REPORT

SoCalGas®
2016-2017 Winter Demand Response Load Impact Evaluation

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Prepared for
Southern California Gas Company

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particular day, the gas savings for Conservation Campaign pilot programs were estimated for the Advisory days as well as for the entire winter from December 2016 through March 2017.

For My Account and Non-My Account customers, Figure 1-1 scales the total therms saved by the number of customers solicited for the Pilot Rebate Program, Conservation Campaign overall and the Seasonal Energy Update (SEU) monthly energy reports treatment, which was the highest performing of the Conservation Campaign. In total, the Conservation Campaign treatments produced nearly 91,000 therms saved across the two Advisories, which equates to 370 therms saved per 1,000 solicited customers. Even though reducing usage on specific days was not a focus of the Advanced Meter Conservation Campaign, these treatments produced nearly *26 times* more gas savings per solicited customer than the Pilot Rebate Program. The most effective Conservation Campaign treatment, "Seasonal Energy Update" monthly energy reports, produced more gas savings per 1,000 solicited customers on Advisory days than the entire Pilot Rebate Program produced with nearly 55,000 total solicited customers. Importantly, these Conservation Campaign treatments have the significant additional benefit of producing gas savings on non-Advisory days, which brings in an additional 1.16 million therms saved throughout the winter (around 4,700 therms saved per 1,000 solicited customers).

Table 3-4: Comparison of Pilot Rebate Program and Conservation Campaign
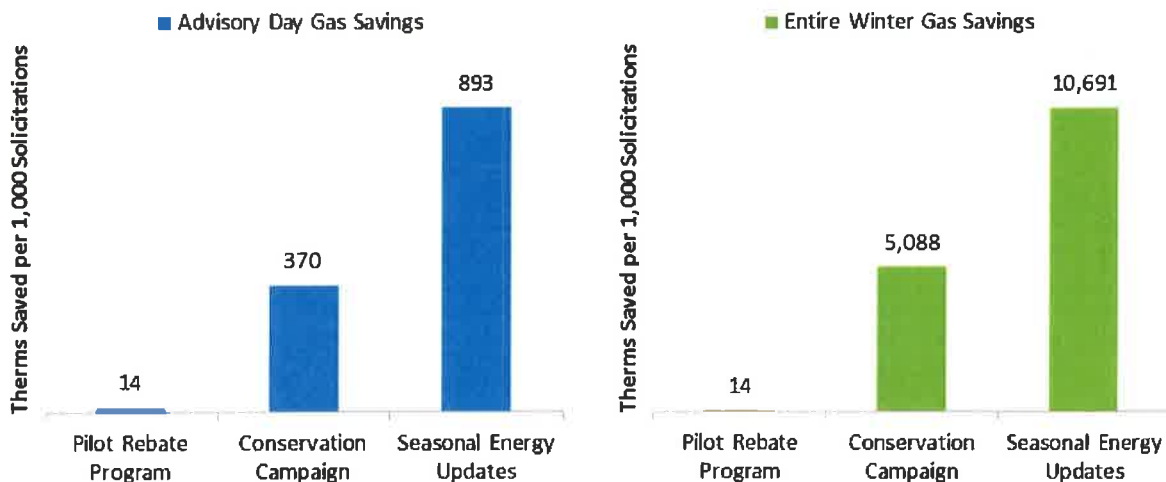
1.3 Nexant Observations and Recommendations

The SoCalGas Advisory had a variety of significant challenges, some of which were likely due to the short lead time for designing and launching the pilots. If a similar need for conservation arises in the future, SoCalGas may be able to address some of these challenges to improve the impacts for these types of pilots, but many of the issues are likely to persist, including:

- Long, multi-day events lead to relatively low impacts (or no impacts)

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2   Introduction

California Public Utilities Commission Resolution G-3522 approved SoCalGas' proposed winter demand response programs (AL 5035-G) with modifications and directed SoCalGas to undertake evaluation efforts of the ex post load reductions provided.[3] Pursuant to this directive, SoCalGas worked with Nexant to conduct a load impact analysis to estimate the therm reductions for all three "Natural Gas Conservation" pilot programs included in the Resolution.

These pilot programs were implemented during the 2016-2017 winter, from December 1, 2016 through March 31, 2017. All three programs utilized the messaging "SoCalGas Advisory – A Call to Conserve Natural Gas" to execute and communicate natural gas demand response events called Advisory days. The pilots were:

- **SoCalGas Advisory Pilot Rebate Program:** An offering that includes incentives for gas usage below a customer-specific 10/10[4] baseline on Advisory days;
- **Core Notification Campaign:** Mass media campaign promoting customer reduction in gas usage on SoCalGas Advisory days; and
- **Noncore Notification Campaign:** Similar to the Core Notification Campaign, but specifically for large noncore customers.

In addition, as another element of the Pilot Rebate Program, SoCalGas implemented a Smart Thermostat direct control demand response pilot, called the "SoCalGas Advisory Thermostat Program." Appendix D provides an overview of this pilot.

During the SoCalGas Advisory program, SoCalGas called two Advisories, the first from December 18 through 20, 2016 and the second from January 23 through 26, 2017, totaling seven days. Pilot Rebate Program participants were eligible to receive rebates if they reduced usage below their customer-specific 10/10 baseline on those days. This report summarizes the impact estimates and impact estimation methodology for each pilot. For the Pilot Rebate Program specifically, this report also provides a summary of enrollment and rebates by customer segment and a baseline accuracy assessment.

Gas impacts on Advisory days were estimated by applying the best practices that have been developed for electric Demand Response (DR) program measurement and evaluation in California. In 2008, the California Public Utilities Commission (CPUC) and joint electric Investor-Owned Utilities (IOUs) developed California's Load Impact Protocols, which required the electric utilities to conduct annual evaluations of all DR programs in the state. As in the annual electric DR evaluations, the SoCalGas Advisory load impact estimates leverage the wide availability of

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[3] Paragraph 7 of the Resolution "Findings" directed SoCalGas as follows: "It is reasonable to authorize SoCalGas an additional $800,000 to undertake evaluation efforts of the ex post load reductions provided by all three proposed programs, including the modifications to the Natural Gas Conservation Rebate Pilot adopted in this resolution. The evaluations should also include an analysis of the accuracy of the baseline method for the Natural Gas Conservation Rebate Pilot and those that were proposed in the draft resolution."

[4] Also referred to as a "10-10 baseline." Paragraph 4 on page 2 of the Resolution directed SoCalGas as follows: "SoCalGas shall use a 10-10 baseline methodology to calculate the load drops for purposes of determining the incentive payment for all participants in the program." On page 13, the methodology is further defined as: "using the participant's gas load profile for the past 10 days, a simple daily use average is calculated to determine the customer's gas load for the day in which the DR event occurred. Weekends, holidays and days when a DR event occurred are all removed from the 10 day calculation and replaced with the next available day in the calendar."

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3 Pilot Rebate Program

This section summarizes the Pilot Rebate Program background, impact evaluation methodology and daily impact estimates. It also provides comparisons to experimental design results and to the gas savings from the SoCalGas Advanced Meter 2016-2017 Conservation Campaign treatments for residential My Account and Non-My Account customers.

3.1 Background

Figure 3-1 shows the cumulative enrollments in the Pilot Rebate Program by day from December 2016 through March 2017. The two SoCalGas Advisories are highlighted by the gray bars. Customers were eligible to receive rebates on a given Advisory day if it was on or after their enrollment date. About 48% of customers were enrolled in the program by the first Advisory day, and 76% were enrolled by the last. Ultimately, 3,408 customers enrolled in the program, but about 24% enrolled too late to be eligible to receive rebates on an Advisory day.

Figure 3-1: Cumulative Enrollment in the SoCalGas Advisory Pilot Rebate Program by Date (December 1, 2016 through March 31, 2017)
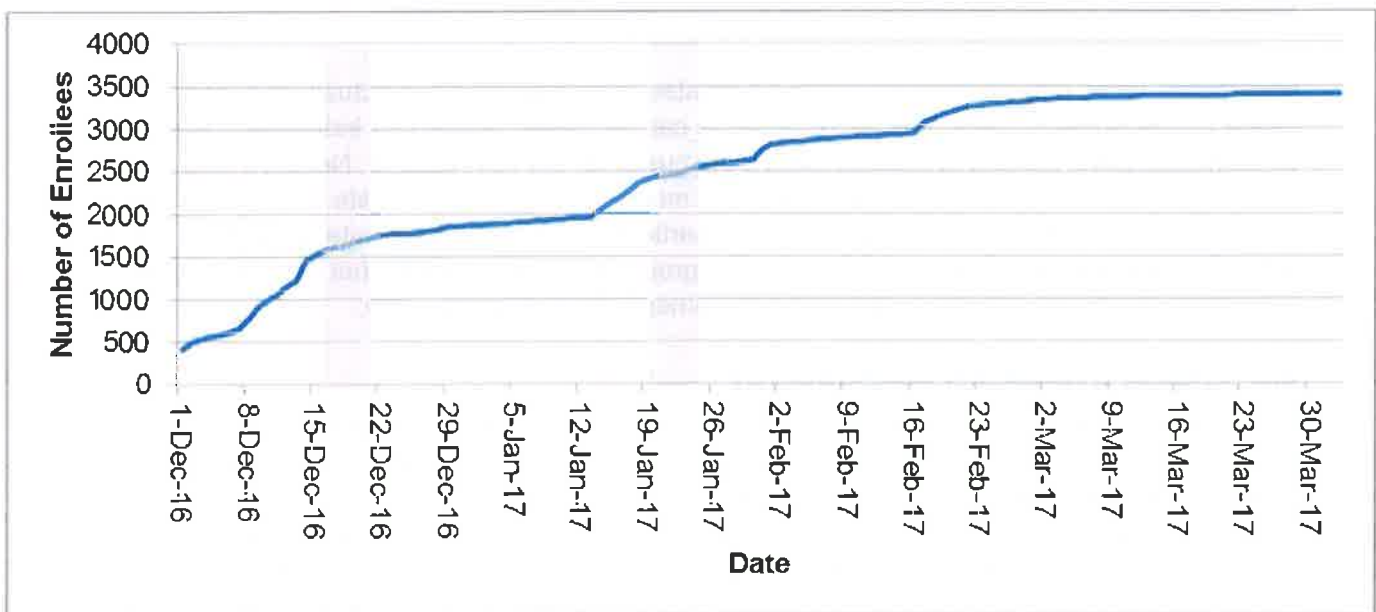
Table 3-1 presents the total customers solicited/eligible and enrolled in the Pilot Rebate Program in each segment, including Core Transport Agent (CTA)-served customers, Highest Winter Load (HWL), My Account and Non-My Account customers. The table also shows the number of customers eligible to receive rebates, the number of customers who earned rebates, and the average rebates they earned. Using the 10/10 baseline methodology as described in Resolution G-3522, Nexant calculated rebates for the 2,556 customers who were enrolled during at least one Advisory day. Rebates were calculated for each customer by adding up the therms the customer reduced below their baseline on each Advisory day and multiplying that total by $2.50 per therm. The final two columns show the total rebates that were paid to each customer segment and total usage below the baseline.

was selected for each customer segment and three groups of Advisory days: December 18 (a Sunday), December 19 and 20, and January 23 through 26. The weather on the proxy days was similar to the weather on the corresponding Advisory days. Figure 3-2 shows hourly temperature profiles for the December 19 and 20 advisory days and their corresponding proxy days.

Figure 3-2: Proxy Day Weather Profiles
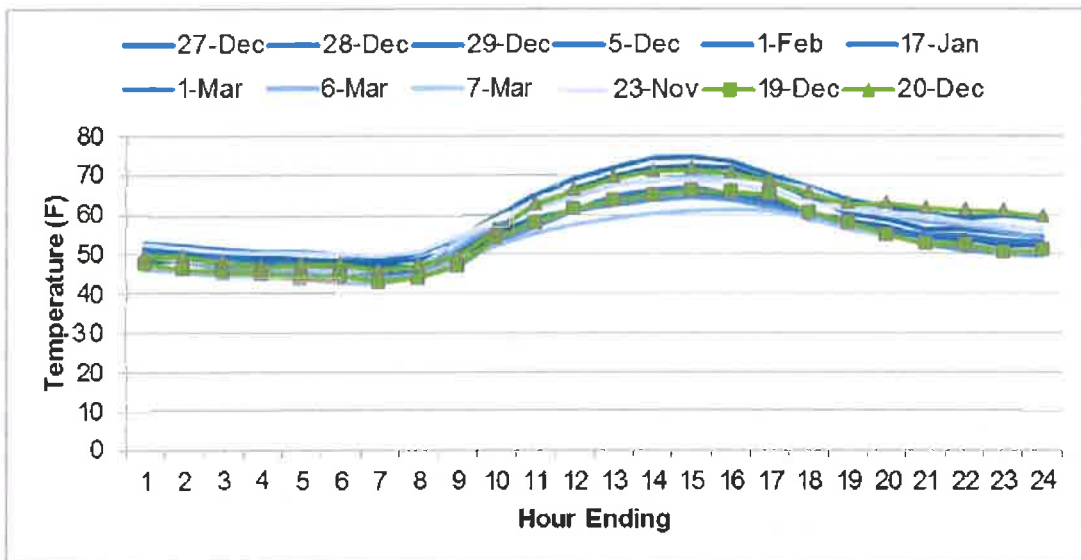
Next, the propensity score model was used to match each participant to a non-participant with similar hourly gas usage on proxy days. A participant could have up to three different matches (one for each set of Advisory days) or they could be matched to the same non-participant multiple times. Customers were guaranteed to be matched to customers within their geographic location and customer segment (for CTA and HWL customers, matched control group customers also had to be on the initial eligibility lists). Each control group customer is only matched to one participant per set of Advisory days.

To summarize, any particular participant has a corresponding control customer for December 18 (a Sunday), another for December 19 and 20, and another for the January Advisory days, given that load patterns on these three sets of days are different. The control customer for December 18 has similar hourly gas consumption during corresponding proxy days, and so on. Figure 3-3 presents the average hourly gas usage on proxy days corresponding to the December 18 Advisory day. The customers presented in this figure are all My Account customers. This figure shows that the treatment group and their corresponding control group have very similar usage patterns on non-Advisory days. It is reasonable to assume that these two groups would have similar usage patterns on Advisory days if not for the effect of the Pilot Rebate Program that is estimated.

non-Advisory day difference in consumption between the two groups is 1.0 therm. The difference on the Advisory day is 3.0. Therefore, the estimated gas consumption impact is 3.0 minus 1.0, or 2.0 therms.

Table 3-2: Difference-in-Differences Example

Group	Non-Advisory Day Usage (Therms)	Advisory Day Usage (Therms)	Total Impact (Therms)
Control	3.0	6.0	3.0 - 1.0 =
Treatment	2.0	3.0	
Difference	**1.0**	**3.0**	**2.0**

The DiD analysis can be done with simple calculations using averages, as in Table 3-2, but regression analysis is required to produce accurate standard errors for assessing statistical significance. Customer fixed effects regression analysis allows each customer's mean usage to be modeled separately, which reduces the standard error of the impact estimates without changing their magnitude. Additionally, standard regression software allows for the calculation of standard errors, confidence intervals, and significance tests for load impact estimates that correctly account for the correlation in customer loads over time. A typical regression specification for estimating impacts is shown in this equation:

$$therms_{i,t} = \alpha_i + \gamma \text{advisory}_t + \beta(\text{treatmentXadvisory})_{i,t} + v_i + \varepsilon_{i,t}$$

In this equation, the variable *therms*$_{i,t}$ equals gas usage during the time period of interest, which in this case is the Advisory day. The index *i* refers to customers and the index *t* refers to the Advisory day of interest. The analysis dataset contains gas usage data during both the non-Advisory proxy days and Advisory days for both treatment and matched control group customers. The variable *advisory* is equal to 1 during a specific advisory day and 0 on proxy days. The *treatmentXadvisory* term is the interaction of *treatment* and *advisory* and its coefficient β is a difference-in-differences estimator of the treatment effect that makes use of the proxy day data. The primary parameter of interest is β, which provides the estimated gas usage impact of the pilot during the relevant period. The parameter a$_i$ is equal to mean usage for each customer for the relevant time period (e.g., daily). The v$_i$ term is the customer fixed effects variable that controls for unobserved factors that are time-invariant and unique to each customer. This model is estimated separately for each customer segment and Advisory day.

3.3 Daily Impact Estimates

Table 3-3 presents gas usage impacts for each customer segment and each Advisory day. The number of customers for each day is based on the number of customers who were enrolled on a particular Advisory day. The Reference Therms column presents what we expect pilot participants would have used if not for the Advisory day. The Observed Therms column presents the average gas consumption for that group of customers on the Advisory day. The estimated impact is the difference between Reference Therms and Observed Therms. A positive value indicates that customers reduced their consumption, while a negative value

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3.4 Comparison to Experimental Design Results

In accordance with the criteria outlined in SoCalGas' AL 5035, the solicitation lists for residential My Account and Non-My Account SoCalGas Advisory Pilot Rebate Program customers were randomly selected from the control groups of the SoCalGas Advanced Meter 2016-2017 Conservation Campaign. Therefore, for comparison purposes, Nexant leveraged these randomized groups to estimate the impacts using an experimental design, which is the CPUC's preferred method for evaluating energy savings, especially for behavioral interventions. Given that not all solicited customers enrolled in the Pilot Rebate Program, Nexant estimated the impacts using a Randomized Encouragement Design (RED). If the RED results showed that there were statistically significant impacts among customers in the *encouraged* group (solicited My Account and Non-My Account customers), the impacts for enrolled customers could then be deduced. However, if the RED results were not statistically significant, the impacts for enrolled customers would not be measurable, given the effect size and percent of customers enrolled on each Advisory day (around 1% to 7%, depending on date and customer segment).

Figure 3-5 and Figure 3-6 provide the results of the Pilot Rebate Program impacts based on the experimental design. The figures show the daily impacts for each encouraged group relative to its respective control group for My Account and Non-My Account customers. Advisory days and non-Advisory days are included to check that the randomization is valid and determine whether there is a change in the pattern when SoCalGas called the Advisories. From December 1, 2016 through February 1, 2017, the estimated change in daily usage for the encouraged groups relative to their respective control groups is not statistically significant. The estimated impacts on both Advisory and non-Advisory days fall within a remarkably narrow range of -1% to 1% of daily usage throughout the winter, even as Pilot Rebate Program enrollment increases. These results confirm that the randomization was valid and corroborate the finding that the Pilot Rebate Program generally did not produce statistically significant reductions in gas usage.

Figure 3-5: Pilot Rebate Program Experimental Design Results for My Account (Impacts for Encouraged Group Relative to Control Group)
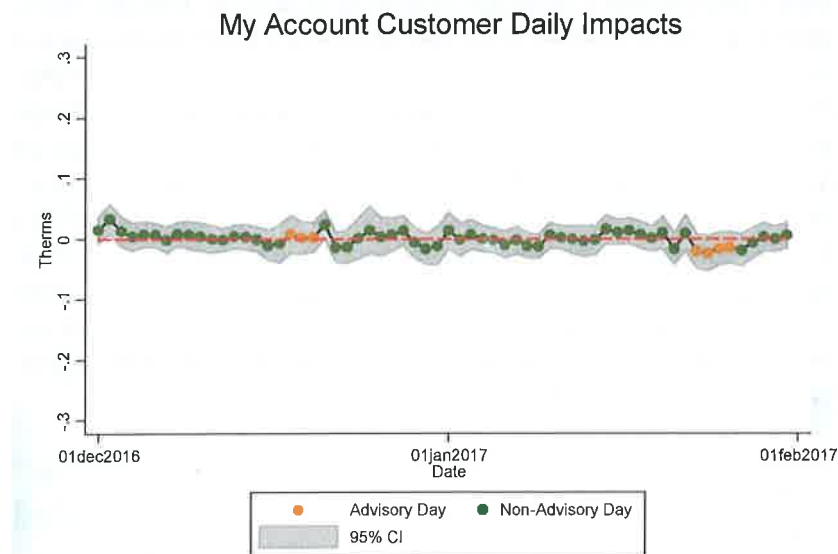
**Table 3-4: Comparison of SoCalGas Advisory Pilot Rebate Program and
2016-2017 AM Conservation Campaign Gas Savings by Customer Segment**

Customer Segment	Treatment	Total Customers Solicited	Advisory Day Gas Savings		Entire Winter Gas Savings	
			Total (Therms)	Per 1,000 Solicited Customers	Total (Therms)	Per 1,000 Solicited Customers
My Account	SoCalGas Advisory Pilot Rebate Program	27,499	792	29	792	29
	Bill Tracker Alert (BTA) w/Tips + Paper Opower HER	40,554	17,722	437	255,322	6,296
	BTA w/o Tips	32,322	5,564	172	70,435	2,179
	BTA w/ Tips	32,022	6,747	211	83,103	2,595
Non-My Account	SoCalGas Advisory Pilot Rebate Program	27,388	0	0	0	0
	Paper Opower HER	53,500	9,032	169	209,944	3,924
	Paper Aclara HER	33,000	12,158	368	143,375	4,345
	Paper In-House HER	13,750	3,338	243	53,596	3,898
	SEU	20,350	18,644	916	211,926	10,414
	SEU (Weatherization version)	20,350	17,687	869	223,203	10,968
Total	**Pilot Rebate Program**	**54,887**	**792**	**14**	**792**	**14**
	AM Conservation Campaign	**245,848**	**90,892**	**370**	**1,250,904**	**5,088**

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Figure 4-1: Residential Core Gas Consumption vs. Temperature
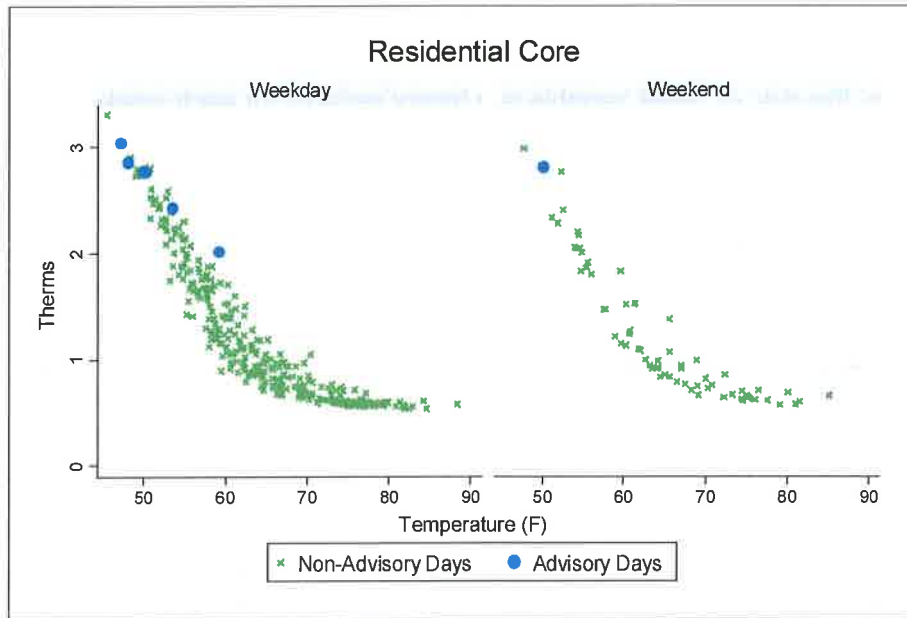
Figure 4-2: Non-Residential Core Gas Consumption vs. Temperature
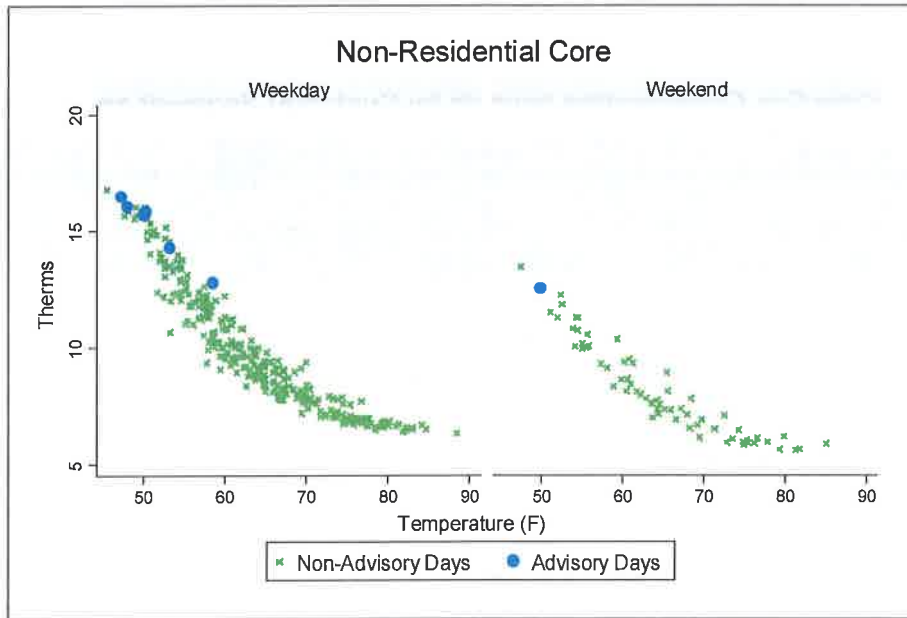
Below 60 degrees Fahrenheit, the relationship between temperature and gas consumption for residential and non-residential customers is somewhat linear. Therefore, a simple temperature variable was included in the regression model along with day of week and time variables as follows:

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To explore why these negative impacts were estimated, Figure 4-3 and Figure 4-4 add the predicted reference usage on Advisory days to the two figures above. In every case, the predicted usage on Advisory days falls within the range of usage that has been observed at a given temperature, which suggests that the predictions are reasonable. However, the Advisory days exhibit usage that is higher than the average usage that is typically observed at a given temperature in many cases. Most notably, the Advisory day that had average temperatures of nearly 60 degrees – December 20 – had average usage for both residential and non-residential core customers that is similar to the level of usage that is typically observed when it is several degrees colder. As a result, the estimates for this day show large negative impacts, even though the usage prediction seems reasonable. Appendix A includes further information on the accuracy testing of the regression models for the Core Notification Campaign to show that the available variables cannot explain this unusually high usage.

Figure 4-3: Residential Core Gas Consumption and Predicted Usage vs. Temperature
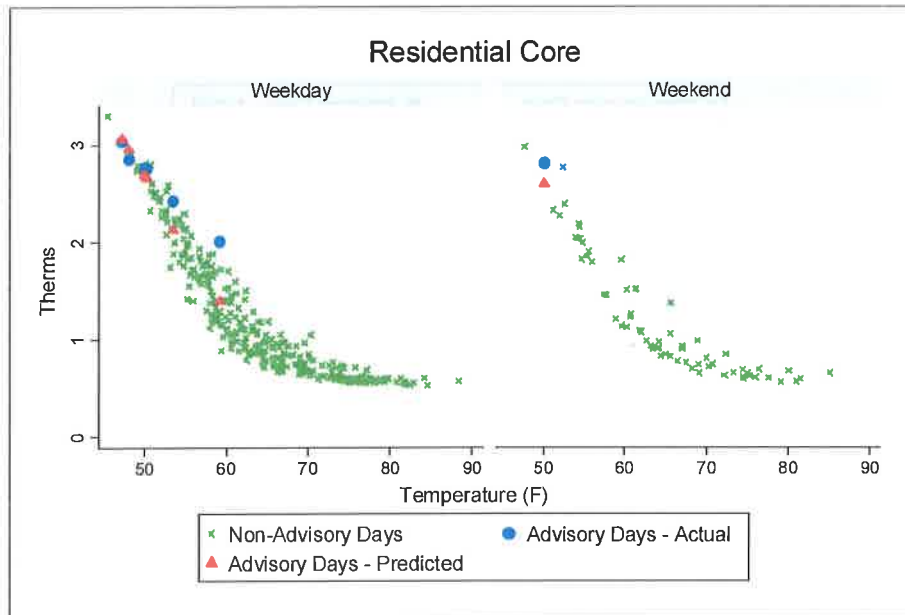
5 Noncore Notification Campaign

This section summarizes the Noncore Notification Campaign background, impact evaluation methodology and daily impact estimates.

5.1 Background

The Noncore Notification Campaign is similar to the pilot described in the previous section, but it is specific to large, noncore customers and included direct email communications to noncore, non-electric generation customers, in addition to the radio and social media announcements summarized in Section 4.1 for core customers.

5.2 Impact Evaluation Methodology

The method for estimating load impacts for the Noncore Notification Campaign is very similar to that used for the core campaign. The analysis dataset was limited to 601 noncore customers with 18 months of hourly gas consumption data. A major difference between core and noncore customers is that noncore customer consumption is not as closely correlated with weather, as shown in Figure 5-1. Note that this figure presents total noncore therms, not therms per customer.

Figure 5-1: Noncore Gas Consumption vs. Temperature
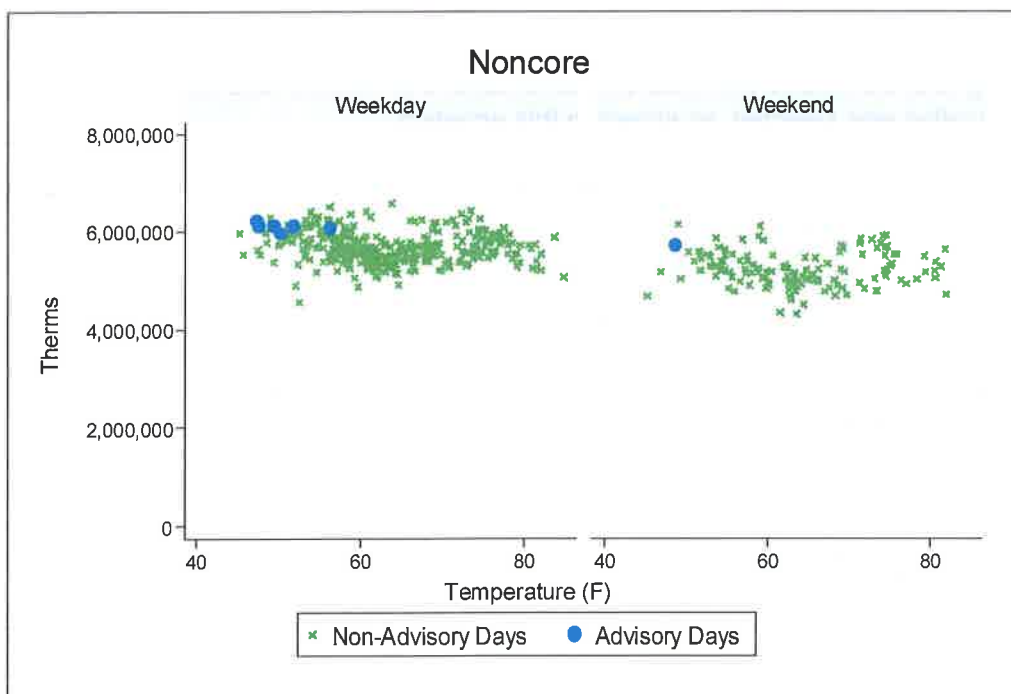
In fact, gas consumption for noncore customers is more closely tied to the day of week. This relationship is shown in Figure 5-2. The time of year plays a large part as well.

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Table 5-1: Noncore Gas Consumption Impacts by Customer Segment and Advisory Day

Population	Number of Customers	Date	Reference (Therms)	Observed (Therms)	Impact (Therms)	Impact (%)	95% Confidence Interval		P-Value
Noncore	601	December 18, 2016	5,736,235	5,720,791	15,444	0.3%	-5.8%	6.3%	0.93
		December 19, 2016	6,148,670	6,118,975	29,695	0.5%	-5.1%	6.1%	0.87
		December 20, 2016	6,181,585	6,073,865	107,720	1.7%	-3.8%	7.3%	0.54
		January 23, 2017	5,910,559	5,972,285	-61,726	-1.0%	-6.9%	4.8%	0.72
		January 24, 2017	6,044,072	6,219,816	-175,744	-2.9%	-8.7%	2.9%	0.33
		January 25, 2017	6,085,918	6,118,554	-32,637	-0.5%	-6.3%	5.2%	0.85
		January 26, 2017	6,068,712	6,128,313	-59,602	-1.0%	-6.7%	4.7%	0.73

Table 6-1: CAISO BAWG Recommended Baselines

Customer Segment	Weekday	Baselines Recommended
Residential	Weekday	Control group
		4 day weather matching using maximum temperature
		Highest 5/10 day matching
	Weekend	Control group
		4 day weather matching using maximum temperature
		Highest 3/5 weighted day matching
Non-residential	Weekday	Control Group
		4 day weather matching using maximum temperature
		10/10 day matching
	Weekend	Control group
		4 day weather matching using maximum temperature
		4 eligible days immediately prior (4/4)

In addition to the recommended BAWG baselines, Nexant incorporated several other baselines evaluated in the BAWG, as well as the current 10/10 day matching baseline for the Pilot Rebate Program and the regression-based approach described in the draft CPUC resolution for the SoCalGas winter demand response programs. The full summary of baselines tested is shown in Table 6-2 and comprise both weather matching and day matching options.

Table 6-2: Tested Baselines for Pilot Rebate Program

Baseline Method	Baseline Type	Notes
Weather Matching	Matching on top X closest weather days based on average temp	Top 3, 4, 5, 10 and 20 days were tested. Method picks the top X days out of last 90
	Matching on top X closest weather days based on HDD(60)	
	Matching on top X closest weather days based on min temp	
Day Matching	Matching the top 4 of the past 4 days	
	Matching the top 3 of the past 5 days	
	Matching the top 3 of the past 5, weighted so that the days closest to the Advisory matter more	
	Matching the top 5 of the past 10 days	
	Matching the top 10 of the past 10 days	
Regression Methods	Regression	
	Regression with Month/DOW	

6.3 Baseline Calculation Process

The baselines shown above were constructed at the individual customer level, and while the baselines developed for modeling electricity consumption also involved a same-day adjustment, Nexant did not include the adjustment as part of this analysis. Same-day adjustments improve

Pilot Rebate Program Baseline Accuracy Assessment

days with similar weather profiles to the Advisory day, based on average temperature, minimum temperature, maximum temperature, or other weather metrics. Because finding a good weather matching day requires more data, considerations of having sufficient data must be balanced against seasonal patterns in gas consumption. For both the BAWG-recommended baselines and the baselines evaluated in this analysis, the look-back period for weather matching baselines was capped at 90 days. While most customers are likely to have 90 days of prior data from which to construct a baseline, customer account changes could impact the number of days available for new customers, reducing the accuracy of the baseline.

Table 6-4: Weather Matching Baseline Methodology

Step	Weekday Baseline 4 Day Matching Using Daily Minimum Temperature
Baseline calculation process	1. Identifying eligible baseline days that occurred prior to an Advisory 2. Identify the hourly participant gas consumption on the Advisory day and on each eligible baseline day during the Advisory period hour. Sum to get daily consumption. 3. Identify the participant-experienced temperatures for each hour of each Advisory day and eligible baseline day
Eligible baseline days	Weekdays, excluding Advisory days and federal holidays, in the 90 days immediately prior to the Advisory.
Baseline day selection criteria	Rank eligible days based on how similar daily minimum temperature is to the Advisory day
Number of days selected to develop baseline	4 days with the closest daily minimum temperature
Calculation of temperatures	Calculate the average temperature, HDD60 or daily minimum temperatures across all 24 hours in both the Advisory day and eligible baseline days.
Advisory	The Advisory is defined as the entire day that the SoCalGas Advisory notification program is activated
Baseline	The daily total average of the customer's gas consumption during baseline days. The baseline includes all 24 hours in day.

Regression-based Baselines

Regression-based baselines were not tested in the BAWG, but were proposed in the draft CPUC resolution for the SoCalGas winter demand response programs as an alternative method to develop baselines. The procedure for regression baselines is to fit a model that will explain daily therm consumption from the Heating Degree Day (HDD) that a customer experiences. HDD is meant to approximate the heating needs of a customer and is calculated by computing the maximum of either the difference between a base temperature, 60°F in this case, and the day's average temperature and zero. So a day with an average daily temperature of 45°F would have an HDD (base 60°F) of 15. A day with an average daily temperature of 70°F would have an HDD of 0.

For this method, all weekend, holiday and Advisory days were excluded before Nexant fit a regression that related daily total load for each customer to their daily HDD values using a full year of pre-Advisory data. This method is intended to work similarly to a weather-matching

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mean squared error. Basically, the best baseline is the one that is the least noisy from day to day and customer to customer.

Best Baselines for Each Segment

Table 6-5 shows the results of the best baseline by customer segment in comparison to the original 10/10 baseline method and the regression-based method. In all cases, day matching methods perform best. The 3/5 baseline, either weighted or unweighted, perform best for three of the four customer groups, in addition to the program overall. The 4/4 baseline performs best for CTA customers. In general, the 3/5 baseline demonstrated a slight upward bias overall, meaning that it tends to overestimate the reference load, causing higher impacts. The regression and 10/10 methods tend to significantly underestimate reference loads, leading to smaller impacts.

Shown in the farthest column on the right is the rank of the baselines' overall bias compared to other baseline methods for that customer segment. This should be interpreted as a value of 1 being the least biased, and a value of 2 being the second-least biased, and so on. There were 22 baselines methods tested for each customer segment, and in each case, the regression-based method performed the worst of all methods tested.

Table 6-5: Best Baseline Performance Compared to Original Baseline Methods

Program (Population)	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Percent Difference	Average Customer Day Bias	Rank of Bias Compared to Other Baselines Tested
All (3,403)	3/5	8.8	9.1	4%	9%	1
	10/10	8.8	7.5	-14%	-18%	17
	Regression	8.8	6.3	-28%	-39%	22
CTA (52)	4/4	26.2	25.5	-3%	-2%	3
	10/10	26.2	24.5	-7%	-5%	19
	Regression	26.2	23.5	-10%	-8%	22
HWL (188)	3/5	104.4	107.9	3%	6%	1
	10/10	104.4	93.0	-11%	-8%	9
	Regression	104.4	82.2	-21%	-19%	22
MA (2,351)	3/5	2.7	2.9	4%	9%	2
	10/10	2.7	2.2	-22%	-18%	18
	Regression	2.7	1.5	-47%	-40%	22
Non-My Account (812)	3/5, Weighted	2.9	3.1	6%	9%	3
	10/10	2.9	2.3	-22%	-19%	18
	Regression	2.9	1.5	-49%	-45%	22

Table 6-6 shows the results for the small subset of 389 highly weather-sensitive customers with a correlation coefficient above 0.8 and a full year of Advanced Meter data from which to fit a regression. Among this select group of customers, the best performing baselines are still day-

based methods demonstrated significant downward bias. The 3/5, 4/4 and 3/5 weighted methods are likely to overstate the impacts of the program and increase the amount of rebates, while the 10/10 and regression methods understate the program impacts, leading to lower aggregate rebates. A full set of results can be found in Appendix C.

Table 6-7: Rebates Calculated on Advisory Days for Different Baseline Methods

Customer Segment	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Average Percent Difference	Total Rebate
CTA	4/4	26.2	24.6	-6%	$115
CTA	10/10	26.2	23.9	-8%	$92
CTA	Regression	26.2	22.0	-16%	$91
HWL	3/5	114.8	114.5	0%	$25,796
HWL	10/10	114.8	100.7	-12%	$15,287
HWL	Regression	114.8	81.6	-29%	$15,215
My Account	3/5	3.6	2.9	-20%	$5,250
My Account	10/10	3.6	2.4	-33%	$2,638
My Account	Regression	3.6	1.5	-59%	$1,456
Non-My Account	3/5, Weighted	3.9	3.3	-16%	$1,930
Non-My Account	10/10	3.9	2.6	-32%	$841
Non-My Account	Regression	3.9	1.5	-61%	$367
All	Best Baseline for Each Segment				$33,091
All	10/10				$18,858
All	Regression				$17,129

Table A-2: Core Gas Consumption Models

Model Number	Independent Variables	Conditions	Non-Residential				Residential			
			19-Dec-16		20-Dec-16		19-Dec-16		20-Dec-16	
			% Impact	p-value	% Impact	p-value	% Impact	p-value	% Impact	p-value
1	HDD65_2, HDD_65, dow, event	-	-10.1%	0.138	-16%	0.043	-14%	0.086	-45%	0.000
2	HDD65_2, HDD_65, dow, ym, event	-	-12.5%	0.009	-16%	0.004	-16%	0.004	-38%	0.000
3	HDD65_2, HDD_65, event	-	-11.9%	0.142	-20%	0.039	-13%	0.097	-43%	0.000
4	HDD65_2, HDD_65, weekday, event	-	-8.3%	0.201	-16%	0.040	-14%	0.085	-44%	0.000
5	HDD65_2, HDD_65, weekday, ym, event	-	-11.1%	0.014	-16%	0.003	-17%	0.003	-38%	0.000
6	HDD65_2, HDD_65, ym, event	-	-14.2%	0.033	-19%	0.014	-16%	0.004	-37%	0.000
7	HDD_65, HDD_58, weekday, month, event	-	-8.9%	0.048	-15%	0.006	-12%	0.022	-36%	0.000
8	HDD_65, HDD_58, weekday, ym, event	-	-10.8%	0.018	-16%	0.002	-15%	0.008	-39%	0.000
9	HDD_65, dow, event	-	-10.0%	0.144	-18%	0.027	-14%	0.090	-42%	0.001
10	HDD_65, dow, ym, event	-	-13.2%	0.007	-15%	0.005	-18%	0.005	-37%	0.000
11	HDD_65, event	-	-11.8%	0.150	-22%	0.025	-13%	0.100	-40%	0.001
12	HDD_65, weekday, event	-	-8.2%	0.213	-18%	0.025	-14%	0.088	-41%	0.001
13	HDD_65, weekday, ym, event	-	-11.8%	0.011	-16%	0.004	-19%	0.004	-36%	0.000
14	HDD_65, ym, event	-	-14.9%	0.028	-19%	0.017	-18%	0.005	-36%	0.000
15	HDD_65_0, HDD_58, event	-	-17.5%	0.135	-21%	0.116	-22%	0.128	-48%	0.024
16	HDD_65_0, HDD_58, weekday, ym, event	-	-9.6%	0.078	-14%	0.032	-14%	0.055	-32%	0.002
17	HDD_65_0, HDD_58, ym, event	-	-12.8%	0.083	-17%	0.047	-14%	0.062	-32%	0.002
18	dow, month, event	-	-15.2%	0.110	-3%	0.780	-21%	0.211	-2%	0.889
19	dow, ym, event	-	-22.5%	0.022	-9%	0.342	-38%	0.046	-16%	0.391
20	mean7, dow, event	-	-7.7%	0.310	-3%	0.739	-12%	0.409	-9%	0.610
21	mean7, dow, ym, event	-	-6.8%	0.247	-1%	0.907	-7%	0.476	-2%	0.844
22	mean7, weekday, event	-	-7.8%	0.293	-2%	0.753	-15%	0.302	-9%	0.6
23	mean7, weekday, ym, event	-	-7.1%	0.216	-1%	0.910	-11%	0.297	-2%	0.8
24	temp2, dow, event	-	-17.5%	0.040	-14%	0.120	-31%	0.082	-32%	0.
25	temp2, dow, ym, event	-	-17.3%	0.011	-12%	0.097	-28%	0.035	-24%	0.
26	temp2, event	-	-20.8%	0.035	-19%	0.082	-32%	0.069	-31%	0.
27	temp2, month, event	-	-14.9%	0.063	-10%	0.231	-18%	0.136	-12%	0.

Accuracy Testing of Core Regression Models

Model Number	Independent Variables	Conditions	Non-Residential				Residential			
			19-Dec-16		20-Dec-16		19-Dec-16		20-Dec-16	
			% Impact	p-value	% Impact	p-value	% Impact	p-value	% Impact	p-value
56	temperature, weekday, ym, event	temperature<60	-9.6%	0.068	-15%	0.013	-15%	0.035	-45%	0.000
57	temperature, ym, event	temperature<60	-14.1%	0.112	-19%	0.066	-15%	0.038	-44%	0.000
58	temperature, dow, ym, event	temperature<=65	-11.0%	0.047	-14%	0.032	-17%	0.034	-37%	0.001
59	temperature, weekday, event	temperature<=65	-8.2%	0.162	-14%	0.037	-14%	0.131	-40%	0.004
60	temperature, weekday, ym, event	temperature<=65	-10.6%	0.040	-15%	0.014	-18%	0.027	-37%	0.001
61	temperature, ym, event	temperature<=65	-14.7%	0.074	-19%	0.049	-17%	0.030	-37%	0.001

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Customer Segment	Population	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Percent Difference	Average Customer Day Bias	Rank of Bias compared to Other Baselines Tested
		Top 5 Day Match on HDD60	26.2	24.6	-6.0%	-4.9%	14
		Top 3 Day Match on Avg Temp	26.2	24.6	-6.1%	-5.1%	15
		Top 4 Day Match on HDD60	26.2	24.6	-6.1%	-4.9%	16
		Top 3 Day Match on HDD60	26.2	24.5	-6.4%	-5.4%	17
		Top 20 Day Match on Avg Temp	26.2	24.5	-6.5%	-5.4%	18
		10/10	26.2	24.5	-6.6%	-5.1%	19
		Top 20 Day Match on HDD60	26.2	24.3	-7.2%	-6.3%	20
		Top 20 Day Match on Min Temp	26.2	24.1	-7.7%	-6.5%	21
		Regression vs HDD60	26.2	23.5	-10.3%	-8.1%	22
HWL	188	3/5	104.4	107.9	3.4%	6.4%	1
		3/5 Weighted	104.4	108.9	4.3%	7.4%	2
		5/10	104.4	109.8	5.2%	8.1%	3
		4/4	104.4	95.1	-8.9%	-5.2%	4
		Base Reg. w/Month & Day of Week Vars	104.4	94.9	-9.1%	-6.6%	5
		Top 10 Day Match on Avg Temp	104.4	93.6	-10.3%	-7.5%	6
		Top 5 Day Match on Avg Temp	104.4	93.3	-10.6%	-7.4%	7
		Top 3 Day Match on Avg Temp	104.4	93.2	-10.7%	-7.6%	8
		10/10	104.4	93.0	-10.9%	-8.1%	9
		Top 4 Day Match on Avg Temp	104.4	92.9	-11.0%	-7.8%	10
		Top 20 Day Match on Avg Temp	104.4	92.4	-11.5%	-8.8%	11
		Top 3 Day Match on Min Temp	104.4	92.2	-11.7%	-8.0%	12
		Top 4 Day Match on Min Temp	104.4	91.7	-12.1%	-9.0%	13
		Top 5 Day Match on Min Temp	104.4	91.7	-12.2%	-8.7%	14
		Top 10 Day Match on Min Temp	104.4	91.2	-12.6%	-9.3%	15
		Top 20 Day Match on Min Temp	104.4	90.4	-13.4%	-10.5%	16
		Top 3 Day Match on HDD60	104.4	90.1	-13.7%	-10.3%	17
		Top 5 Day Match on HDD60	104.4	89.8	-13.9%	-10.1%	18
		Top 4 Day Match on HDD60	104.4	89.4	-14.3%	-10.4%	19
		Top 10 Day Match on HDD60	104.4	89.4	-14.4%	-11.4%	20
		Top 20 Day Match on HDD60	104.4	87.0	-16.6%	-13.3%	21
		Regression vs HDD60	104.4	82.2	-21.3%	-18.8%	22
My Account	2351	5/10	2.7	2.8	2.3%	7.5%	1
		3/5	2.7	2.9	4.5%	9.1%	2
		3/5 Weighted	2.7	2.9	6.8%	11.5%	3
		Top 4 Day Match on Avg Temp	2.7	2.5	-10.4%	-6.0%	4
		Top 3 Day Match on Avg Temp	2.7	2.5	-10.5%	-5.8%	5
		Top 5 Day Match on Avg Temp	2.7	2.4	-11.0%	-6.8%	6
		Top 4 Day Match on HDD60	2.7	2.4	-11.3%	-6.7%	7

Table B-2: Full Proxy Day Results for Customers with a Full Panel of Data

Customer Segment	Population	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Percent Difference	Average Customer Day Bias	Rank of Bias compared to Other Baselines Tested
All	1817	3/5	13.5	14.0	3.6%	9.1%	1
		5/10	13.5	14.1	4.5%	7.8%	2
		3/5 Weighted	13.5	14.2	4.7%	11.4%	3
		4/4	13.5	12.3	-9.1%	-8.0%	4
		Top 5 Day Match on Avg Temp	13.5	12.1	-10.7%	-8.2%	5
		Top 3 Day Match on Avg Temp	13.5	12.1	-10.8%	-7.2%	6
		Top 10 Day Match on Avg Temp	13.5	12.1	-10.8%	-9.6%	7
		Top 4 Day Match on Avg Temp	13.5	12.1	-11.0%	-7.7%	8
		Base Reg. w/Month & Day of Week Vars	13.5	12.0	-11.3%	-12.6%	9
		Top 3 Day Match on Min Temp	13.5	11.9	-12.4%	-11.7%	10
		Top 20 Day Match on Avg Temp	13.5	11.8	-12.6%	-14.4%	11
		10/10	13.5	11.8	-12.7%	-17.1%	12
		Top 5 Day Match on Min Temp	13.5	11.8	-12.8%	-12.5%	13
		Top 4 Day Match on Min Temp	13.5	11.8	-12.8%	-12.6%	14
		Top 3 Day Match on HDD60	13.5	11.7	-13.3%	-8.9%	15
		Top 10 Day Match on Min Temp	13.5	11.7	-13.5%	-14.3%	16
		Top 5 Day Match on HDD60	13.5	11.7	-13.6%	-9.4%	17
		Top 4 Day Match on HDD60	13.5	11.7	-13.8%	-8.9%	18
		Top 10 Day Match on HDD60	13.5	11.6	-14.4%	-12.6%	19
		Top 20 Day Match on Min Temp	13.5	11.5	-14.9%	-18.1%	20
		Top 20 Day Match on HDD60	13.5	11.2	-17.3%	-18.3%	21
		Regression vs HDD60	13.5	10.2	-24.7%	-34.0%	22
CTA	42	5/10	25.8	25.9	0.3%	2.1%	1
		3/5	25.8	26.1	1.1%	2.5%	2
		3/5 Weighted	25.8	26.3	2.2%	3.5%	3
		4/4	25.8	24.9	-3.4%	-2.0%	4
		Top 3 Day Match on Min Temp	25.8	24.4	-5.3%	-4.0%	5
		Top 4 Day Match on Min Temp	25.8	24.4	-5.4%	-4.5%	6
		Top 5 Day Match on Min Temp	25.8	24.3	-5.6%	-4.8%	7
		Base Reg. w/Month & Day of Week Vars	25.8	24.3	-5.8%	-3.8%	8
		Top 10 Day Match on Avg Temp	25.8	24.2	-6.2%	-5.2%	9
		Top 5 Day Match on Avg Temp	25.8	24.0	-6.7%	-5.5%	10
		Top 10 Day Match on Min Temp	25.8	24.0	-6.8%	-5.8%	11
		Top 10 Day Match on HDD60	25.8	24.0	-6.8%	-6.0%	12
		Top 20 Day Match on Avg Temp	25.8	24.0	-7.1%	-6.0%	13
		Top 4 Day Match on Avg Temp	25.8	23.9	-7.2%	-5.6%	14

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Customer Segment	Population	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Percent Difference	Average Customer Day Bias	Rank of Bias compared to Other Baselines Tested
		Top 4 Day Match on HDD60	2.7	2.3	-13.7%	-7.6%	9
		Top 5 Day Match on HDD60	2.7	2.3	-14.1%	-8.4%	10
		Top 10 Day Match on Avg Temp	2.7	2.3	-14.5%	-8.9%	11
		Top 10 Day Match on HDD60	2.7	2.2	-17.0%	-12.2%	12
		Top 3 Day Match on Min Temp	2.7	2.2	-17.0%	-10.7%	13
		Top 5 Day Match on Min Temp	2.7	2.2	-17.3%	-11.5%	14
		Top 4 Day Match on Min Temp	2.7	2.2	-17.4%	-11.7%	15
		Top 10 Day Match on Min Temp	2.7	2.1	-19.2%	-13.8%	16
		Top 20 Day Match on Avg Temp	2.7	2.1	-19.5%	-14.1%	17
		Base Reg. w/Month & Day of Week Vars	2.7	2.1	-21.8%	-10.8%	18
		10/10	2.7	2.1	-22.0%	-17.6%	19
		Top 20 Day Match on HDD60	2.7	2.0	-22.9%	-18.1%	20
		Top 20 Day Match on Min Temp	2.7	2.0	-23.4%	-18.1%	21
		Regression vs HDD60	2.7	1.5	-43.3%	-33.7%	22
		5/10	2.8	2.9	1.1%	5.2%	1
		3/5	2.8	2.9	3.7%	7.4%	2
		3/5 Weighted	2.8	3.0	5.8%	9.4%	3
		Top 3 Day Match on Avg Temp	2.8	2.5	-12.2%	-9.7%	4
		4/4	2.8	2.5	-12.4%	-9.8%	5
		Top 4 Day Match on Avg Temp	2.8	2.5	-12.7%	-10.0%	6
		Top 5 Day Match on Avg Temp	2.8	2.5	-13.1%	-10.5%	7
		Top 3 Day Match on HDD60	2.8	2.4	-13.7%	-10.9%	8
		Top 4 Day Match on HDD60	2.8	2.4	-14.2%	-11.4%	9
		Top 5 Day Match on HDD60	2.8	2.4	-14.6%	-11.9%	10
Non-My Account	504	Top 10 Day Match on Avg Temp	2.8	2.4	-14.7%	-12.3%	11
		Top 10 Day Match on HDD60	2.8	2.4	-17.1%	-14.7%	12
		Top 3 Day Match on Min Temp	2.8	2.3	-18.2%	-15.9%	13
		Top 4 Day Match on Min Temp	2.8	2.3	-18.5%	-16.3%	14
		Top 5 Day Match on Min Temp	2.8	2.3	-18.9%	-16.5%	15
		Top 10 Day Match on Min Temp	2.8	2.3	-20.1%	-18.1%	16
		Top 20 Day Match on Avg Temp	2.8	2.3	-20.2%	-18.0%	17
		10/10	2.8	2.2	-22.7%	-20.2%	18
		Base Reg. w/Month & Day of Week Vars	2.8	2.2	-23.5%	-19.6%	19
		Top 20 Day Match on Min Temp	2.8	2.2	-23.9%	-21.8%	20
		Top 20 Day Match on HDD60	2.8	2.2	-24.0%	-21.7%	21
		Regression vs HDD60	2.8	1.5	-45.9%	-42.5%	22

Customer Segment	Population	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Percent Difference	Average Customer Day Bias	Rank of Bias compared to Other Baselines Tested
		Top 5 Day Match on HDD60	37.3	31.7	-15.0%	-15.1%	15
		Top 3 Day Match on Avg Temp	37.3	31.6	-15.2%	-15.0%	16
		10/10	37.3	31.6	-15.4%	-15.2%	17
		Top 3 Day Match on HDD60	37.3	31.6	-15.4%	-15.3%	18
		Top 4 Day Match on Avg Temp	37.3	31.4	-15.8%	-15.7%	19
		Top 4 Day Match on HDD60	37.3	31.3	-16.1%	-16.1%	20
		Top 20 Day Match on Min Temp	37.3	31.2	-16.5%	-16.1%	21
		Regression vs HDD60	37.3	30.5	-18.4%	-18.3%	22
HWL	16	3/5 Weighted	93.1	82.6	-11.3%	-11.6%	1
		3/5	93.1	80.0	-14.0%	-14.4%	2
		5/10	93.1	76.2	-18.2%	-18.3%	3
		4/4	93.1	73.5	-21.0%	-21.5%	4
		Top 3 Day Match on Min Temp	93.1	68.8	-26.1%	-26.7%	5
		Top 5 Day Match on Avg Temp	93.1	68.4	-26.5%	-27.2%	6
		Top 5 Day Match on HDD60	93.1	68.3	-26.6%	-27.2%	7
		Top 10 Day Match on Avg Temp	93.1	68.0	-26.9%	-27.4%	8
		Top 10 Day Match on HDD60	93.1	67.8	-27.2%	-27.6%	9
		Top 5 Day Match on Min Temp	93.1	67.5	-27.5%	-27.6%	10
		Top 4 Day Match on HDD60	93.1	67.0	-28.0%	-28.5%	11.5
		Top 4 Day Match on Avg Temp	93.1	67.0	-28.0%	-28.5%	11.5
		Base Reg. w/Month & Day of Week Vars	93.1	67.0	-28.0%	-28.3%	13
		Top 4 Day Match on Min Temp	93.1	66.6	-28.4%	-28.6%	14
		Top 3 Day Match on Avg Temp	93.1	66.3	-28.8%	-29.3%	15.5
		Top 3 Day Match on HDD60	93.1	66.3	-28.8%	-29.3%	15.5
		Top 20 Day Match on Avg Temp	93.1	65.5	-29.7%	-30.2%	17
		Top 10 Day Match on Min Temp	93.1	65.1	-30.0%	-30.3%	18
		Top 20 Day Match on HDD60	93.1	65.1	-30.1%	-30.6%	19
		10/10	93.1	62.6	-32.7%	-33.3%	20
		Top 20 Day Match on Min Temp	93.1	61.0	-34.4%	-34.8%	21
		Regression vs HDD60	93.1	50.8	-45.4%	-46.1%	22
My Account	245	3/5	3.1	3.1	-0.7%	0.7%	1
		3/5 Weighted	3.1	3.2	1.9%	3.6%	2
		5/10	3.1	2.9	-5.4%	-4.0%	3
		4/4	3.1	2.7	-14.1%	-13.6%	4
		Top 5 Day Match on Avg Temp	3.1	2.6	-17.8%	-16.7%	5
		Top 5 Day Match on HDD60	3.1	2.5	-18.4%	-17.3%	6
		Top 3 Day Match on Avg Temp	3.1	2.5	-18.5%	-17.2%	7
		Top 4 Day Match on Avg Temp	3.1	2.5	-18.5%	-17.2%	8

Appendix C   Pilot Rebate Program Baseline Advisory Day Results

Table C-1: Full Advisory Day Results

Customer Segment	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Average Percent Difference	Total Rebate
CTA	Top 10 Day Match on Avg Temp	26.2	24.1	-7.8%	$ 121
	Top 20 Day Match on Avg Temp	26.2	23.7	-9.2%	$ 110
	Top 3 Day Match on Avg Temp	26.2	24.3	-6.9%	$ 225
	Top 4 Day Match on Avg Temp	26.2	24.3	-7.2%	$ 174
	Top 5 Day Match on Avg Temp	26.2	24.3	-7.1%	$ 170
	5/10	26.2	25.8	-1.5%	$ 288
	4/4	26.2	24.6	-5.9%	$ 115
	Top 10 Day Match on HDD60	26.2	24.1	-7.9%	$ 122
	Top 20 Day Match on HDD60	26.2	23.7	-9.5%	$ 109
	Top 3 Day Match on HDD60	26.2	24.4	-6.8%	$ 229
	Top 4 Day Match on HDD60	26.2	24.3	-7.2%	$ 174
	Top 5 Day Match on HDD60	26.2	24.2	-7.3%	$ 170
	Top 10 Day Match on Min Temp	26.2	23.7	-9.3%	$ 142
	Top 20 Day Match on Min Temp	26.2	23.4	-10.5%	$ 128
	Top 3 Day Match on Min Temp	26.2	24.2	-7.5%	$ 200
	Top 4 Day Match on Min Temp	26.2	24.1	-7.8%	$ 168
	Top 5 Day Match on Min Temp	26.2	23.9	-8.6%	$ 151
	Regression vs HDD60	26.2	22.0	-15.7%	$ 91
	Base Reg. w/Month & Day of Week Vars	26.2	24.0	-8.1%	$ 159
	10/10	26.2	23.9	-8.5%	$ 92
	3/5	26.2	25.6	-2.0%	$ 238
	3/5 Weighted	26.2	26.0	-0.7%	$ 280
HWL	Top 10 Day Match on Avg Temp	114.8	96.9	-15.6%	$ 13,619
	Top 20 Day Match on Avg Temp	114.8	97.0	-15.5%	$ 13,829
	Top 3 Day Match on Avg Temp	114.8	94.9	-17.3%	$ 15,107
	Top 4 Day Match on Avg Temp	114.8	95.1	-17.1%	$ 13,860
	Top 5 Day Match on Avg Temp	114.8	95.2	-17.0%	$ 12,908
	5/10	114.8	117.1	2.0%	$ 27,668
	4/4	114.8	103.1	-10.2%	$ 15,881
	Top 10 Day Match on HDD60	114.8	95.4	-16.9%	$ 13,628
	Top 20 Day Match on HDD60	114.8	94.8	-17.4%	$ 13,868
	Top 3 Day Match on HDD60	114.8	94.7	-17.5%	$ 15,362
	Top 4 Day Match on HDD60	114.8	94.9	-17.3%	$ 13,785
	Top 5 Day Match on HDD60	114.8	94.8	-17.4%	$ 13,486
	Top 10 Day Match on Min Temp	114.8	96.1	-16.3%	$ 14,173
	Top 20 Day Match on Min Temp	114.8	94.6	-17.6%	$ 13,404

Customer Segment	Baseline Type	Average Daily Use	Average Baseline Predicted Use	Average Percent Difference	Total Rebate
	Top 20 Day Match on HDD60	3.9	2.5	-34.8%	$ 817
	Top 3 Day Match on HDD60	3.9	2.6	-33.7%	$ 1,446
	Top 4 Day Match on HDD60	3.9	2.6	-31.3%	$ 1,325
	Top 5 Day Match on HDD60	3.9	2.7	-30.2%	$ 1,288
	Top 10 Day Match on Min Temp	3.9	2.6	-31.6%	$ 1,004
	Top 20 Day Match on Min Temp	3.9	2.5	-36.3%	$ 822
	Top 3 Day Match on Min Temp	3.9	2.8	-28.2%	$ 1,456
	Top 4 Day Match on Min Temp	3.9	2.7	-29.0%	$ 1,311
	Top 5 Day Match on Min Temp	3.9	2.7	-29.6%	$ 1,194
	Regression vs HDD60	3.9	1.5	-60.8%	$ 367
	Base Reg. w/Month & Day of Week Vars	3.9	2.7	-29.2%	$ 1,004
	10/10	3.9	2.6	-31.6%	$ 841
	3/5	3.9	3.2	-17.5%	$ 1,748
	3/5 Weighted	3.9	3.3	-15.5%	$ 1,930

June 2017

OVERVIEW OF SOCALGAS[(R)]WINTER THERMOSTAT DEMAND RESPONSE PILOT

Summary and Key Outcomes

In the winter of 2017 Southern California Gas Company (SoCalGas) partnered with ecobee and EnergyHub to implement the "SoCalGas Advisory Thermostat Program." This pilot program was an element of the "Natural Gas Conservation Pilot Rebate Program" as described in SoCalGas Advice Letter 5035. The pilot was an innovative gas demand response program intended to reduce gas demand by direct control of customer thermostats. The pilot used the Bring Your Own Thermostat™ (BYOT) model to recruit existing customers with ecobee thermostats into the program by offering up to $50 of incentives. The following are the pilot's key stats and outcomes:

- 2,488 eligible ecobee thermostats within SoCalGas territory
- 411 thermostats applied
- 396 thermostats successfully enrolled
- 16% enrollment rate (above the industry average for first year)

Program Design

Season	January 19, 2017-March 31, 2017
Control Parameters	Up to 4-degree offset; Events from 5am-9am and/or 5pm-9pm; Opt-out allowed
Number of events per season	No more than 5
Customer eligibility criteria	Must be an ecobee owner within SoCalGas territory with active SoCalGas account and an activated Advanced Meter, but outside of SCE territory. Ecobee thermostat must control heat.
Program Name and messaging	"SoCalGas Advisory Thermostat Program"
Customer rebate (upfront and ongoing)	$25 for signing up, $25 end of season for staying in the program. Incentive paid to customers via check.

Engagement Strategy

EnergyHub and ecobee implemented a digital engagement campaign to recruit SoCalGas customers from the existing base of 2,488 ecobee thermostats. The campaign included

✳EnergyHub

🐝ecobee

www.energyhub.com

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