-18 (AM)	-0.18	14%	0.66	7%	-0.14	17%	0.34	20%
2021-01-29 (AM)	-0.22	10%	0.62	7%	-0.12	17%	0.27	26%
2021-01-29 (PM)	-0.27	7%	0.61	7%	-0.12	16%	0.21	33%
2021-01-30 (AM)	-0.29	7%	0.66	7%	-0.17	12%	0.19	38%



Figure 0-1. Per-unit event delta by window in therms and percentage



3.2 Time of day savings

3.2.1 AM events

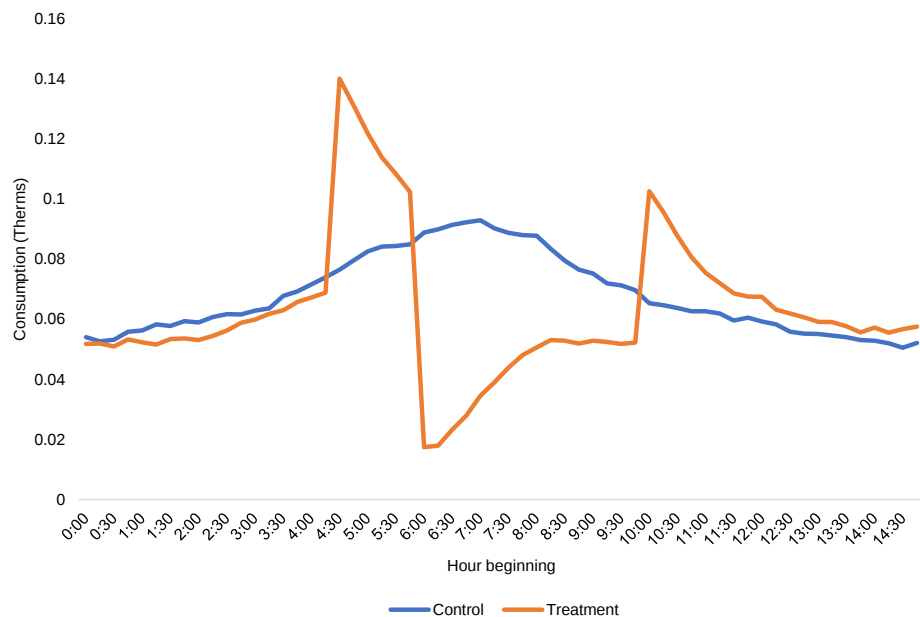
Table 0-2. AM event per-unit energy savings summary

Window	Minutes	Treatment Consumption	Control Consumption	Delta
Pre-Heat	90	0.72	0.49	-0.22
Event	240	0.67	1.34	0.64
Snapback	90	0.51	0.38	-0.14

*Averages across events are weighted averages of event results using group counts. The delta is weighted using treatment group counts.



Figure 0-2. AM event load shape



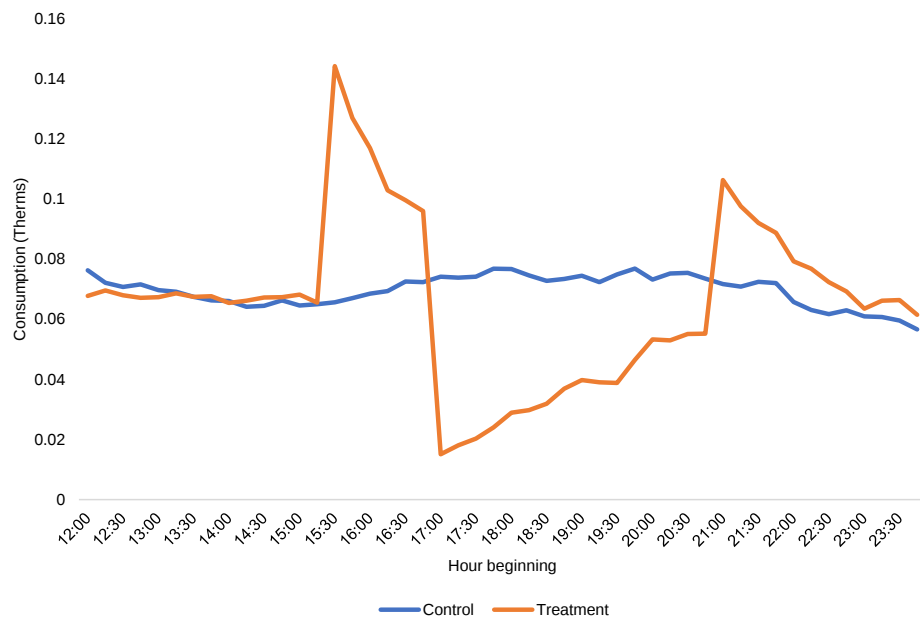
3.2.2 PM events

Table 0-3. PM event per-unit energy savings summary

Window	Minutes	Treatment Consumption	Control Consumption	Delta
Pre-Heat	90	0.69	0.42	-0.27
Event	240	0.59	1.19	0.61
Snapback	90	0.54	0.42	-0.12



Figure 0-3. PM event load shape



Aggregate daily and event savings

Table 0-4. Total program daily and event savings by event in therms with relative precision at 95% confidence

Event Date	Pre-Heat Delta	Relative Precision (95 / x)	Event Delta	Relative Precision (95 / x)	Snapback Delta	Relative Precision (95 / x)	Net Delta (Daily savings)*	Relative Precision (95 / x)
2020-12-18 (AM)	-180	14%	658	7%	-136	17%	341	20%
2021-01-29 (AM)	-304	10%	847	7%	-168	17%	376	26%
2021-01-29 (PM)	-189	7%	424	7%	-87	16%	147	33%
2021-01-30 (AM)	-200	7%	449	7%	-119	12%	131	38%

*Assuming 90-minute snapback