DNV·GL

Auto Bill Pay and Budget Billing Impact Evaluation – Residential

California Public Utilities Commission

CALMAC ID: CPU0163.01

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CONTENTS

List of figures

List of tables

Glossary

ABP	Auto Bill Pay (also called Auto Pay) is a means of automating payment for a recurring bill that offers customers' convenience and minimizes or eliminates late payments.
BB	Budget Billing is a payment plan that allows customers to spread their bills over the course of a year through a flat monthly rate based on customers' past usage and bills. Budget billing programs are also referred to as flat billing, balanced billing, or level payment programs.
HER	Home Energy Reports are electronic or paper reports on energy consumption sent to customers at regular intervals (often monthly, like an energy bill) educating them on their consumption, how their consumption compares to other similar homes or to their own consumption historically, and provides them with energy saving tips and information.

1 EXECUTIVE SUMMARY

This section contains a summary of more detailed findings found in this report.

1.1 Introduction

This report presents findings from DNV GL's evaluation of auto bill pay (ABP) and budget billing (BB) services administered by Pacific Gas and Electric Company (PG&E). ABP is a means of automating payment for a recurring bill that offers customers' convenience and minimizes or eliminates late payments. BB is a payment plan that allows customers to spread their bills over the course of a year through a flat monthly rate based on customers' past usage and bills. Budget billing programs are also referred to as flat billing, balanced billing, or level payment programs.[1]

1.2 Purpose of the evaluation

Recent research by Sexton[2] found that residential customers of a Southeastern utility who were enrolled in ABP used 4% more energy than their peers, controlling for other factors. The study also found that low-income customers enrolled in a budget billing (BB) program designed to smooth seasonal bill extremes increased their consumption by 6.7%. The results from the Sexton paper seem to imply that customers are more likely to consume more energy due to the absence of a bill reminder/price signal (i.e., paper or electronic bills).

The objective of this study is to examine the effect of ABP and BB on residential customer electric consumption in California. This report provides Phase 1 of the analysis using data from PG&E's residential Home Energy Report (HER) program that serves as a proof of concept. Phase 2, which will be presented in a later report, will evaluate the effect of ABP and BB on the remaining IOUs' and PG&E's residential gas use. The researchable questions this evaluation seeks to answer include those shown in Table 1.

Table 1: Key research questions

	What are the pre- and post-electricity consumption trends of customers who use ABP and BB?
	How do they compare to customers who do not use such payment methods?
	What are the demographic characteristics for customers who choose the various bill-pay options?
	Can the IOUs use these characteristics for targeting and education/marketing purposes?

[1] PG&E's Budget Billing program averages customers' monthly energy costs over the past 12 months to arrive at a flat monthly payment amount that does not change significantly from season to season. Energy usage is monitored and this amount is adjusted up or down once every four months if there are any significant changes in energy usage.

[2] Automatic Bill Payment and Salience Effects: Evidence from Electricity Consumption, Steven Sexton, The Review of Economics and Statistics, May 2015, 97(2): 229-241.

1.3 Approach

This impact evaluation used energy consumption data and a customer survey among users and non-users of ABP and BB to answer the key research questions.

1.3.1 Methods

There are two phases to this study. In Phase 1, we examined the effect of ABP and BB on the electricity consumption of PG&E's residential customers. We used the prepared analysis data set from the impact evaluation of each of PG&E's multiyear Home Energy Report (HER)[3] programs for this purpose. In particular, we focused on what effects ABP and BB had on the residential electricity consumption trends of PG&E's HER participants in two different HER waves. This allowed us to conduct a basic replication of Sexton's recent study that found evidence of an increase in consumption associated with participation in both services. We also compared the effects of ABP and BB on customers with and without HERs using this approach.

This analytical approach in this Phase 1 of the study, similar to the one used in Sexton's work, is the "pooled" fixed effects approach[4] used to evaluate behavioral programs such as Opower's HER program. Our findings from this phase will inform Phase 2, the evaluation of the effect of ABP and BB on the remaining IOUs' and PG&E's residential gas use, which will be presented in a later report.

While the impact evaluation identifies differences in consumption associated with ABP and BB, primary research among users and non-users of ABP and BB uncovered the motivators and barriers related to use of ABP and BB. It also revealed self-reported bill review behavior and the attitudes, values, and demographics of customers.

1.4 Key findings

The primary findings stemming from our evaluation are summarized in Figure 1. More detail on these findings can be found in Sections 3 and 4 of this report.

[3] Home Energy Reports are electronic or paper reports on energy consumption sent to customers at regular intervals (often monthly, like an energy bill) educating them on their consumption, how their consumption compares to other similar homes or to their own consumption historically, and provides them with energy saving tips and information. Experimental waves of the Home Energy Reports program are not representative of PG&E's customer base. With the exception of the Gamma Wave, each experiment excludes one or more of the customers in the lowest quartiles of energy use. Phase I of this evaluation will represent a proof-of-concept and widening the scope of customers studied can be considered for Phase II of this evaluation.

[4] For a discussion of approaches see, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures NREL/SR-7A30-53827 April 2013.

Figure 1: Key findings

Area of Research	Finding
ABP impact	**ABP use is associated with a 1.1%-1.6% increase in consumption.**
 **BB impact**	**BB use is associated with a 3.8%-4.7% increase in consumption.**
 **ABP and BB impact within HER**	**Receipt of HERs dampens 100% of the increased consumption associated with ABP use. Receipt of HERs dampens between 20% and 33% of the increased consumption that accompanies BB use.**
ABP and BB user profile	**ABP users tend to be more affluent and educated. BB users have a higher prevalence of low-income customers.**
 **Bill review behavior**	**Regularity of bill review for amount owed is markedly higher for those who do not use either ABP or BB relative to those who use both.**

1.5 Conclusions and recommendations

This research provides evidence that ABP and BB programs are associated with increases in energy consumption by customers. The research also provides information on characteristics of program participants through the process evaluation. The ultimate intent of this research is to support insight on how ABP and BB may be modified to promote energy conservation. Below we propose opportunities to combine ABP and BB with other energy management technology options such as Home Energy Reports that mitigate the potential effects of ABP and BB services.

The results presented here provide further evidence to support Sexton's claim that there are consumption increases associated with participation in ABP and BB programs. Due to data constraints, our results only capture relatively short term effects, but despite this limitation we find consistent, statistically significant increases in electric consumption across two independent groups of PG&E customers. As might be expected given the shorter duration, the magnitudes of the effects that we identify are smaller than those reported by Sexton. While we replicate the spirit of Sexton's paper, we also find that the self-selection implications of the endeavour need further consideration, particularly for BB customers.

In an extension to Sexton's work, we also provide evidence that HERs at least partially claw back these increases in consumption associated with ABP or BB participation. While ABP and BB are hypothesized to decrease customers' awareness of their spending in any given month, HERs increase customers' awareness of consumption itself perhaps counteracting the loss of price salience. HERs counteracted 100% of the increased consumption associated with ABP, while reducing the much greater increases by BB customers by up to 30%.

The key recommendations from our evaluation are summarized below. These results have different implications for customers choosing to go onto the two different programs. The choice to go on ABP is based on convenience. The customer prefers to forego that monthly hassle of paying the bill so automates the process. The effects that Sexton identifies and that we also find can be seen as a hidden cost of this service, whether tied to a loss of price salience or otherwise. Further, from a regulatory perspective, increased consumption due to loss of price salience is an unintended and possibly unnecessary side effect of the increased convenience of ABP. It would be appropriate to take action that attempts to limit the unnecessary effects of the ABP service.

These actions could include something like HERs that would help to maintain a focus on consumption level combatting loss of price salience. This analysis indicates that, at least in the short term, HER reports can fully counteract the consumption increases associated with participation in ABP.

BB, on the other hand, is a service that customers choose to even out utility payments over the year. The service directly separates consumption from its immediate price effect in terms of the utility bill that is received after a month of consumption. In this respect, during summer months, BB potentially offers a short term negative price effect. The effective cost of cooling has been substantially reduced in terms of the payment on summer bills. This could cause additional upward pressure on consumption in addition to the effect of loss of price salience. That an increase of this magnitude occurs in such a short span of time supports the possibility that more than loss of price salience is occurring.

Another way to understand the increase in consumption is that BB, by effectively lowering the immediate cost of cooling by spreading them over the full year, makes it easier for BB participants to meet their full comfort needs despite tight budgets. Both explanations flow from the same economic mechanism but put a different emphasis on the outcomes. As a result, the regulatory perspective on the BB effect may need to be more nuanced than for ABP.

In addition to receiving some type of HERs, which do address a portion of the consumption increase, HVAC program options offered to BB customers could be enhanced with additional incentives. This could facilitate BB customers meeting their comfort needs while still lowering their overall cooling consumption. It could also help target customers with substantial AC load and high potential AC savings with either a tune up or an EE unit replacement. We note that 23% of all BB customers in 2015 are also on CARE.[5] Thus, budget concerns of these customers will be partly addressed by the above energy saving recommendations.

Budget billing is currently marketed as a way for customers to have more manageable monthly payments. We found that BB use is associated with relatively lower levels of education and income in contrast with ABP use. Fewer customers reported actively searching for BB on the utility website in comparison with ABP. BB users also see a higher spike in consumption relative to ABP.

The above findings suggest a closer look at the inadvertent increase in consumption that accompanies BB use, especially given that a higher proportion of BB users have relatively lower incomes.

[5] Source: PG&E 2015 electric billing dataset

2 INTRODUCTION

2.1 Background

This report presents findings from DNV GL's evaluation of the impact of automatic bill payment (ABP) and budget billing (BB) on household consumption. Investor-owned utilities (IOU) Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas and Electric Company (SDG&E), and Southern California Gas Company (SCG) offer their customers APB and BB options. Currently, 16% of PG&E's residential customers are enrolled in auto-pay and budget billing (Table 2).

Table 2: 2015 ABP, BB, and total customer counts

	Number	Percent of total
ABP	601,125	13%
BB	220,367	5%
ABP and BB	779,978	16%
Total electric customers	4,758,236	

ABP programs offer customers the convenience of automating a recurring transaction and minimizing or eliminating late payments. They offer IOUs the ability to collect regular payments owed to them by customers more efficiently. Moving customers to ABP enables IOUs to better manage payments owed to them by reducing the number of customers with a late payment or non-payment and the labor hours required to manage bill payments through non-automated options. BB programs offer customers the option to spread their bills over the course of a year through a flat monthly rate which is determined based on customers' past usage and bills. Budget billing programs are also referred to as flat billing, balanced billing, or level payment programs.

A recent study by Sexton (2015) investigates the causal effects of enrolling in ABP and BB on household level electricity consumption. Using data from residential customers of a utility in the Southeast, Sexton finds that enrollment in an ABP program increases average monthly electricity consumption by about 4% overall and up to 6% for more recent enrollments. He also reports an increase in consumption of 7% due to enrollment in a BB program designed to smooth seasonal bill extremes (flat billing). These effects have not previously been examined and are of interest to the CPUC in their role as regulator.

2.2 Evaluation objectives

The objective of this study is to examine the effect of ABP and BB on residential customer gas and electric consumption in California. This study presents a proof of concept in Phase 1 of this research, with a focus on electricity use for two waves of the PG&E Home Energy Reports (HER) Program.[6] This allows for a basic replication of the Sexton study while offering an extension of the work to compare effects of ABP and BB on customers with and without HER. Based on learning from Phase 1, the approach will be refined as needed and evaluation of ABP and BB will be conducted on the remaining IOUs.

The key research questions and the corresponding evaluation types are summarized below (Table 3).

Table 3: Key research questions

	What are the pre- and post energy-consumption trends of customers who use ABP and BB?
	How does it compare to customers who do not use such payment methods?
	What are the demographic characteristics for customers who choose the various bill-pay options?
	Can the IOUs use these characteristics for targeting education/marketing purposes?

The report presents the results from the impact evaluation in Section 3 and the results from primary research among ABP and BB users and non-users in Section 4. A summary of conclusions and recommendations are in Section 5. Appendix A summarizes the recommendations, Appendix B includes verbatim comments on barriers to use of ABP, and Appendix C provides the survey used in the customer research.

[6] Home Energy Reports are electronic or paper reports on energy consumption sent to customers at regular intervals (often monthly, like an energy bill) educating them on their consumption, how their consumption compares to other similar homes or to their own consumption historically, and provides then with energy saving tips and information. Experimental waves of the Home Energy Reports program are not representative of PG&E's customer base. With the exception of the Gamma Wave, each experiment excludes one or more of the customers in the lowest quartiles of energy use. Phase I of this evaluation will represent a proof-of-concept and widening the scope of customers studied can be considered for Phase II of this evaluation.

3 IMPACT EVALUATION

3.1 Theoretical background

Sexton's study provides valuable theory and evidence to support the hypothesis that programs such as ABP and BB cause an increase in customers' energy consumption. Using economic theory, Sexton offers a thesis of why programs such as ABP and BB have adverse effect on consumption. In the absence of full information and limitations in available attention (called bounded rationality), consumers make less than optimal decisions regarding the consumption of goods. Without these sorts of limitations, consumers would not be swayed by the cost of product and service attributes that are less prominent. For example, when buying air tickets from low cost carriers people often respond more to the upfront low airfare than all the additional costs including for baggage, seating choice and taxes. It is inattention to these types of 'less prominent' prices that leads to consumption that is not optimal. Therefore, programs that change product or service characteristics can affect consumption choice.

ABP alters the importance of cost or price salience because there is no requirement for people to look at their bills before funds are withdrawn for payment. Sexton hypothesizes that the reduction in price salience due to inattention to the cost of energy results in consumption increases. The "loss of price salience" argument is also essential to motivating the econometric analysis performed to produce the estimates of program effect. It can be difficult to estimate effects of a decision where participants opt into a program. If the decision to participate is correlated with the person's outcome, then estimates of the treatment effect may suffer from selection bias. In this case, because the effect is hypothesized to be due not to choice itself but to the resulting loss of price salience, the correlation may be less likely. As Sexton states, "the

treatment effect is essentially unintended, and the self-selection constraint is likely satisfied."[7] Further, "intuitively, it is unlikely that an individual selects into ABP or BB because he expects to consume more electricity than he otherwise would."[8] Sexton makes additional, more technical arguments to support his claim that the estimates of these treatment effects are valid. Ultimately, the purpose of the analysis is not to assess the validity of Sexton's argument but to see if the results are consistent when the analysis is applied to California data. For this analysis, we accept Sexton's findings on ABP as a given.

Similar to ABP, Sexton hypothesizes that budget billing diminishes price salience by disconnecting the cost of consumption in a given month from the actual energy consumed. Sexton appears to believe that BB can be understood on the same terms as ABP and that his arguments regarding loss of price salience apply for BB as well.

From our perspective, the motivation to participate in BB, however, has an important distinction relative to ABP that Sexton overlooks. To the extent that price is experienced through total monthly bills, BB effectively changes the price of energy. BB causes an effective drop in price during the summer months, as perceived through the bill, and an increase in price during months where consumption was previously lower than the mean bill across the year. From an economic perspective, an effective price decrease would be consistent with an increase in consumption during those summer months. While this disconnect does not rule out price insalience as a consequence of BB, it opens the possibility of motivations to participate in BB that could be more closely tied to consumption increases.

It seems reasonable, for instance, that BB could be motivated by customers who find it challenging to pay high summer cooling bills. BB would support an effort to maintain desired comfort during the summer by spreading the cost over the full year. This is quite different from an argument based on "loss of price salience" though it could have the same effect of increasing consumption overall.

This recognition means that BB participants may need to be considered independently from ABP. With regard to the analysis challenge of estimating a treatment effect in the presence of self-selection, we cannot assume consumption increase as an unintended consequence. This increases the likelihood of self-selection bias in estimated treatment effects. Also, per Sexton, in this case there is reason to believe the bias would be upward as consumption is directly associated with comfort. Despite this, Sexton believes the results are still valid for the subset of the population opting into these programs – "Although strict exogeneity is necessary to interpret (treatment effects) as estimates of PATEs (population averaged treatment effects), their interpretation as population averaged treatment effects on the treated (PATTs) does not depend on independence of treatment status and potential outcomes."

We examined the effect of ABP and BB among California's IOU residential customers based on the prepared analysis data sets used in the impact evaluation of each of their multiyear Home Energy Report (HER)[9] programs. This report presents Phase 1 of the analysis using data from PG&E's residential HER program that serves as a proof of concept. In particular, we focused on what effects ABP and BB have on the residential electricity consumption trends of PG&E's HER participants in two different HER waves. The approach we take

[7] Sexton (2015). p. 233.

[8] Ibid. p. 233.

[9] Home Energy Reports are electronic or paper reports on energy consumption sent to customers at regular intervals (often monthly, like an energy bill) educating them on their consumption, how their consumption compares to other similar homes or to their own consumption historically, and provides then with energy saving tips and information. Experimental waves of the Home Energy Reports program are not representative of PG&E's customer base. With the exception of the Gamma Wave, each experiment excludes one or more of the customers in the lowest quartiles of energy use. Phase I of this evaluation will represent a proof-of-concept and widening the scope of customers studied can be considered for Phase II of this evaluation.

allows for a basic replication of Sexton's study while extending the work to compare effects of ABP and BB on customers with and without Home Energy Reports. Our findings from this phase will inform Phase 2, which is the evaluation of the effect of ABP and BB on the remaining IOUs and PG&E's residential gas use. The combined results are facilitated by the fact that Sexton's approach and the econometric model used in the study are similar to the "pooled" fixed effects approach[10] used to evaluate behavioral programs such as Opower's HER program.

3.2 Model specification

We identify ABP and BB enrollment for all members of PG&E's HER treatment and control groups and combine monthly consumption data of all participants in a wave into a single regression analysis.[11] This is also referred to as a "time-series cross-sectional analysis" because observations vary both across time and across individual dwellings. We then use a pooled fixed-effects regression model to measure the effect of ABP and BB enrollment on electricity consumption and the effect of ABP and BB conditional on Opower's HER participation. Using a pooled fixed-effects approach allows for the measurement of ABP and BB and HER-related impacts while also controlling for other possible confounding factors. However, there is still a possibility of self-selection bias that could potentially affect the results. Section 3.4 below describes the issue of self-selection further.

The pooled fixed-effects model we estimate is given by:

$$C_{jt} = \mu_j + \lambda_t + \gamma_A ABP_{jt} + \gamma_B BB_{jt} + \gamma_H HER_{jt} + \gamma_{AH} ABP_{jt} * HER_{jt} + \gamma_{BH} BB_{jt} * HER_{jt} + \varepsilon_{jt}$$

- Cjt = the log of average daily consumption during interval t for household j
- μ_j = unique intercept for each household j
- λt = 0/1 indicator for each time interval t (month-year) that tracks systematic change over time
- $HERjt$ = 0/1 dummy variable equal to 1 if household j is in the HER treatment group in period t, 0 if household j is in the comparison group in period t
- $ABPjt$ = 0/1 dummy variable equal to 1 if household j is an ABP enrollee in period t, 0 otherwise
- $BBjt$ = 0/1 dummy variable equal to 1 if household j is an BB enrollee in period t, 0 otherwise
- ε_{jt} = error term or random noise of the model

Table 4 provides a definition of each parameter of interest from our model. The names of the parameters are also used in tables where we present results based on model estimates in Section 3.1.

[10] For a discussion of approaches see, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures NREL/SR-7A30-53827 April 2013

[11] ABP and BB enrollment data was merged to HER program and billing data for this analysis.

Table 4: Definition of model parameters of interest

Model Coefficient	Name of Parameter
γ_H	Post HER treatment
γ_A	On ABP
γ_B	On BB
γ_{AH}	Post HER treatment on ABP
γ_{BH}	Post HER treatment on BB

Interest in this model centers around the estimates associated with the ABP and BB flags, or indicator variables, that show the correlation of consumption associated with enrollment in these two programs. The coefficient estimates of γ_A and γ_B will reveal if the hypothesized increase in consumption due to loss of price salience occurs, and if it does, the extent of the increase for PG&E's residential electric ABP and BB enrollees.

Unlike the data set that Sexton used in his study, which features a long-time series for each household with sufficient pre- and post-ABP and BB enrollment data, our data set includes a lot of households who have been on these payment plans longer than the span of the data set. The long-term effect of ABP and BB for such households is absorbed in the individual-specific intercept term, μ_j. Therefore, the estimated coefficients for the ABP and BB indicator variables will reflect the association of ABP and BB with consumption for customers that are more recent enrollees. In particular, the coefficients will reflect the association of consumption with these payment plans for customers who enrolled in these plans since the start of the analysis period for each HER cohort.

Additionally, our model provides an estimate of HER treatment effect on consumption (captured by an estimate of the parameter γ_H) for customers that are not enrolled in either ABP or BB. This is an estimate of baseline HER-treatment effect. Our model also provides the marginal (additional) effect of HER treatment on those enrolled in ABP and BB. The interaction between the post HER-treatment indicator, and the ABP and BB enrollment flags measure this effect. In particular, the estimates of the parameters of these interactions (γ_{HA} and γ_{HB}) indicate the direction and degree of these marginal effects. The total HER treatment effect on ABP and BB enrollees, though, is the sum of the estimated baseline HER-treatment effect and the incremental (marginal) HER treatment effect on these customers. It is given by sums of the following parameters for ABP and BB, respectively:

$$\gamma_H + \gamma_{AH}$$

$$\gamma_H + \gamma_{BH}$$

Both the estimates of the sum and marginal effects permit us to discern if HER treatment has an effect that is greater, less than or about the same on ABP and BB enrollees than on those in the HER treatment group not enrolled in either. They indicate if HER treatment effect has the same or different effects on customers who use these forms of payment methods.

Following Sexton, we log the left-hand side variable of the model so that the estimated coefficients can be interpreted as percent changes. We discuss model estimates in Section 3.4.

3.3 Data

As we stated in Section 1.2, the objective of this study is to examine the effect of ABP and BB on residential energy consumption in California. In this Phase 1 report, we present results using electric data from PG&E's HER wave 3 and 4 cohorts. We identify ABP and BB enrollment among these cohorts using rosters of such enrollees we received from PG&E. We describe the data and data sources used in our study in this section.

3.3.1 Billing data

We used PG&E's HER program data set in order to leverage the experimental design and the prepared analysis data set used in the impact evaluation. This data set provides information for all of PG&E's HER waves starting with the first wave (Beta) that began in July 2011. Table 5 provides a summary of each HER wave including launch dates, frequency of reports for each wave and types of customers that were targeted.

Table 5: Features of HER data set used in the study

Wave	Fuel type/Frequency of report/Area	Launch Date	Target Group
Beta	Dual fuel - standard frequency	11-Jul	highest usage quartile in service areas in the San Francisco Bay Area
Gamma	Dual fuel – standard frequency	11-Nov	all usage quartiles and 6 PG&E baseline territories
	Dual fuel – reduced frequency		all usage quartiles, 6 PG&E baseline territories
	Electric only - standard frequency		all usage quartiles, 6 PG&E baseline territories, single fuel
Wave One	Dual fuel - standard frequency	12-Feb	highest 3 usage quartiles, entire residential population
	Electric only - standard frequency		highest 3 usage quartiles, entire residential population, single fuel
Wave Two	Area 7 - standard frequency	13-Feb	Area 7: Humboldt, Mendocino, Lake, and Sonoma Counties
	Non - Area 7 - standard frequency		Not in Area 7
Wave Three	Dual or single – standard frequency	13-Jul	highest 3 usage quartiles
Wave Four	Dual fuel – standard frequency	14-Mar	highest 3 usage quartiles
Wave Five	Dual fuel - standard frequency	14-Oct	highest 3 usage quartiles
Wave Six	Dual fuel- standard frequency	15-Sep	highest 3 usage quartiles

We focused our study on PG&E's HER wave 3 and wave 4 rollouts.[12] We estimated the pooled fixed-effects model for each wave separately in order to identify the effect of enrollment in the two payment plans on consumption as well as the additional effect of HER treatment for households enrolled in these programs. HER wave 3 began in July 2013 and involved 225,000 and 75,000 randomly assigned treatment and control households. PG&E's fourth HER wave started in March 2014 and involved 200,000 and 75,000 randomly assigned treatment and control households.

Impact evaluation of HER treatment for each cohort requires at least 12 months of pre- and post-treatment data. Thus, the wave 3 HER data set we used has monthly consumption data for each treatment and control households from July 2012 until December 2015 except for households that terminated service sometime before the end of the study period. Similarly, wave 4 data had monthly consumption for the period March 2013 to December 2015. Consumption data were sourced from utility billing records and supplemented with customer information data from the utility. A thorough discussion of data preparation and disposition can be found in DNV GL's "Review and Validation of 2015 Pacific Gas and Electric Home Energy Reports Program Impacts."[13]

In order to identify customers that opted in or out of the two payment plans, DNV GL requested information on payment plan participation for treatment and control households used in PG&E's HER studies. We received a full roster of PG&E's electric and gas customers that ever participated in ABP and BB, including dates each customer opted in and out of each plan. We identified which of the HER participants, both treatment and control, enrolled in ABP and BB plans using this roster.

3.3.2 Data summary

Of PG&E's approximately 4.7 million electric customers in 2015, 601,125 (13%) customers were on ABP and 220,367 (5%) were on BB (Table 2). Our analysis is based on a subset of the total electric customer base selected for the third and fourth HER experiment. We present a summary of the data for each wave in Table 6.

First, we note that 9-10% of households in each wave were enrolled in ABP while 6%-8% of households were enrolled in BB. The mean date of ABP enrollment is January 2008 for wave 3 and June 2009 for wave 4. These start times precede the start of the analysis period in each data set. In fact, a full 85-89% of those on ABP and about 80% of those on BB are enrolled before the start of the analysis period in the data set for each wave. There are households that have been on either of these payment methods as early as 2001. As we indicated in Section 3.2, the estimated ABP and BB coefficients reflect the association of these payment plans with consumption on households that have enrolled in these plans since the start of our study period.

[12] We focus on more than one HER wave to ascertain that our findings are stable across waves and not a function of a specific dataset. These specific HER waves were chosen from a set of 6 possible waves as they represent the widest possible coverage (territory and consumption level) and included a higher number of customers on both ABP and BB relative to other HER waves.

[13] http://calmac.org/publications/DNVGL_PGE_HERs_2015_final_to_calmac.pdf

Table 6: Summary statistics of data set used in the study

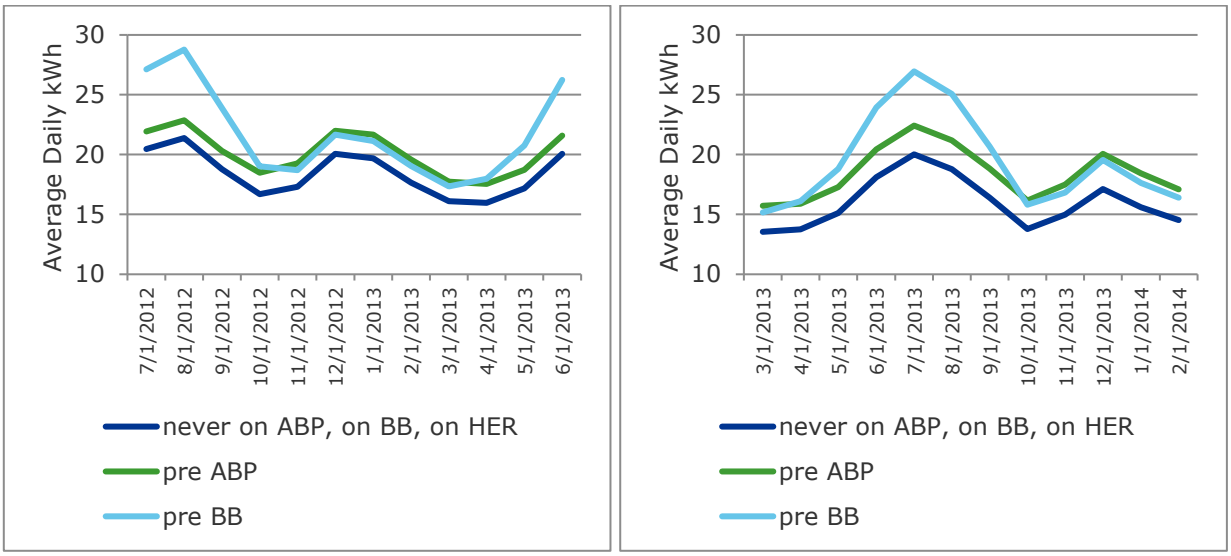
	Wave Three	Wave Four
Number of households	229,522	223,859
Number of ABP households	21,287	21,488
Number of BB households	18,480	13,664
Percent of households in ABP	9%	10%
Percent of households in BB	8%	6%
Number of HER treatment households	173,653	162,836
Number of HER control households	57,709	61,023
Number of ABP households in HER treatment	15,939	15,636
Number of BB households in HER treatment	13,841	9,927
Mean date of ABP enrollment	Jan-08	Jun-09
Minimum date of ABP enrollment	Jan-02	May-02
Mean date of BB enrollment	Jun-08	Jan-10
Minimum date of BB enrollment	Mar-01	Sep-01
Percent ABP enrollment before data start	85%	89%
Percent BB enrollment before data start	80%	79%
Mean daily kWh	18.02	16.02
Minimum daily kWh	0.00	0.00
Maximum daily kWh	509.31	631.55

The table also provides the average, minimum, and maximum daily consumption for each cohort. Such summary figures are useful, but it would also be informative to examine the pattern of consumption over a 12-month period to see seasonal variations and differences in consumption among households that eventually enroll in these payment plans versus those who never do.

We compared the level of consumption among ABP and BB households before their enrollment in these plans to the consumption of those that never do. For this purpose, we used monthly consumption data prior to enrollment in ABP and BB for both the wave 3 and wave 4 HER cohort and for those who do not enroll in either payment plan.[14] These are the pre-HER treatment periods as well and reflect electricity usage that is unaffected by any of the programs under consideration in this study. Figure 2 provides plots of monthly consumption for all three types in the HER wave 3 and wave 4 data sets.

[14] Pre-enrollment data from July 2012 - June 2013 is used for the HER wave 3 cohort that enroll in ABP and BB after July 2013 and from March 2013 - February 2014 for the HER wave 4 cohort that enroll in ABP and BB after March 2014.

Figure 2: Average daily consumption (kWh) before ABP and BB enrollment – waves 3 and 4



Both figures indicate that consumption among eventual ABP and BB enrollees is higher than it is for those that never enrolled in these plans. It is also higher for eventual BB enrollees than for ABP enrollees. For eventual BB enrollees, the summer month consumption is clearly well above the rest, while their consumption coincides with that of future ABP enrollees during the rest of the months. These figures suggest that there is something different about the people who end up enrolling on these payment plans.

The modeling approach controls for mean differences in consumption and, by extension, other non-time-varying effects across customers. The model also only measures program effect for customers who joined the payment plans during the analysis period, and have pre- and post-participation consumption data. However, it is the kinds of differences in consumption across groups noted in the figure above that support the concern that potential self-selection could affect estimated results.

3.4 Results

We present results from the pooled fixed effects model for each cohort in this section.

3.4.1 Pooled fixed-effects model results

We provide model estimates from the pooled fixed effects model for both waves in Table 7. The model standard errors are clustered at the household level because monthly consumption values for a given household are not independent. This approach allows us to avoid standard errors that over-estimate the precision of estimated coefficients.

Table 7: Pooled fixed effects model estimates for HER wave 3 and wave 4

	Wave 3			Wave 4		
Parameter	**Coefficient Estimate**	**Standard Error**	**P value**	**Coefficient Estimate**	**Standard Error**	**P value**
Post HER treatment	-0.010	0.001	0.000	-0.007	0.001	0.000
On ABP	0.016	0.004	0.000	0.011	0.004	0.006
On BB	0.047	0.004	0.000	0.038	0.004	0.000
Post HER treatment on ABP	-0.008	0.002	0.000	-0.012	0.002	0.000
Post HER treatment on BB	0.001	0.002	0.650	-0.006	0.002	0.008

The model we specify included time-month effects (λ_t) for each of the 42 months in wave 3 and 34 months in wave 4. These effects control for exogenous trend common to all households and do not affect the parameter estimates of interest that the model is designed to address. Therefore, we do not present the parameter estimates of the time-specific effects in the table to conserve space.

We use the logged value of the dependent variable (average daily kWh) in these models. Parameter estimates from a model with a logged dependent variable can be interpreted as percent changes. For instance, the parameter estimate for HER treatment (post HER treat) has a value of -0.010 in the model for wave 3, which can be interpreted as a 1.0% reduction in average daily use as a result of HER treatment.

3.4.2 Effects of ABP and BB

The parameter estimates on ABP and BB indicate that enrollment in both forms of payment plans are associated with statistically significant increases in consumption. Within the first two years after ABP enrollment, we estimate a 1.6% increase in consumption in HER wave 3 and a 1.1% increase in HER wave 4. The corresponding increase in consumption for BB enrollment is estimated at 4.7% for the wave 3 cohort and at 3.8% for the wave 4 cohort.

In this study, we have attempted to replicate Sexton's work on the effect of ABP and BB enrollments using electric data from one California IOU. Similar to Sexton's results, we find that both ABP and BB participation are associated with increases in consumption. It appears that the loss of price salience may be at work for ABP. For BB, some combination of loss of price salience and effective summer price reduction may be at work.

Unlike those reported in Sexton, where consumption increases average about 4% for ABP residential customers and 6% for BB residential customers, the increases we see in this setting are more modest at about 1% to 1.6% for ABP and at about 4% to 5% percent for BB. The reduced effect levels may reflect differences in payment plan recruitment, the structure of the plans, differing behavioral responses to such offerings, and possible differences in weather correlation between ABP and BB in the two jurisdictions.

More importantly, the lower estimates may also reflect differences in the data sets we use to study the effect of ABP and BB. Unlike Sexton, who had the advantage of a long time-series with sufficient pre-ABP and BB enrollment information, we have people who are on these plans for much longer than we have data for in our study.

Given the data available, there is no model that can distinguish between the relationship of the payment plans and consumption, and the effect of general program population characteristics of these long-term participants on consumption. The model specification we use effectively removes the association of ABP and

BB and consumption for those who enrolled in these plans prior to the start of our data set. The individual- or household-specific terms (μ_j) absorb these effects for such households. The coefficient estimates on the ABP and BB flags then pick up the relationship of ABP and BB and consumption for those who go on these plans during the time period covered by the data. The coefficients estimate this relationship for HER wave 3 participants who enroll in the plans after July 2012 and for HER wave 4 participants who enroll in the plans after March 2013.

The relationships we estimate are, therefore, short-term ones, which may explain why our payment plan coefficients, especially for ABP, are lower those reported in Sexton's study. In addition, Sexton's higher results could be driven by the presence of early adopters of ABP and BB who could have a different propensity to loss of price salience than later adopters and thus a higher increase in consumption regardless of the tenure of their participation.

3.4.3 Effects of HER treatment on ABP and BB enrollees

Our study features the additional interactive effects of these programs and HER treatment on consumption. The parameter estimates from the models indicate that HER treatment induces about a 1% reduction in consumption in wave 3 and 0.7% reduction in wave 4. These estimates are statistically significant at least at the 95% confidence level.

The models also indicate that the additional (marginal) HER treatment effect for those enrolled in ABP and BB are statistically significant except for those on BB in wave 3. The results indicate that effects of HER treatment for such enrollees are different than baseline HER treatment effect. We obtain the total effect of HER treatment for those enrolled in these payment plans by adding the baseline HER effect to the marginal effect. For instance, for the wave 3 cohort, the total HER treatment effect on those enrolled in ABP is -0.018, which reflects a reduction in consumption of 1.8% for this group. We provide the total HER estimate effects along with their statistical significance for ABP and BB enrollees in both cohorts in Table 8.

Table 8: Estimate of total HER effect for ABP and BB enrollees in HER wave 3 and wave 4

	Wave 3 Model Estimates			Wave 4 Model Estimates		
Parameter	**Coefficient Estimate**	**Standard Error**	**P value**	**Coefficient Estimate**	**Standard Error**	**P value**
Total HER effect on ABP	-0.018	0.002	-0.015	-0.019	0.002	0.000
Total HER effect on BB	-0.010	0.002	-0.006	-0.013	0.002	0.000

Another way to look at these effects is provided in Table 9. The outcomes for each group are provided relative to the control group customers who were not enrolled in either program.

Table 9: Final effects of ABP and BB

	HER Wave 3		HER Wave 4	
	Control	Treatment	Control	Treatment
No ABP and BB	100.0%	99.0%	100.0%	99.3%
ABP	101.6%	99.8%	101.1%	99.2%
BB	104.7%	103.8%	103.8%	102.5%

It is evident that HER treatment has a greater effect on ABP and BB enrollees than those not enrolled in either program, except for the BB enrollees in wave 3. For BB enrollees in wave 3, HER treatment effect is no different than baseline effect. HER treatment appears to shaves off the entire increase in consumption for those enrolled in ABP in both waves. For example, in wave 3 while ABP enrollees see an average consumption increase of 1.6%, HER treatment decreases their consumption by 1.8%. HER treatment counteracts about 20% to 30% of the increase in consumption for BB enrollees.

3.4.4 Estimated kWh impact

The kWh impact of ABP and BB is presented in this section. We examined both the per household and across all households consumption change associated with the payment plans in 2015 for each wave. We used pre-ABP and pre-BB enrollment consumption as baseline in each case. As we noted in Section 3.4.3, we estimated the short-run relationship of both payment methods and consumption due to the type of data we have available. Baseline consumption levels for ABP and BB in wave 3 are based on the average level of consumption of customers from July 2012 to June 2013 for those that enroll in ABP and BB after July 2013. This is the pre-HER treatment period as well and reflects electricity usage that is unaffected by any of the programs under consideration in this study.

Similarly, baseline consumption levels for ABP and BB in wave 4 are based on the average level of consumption of customers prior to the start of HER treatment in March 2014 and their enrollment in these payment plans.

We use the estimated effects of the payment plans as well as HER treatment, summarized in Table 9, to compute the impact on kWh. We present the 2015 ABP effect on kWh in Table 10.

Table 10: 2015 kWh effect of ABP

	Wave 3	Wave 4
Baseline average annual kWh per household	6,722	7,352
Number of households on ABP	601,125	601,125
ABP effect on annual kWh per household	109	83
ABP effect on annual kWh per household with HER	-12	-57
ABP effect on total annual kWh	65,733,146	49,765,693
ABP effect on total kWh with HER	-7,319,923	-34,262,986

The average estimated increases in electricity consumption per household were 109 kWh for wave 3 and 83 kWh for wave 4. Those that received HER treatment, on the other hand, reduced their consumption by 12 kWh and 57 kWh per household for HER waves 3 and 4, respectively. As we reported in Table 2, there were about 600,000 households on ABP in 2015. Therefore, the total estimated kWh increases were 66 million

and 50 million kWh for waves 3 and 4, respectively, in 2015. These increases were more than offset by HER treatment with total kWh reductions of 7 million and 34 million for waves 3 and 4, respectively.

We present the 2015 BB effect on kWh in Table 11.

Table 11: 2015 kWh effect of BB

	Wave 3	Wave 4
Baseline average annual kWh per household	7,086	7,958
Number of households on BB	220,367	220,367
BB effect on annual kWh per household	334	303
BB effect on annual kWh per household with HER	266	203
BB effect on total annual kWh	73,548,515	66,829,524
BB effect on total kWh with HER	58,715,922	44,654,822

The estimated BB effect on consumption is bigger than the ABP effect. On a per household basis, BB is associated with increases of 334 and 303 kWh for waves 3 and 4, respectively, in 2015. While HER treatment dampens these increases, it does not reverse them as in the ABP case. The increases in kWh per household for those on BB that received HER treatment were 266 and 206 for waves 3 and 4, respectively. In 2015, the number of households on BB were about 220,00. Thus, the estimated increase in total kWh were 74 million and 67 million for waves 3 and 4, respectively, in 2015.

The estimated kWh effects of ABP and BB reflect short-term outcomes. Our results are thus conservative and the likely impact on kWh is larger if we were to use data that permitted us to estimate the long-run effect of these plans.

4 ABP AND BB CUSTOMER CHARACTERIZATION

In addition to understanding the potential consumption effects of programs like ABP and BB, it is important to understand the characteristics of customers that opt into such programs. ABP and BB are opt-in services that only a subset of customers will choose. Understanding the enrollment decision is key to fully understanding the differences between users of the service and non-users, and extrapolating results to future/potential users. This research furthers our understanding of customers who use ABP and BB payment methods and will help to determine whether they represent an attractive target for PA programs due to high usage.

While the impact evaluation identifies differences in consumption associated with ABP and BB, this primary research among ABP and BB users and non-users helps to reveal the motivation to participate and the variability in customer demographics and behaviors that could potentially lead to these differences in consumption. With knowledge about specific characteristics that may be prevalent among users, program designers will be equipped to target this group with messaging that may help customers become aware of and/or better manage their consumption.

4.1 Overall results

Key findings from the survey of ABP and BB users and non-users that help to provide context for the impact findings include:

- Reasons stated by respondents for ABP and BB participation echo the selling points of these methods – convenience of payment method and increased predictability of their bill amount,

respectively. These selling points of the ABP and BB programs highlight the aspects of the programs that are hypothesized to drive to loss of price salience.

- Regular utility bill review is lower among those using ABP, BB, or both relative to those who use neither. This self-reported behavior corroborates the loss of price salience that is theorized to accompany use of ABP and BB and is in line with results observed in our impact evaluation. The surveys also provide results that help better understand the ABP or BB user and may help to target efforts to counteract the effects of these programs.
- ABP use is associated with higher levels of education and income in contrast with BB use which has a higher prevalence of lower-income customers.
- More active channels were mentioned as sources of awareness for ABP in comparison with sources of awareness for BB where more passive sources of awareness were mentioned. Given that BB use is associated with a higher spike in consumption relative to ABP and the fact that BB users tend to have a higher proportion of lower-income customers, this could have implications for how the BB option is marketed.
- There does not seem to be pent-up demand among customers who currently do not use ABP or BB to consider use of either payment method. An overwhelming majority of non-users are clear about the reasons why they would not enroll in either ABP or BB – control over their payments and the desire to pay for exactly what they use are key reasons for not using ABP and BB respectively.

4.2 Survey methodology

This section summarizes the survey mode and design, and sample disposition.

4.2.1 Survey mode and design

The ABP survey was a web survey and the sample frame mirrors the base used in the impact evaluation for this study – waves 3 and 4 of PG&E's HER experimental design. Email addresses are known for a sizeable number of respondents in both the treatment and control groups and this approach allows us to capture maximum information from a robust sample with minimal additional incremental cost per additional survey.

The survey sought to capture data that would provide insight into various bill payment methods used by customers and covered the following topics:

- Payment modes used
- Motivators of enrollment in ABP and BB among participants
- Barriers to enrollment in ABP and BB among non-participants
- Channel through which participant learned about the payment options
- Satisfaction with payment options
- Awareness of monthly bill amount – magnitude, range (winter/summer) etc.
- Frequency of reviewing bill
- Self-reported perception of consumption trends
- General attitudes and behavior (climate change, conservation, price sensitivity etc.)
- Technology use
- Demographics
- Dwelling characteristics

4.2.2 Sample disposition

The ABP survey was an online survey administered from May 16 2017 to May 30 2017. The sample frame for this survey is the same as the data used in the impact evaluation which includes all residential customers in waves 3 and 4 of PG&E's HER program. All customers who had available email contact information and who were not on the IOUs' do-not-contact list were included in the final survey sample frame and eligible to take the survey. While no incentives for completion were offered to those who were invited to take the survey, respondents were reminded via email and encouraged to complete the survey. The survey disposition is summarized below (Table 12).

Table 12: Survey disposition

	Total
Sample Frame	104,094
Completes	7,279
Response Rate	7.0%

4.3 Survey Findings

This section summarizes findings from the Bill Payment survey.

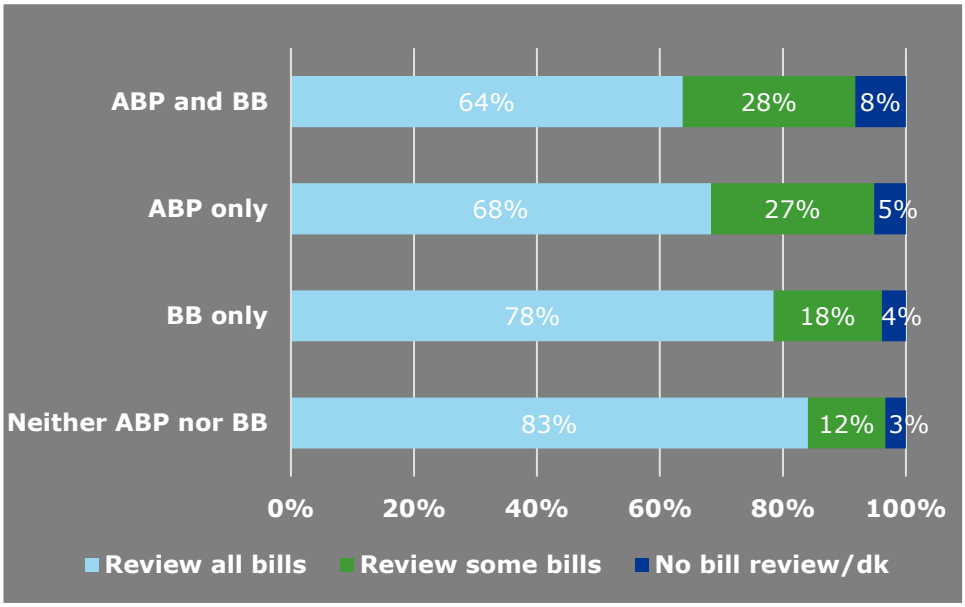
4.3.1 ABP and BB users

Findings related to sources of awareness and motivators of use of ABP and BB, bill review behavior by users and non-users, and satisfaction with most often used payment method are summarized in this section.

4.3.1.1 Bill review behavior by ABP and BB use

Respondents were asked to indicate if they reviewed their monthly utility bill for the amount they owed. Regular bill review without fail each month is most common (83%) among respondents using neither ABP nor BPP, and least common (64%) among respondents using both ABP and BB (Figure 3). In particular, ABP seems to be associated with lower frequency of bill review. The direction of causality is unclear: People who are uninterested in reviewing their bills may be more likely to enroll in ABP, but it is also possible that enrolling in ABP may cause people to review their bills less frequently.

Figure 3: Bill review behavior by ABP and BB use



4.3.1.2 Customer profile

We examined the survey sample on key demographic characteristics and compared against statewide statistics for California and within the sample by users and non-users of ABP and BB. The overall population targeted for the HER program waves were customers in the top 3 quartiles of load, so we expect that demographic comparison from the overall California population accordingly. Survey respondents had a higher proportion of those with annual household incomes greater than $75,000 and a college degree education or higher (Table 13).[15] They also had larger homes with an average of three bedrooms versus the California general population average of 2.6 bedrooms.

A comparison of ABP and BB users versus non-users within the survey shows some significant demographic differences by income and education with ABP only customers being more affluent and educated relative to their BB only counterparts. ABP only customers report significantly higher income with around three-fourth (78%) reporting incomes over $75,000 versus between 52% and 65% for all other user and non-user groups. ABP users are also more likely to have a undergraduate degree or higher relative to BB only users at 81% versus 61% respectively. There are no significant differences by ABP and BB users and non-users by household size and home size as measured by the number of bedrooms.

Respondents indicating that they are highly price conscious does not vary significantly by use of ABP or BB, though ABP only users are marginally higher on this attribute versus BB only users at 49% to 46% respectively. Respondents were asked to choose the one reason that would motivate them to save energy from a list of 6 possible options. Around 4% of respondents indicated that saving money would be the key reason that would motivate them to save energy. In terms of environmental awareness, while over three-fourths of all customers indicate awareness of what a carbon footprint means, ABP only users are significantly more aware of what a carbon footprint is and this is in line with their higher education levels.

[15] Low-income or in-language/non-English speaking customers who face the barrier of the digital divide in higher proportions are not as likely to participate in a web survey in English.

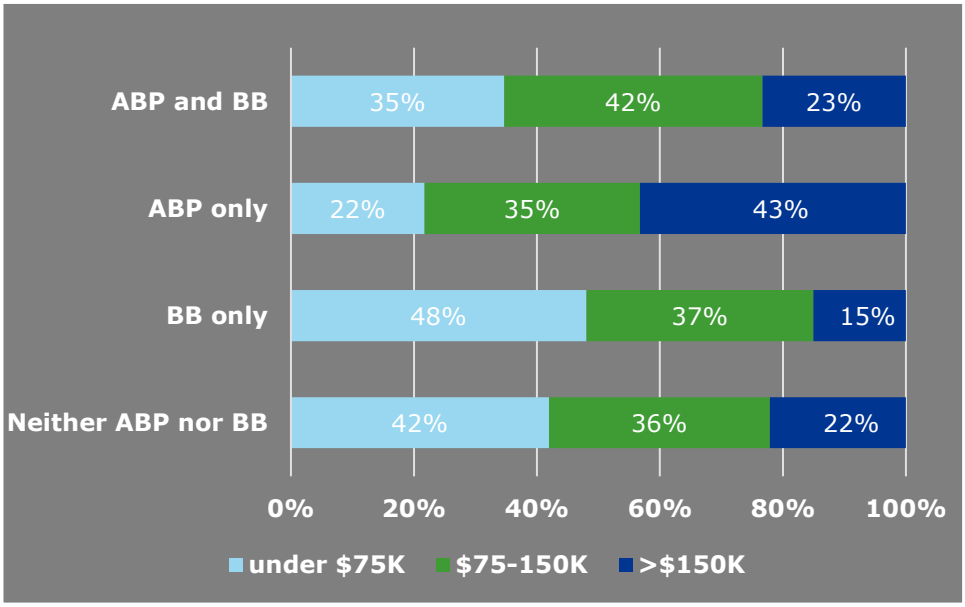
Table 13: Customer profile

	CA	Total Survey (n=7,279)	ABP and BB non-user (n=3973)	BB only user (n=386)	ABP only user (n=2,520)	ABP and BB user (n=400)
Income over $75,000	42%	65%*	58%	52%	78%*	65%
Education – Bachelor's degree or higher	31%	69%*	63%	61%	81%*	63%
Number of members in the household	2.9[16]	2.8	2.8	2.8	2.7	2.6
Number of bedrooms in home	2.6[17]	3.0*	3.0	3.0	3.0	3.0
Attitudes and Values						
Highly price-conscious		47%	45%	46%	49%	46%
ONE reason to save energy – Save money		4%	4%	4%	4%	5%
Awareness of carbon footprint		78%	76%	75%	83%	76%

Note: * Indicates statistically significant difference at the 95% confidence level between CA and the survey sample and ABP only users and all other groups.

An examination of the income distribution within each of these groups reveals that ABP only users are the most affluent with 43% reporting a household income over $150,000 (Figure 4). BB only users have the lowest prevalence of high income customers, at around one-third that of ABP only customers, at 15%.

Figure 4: Income by payment method used

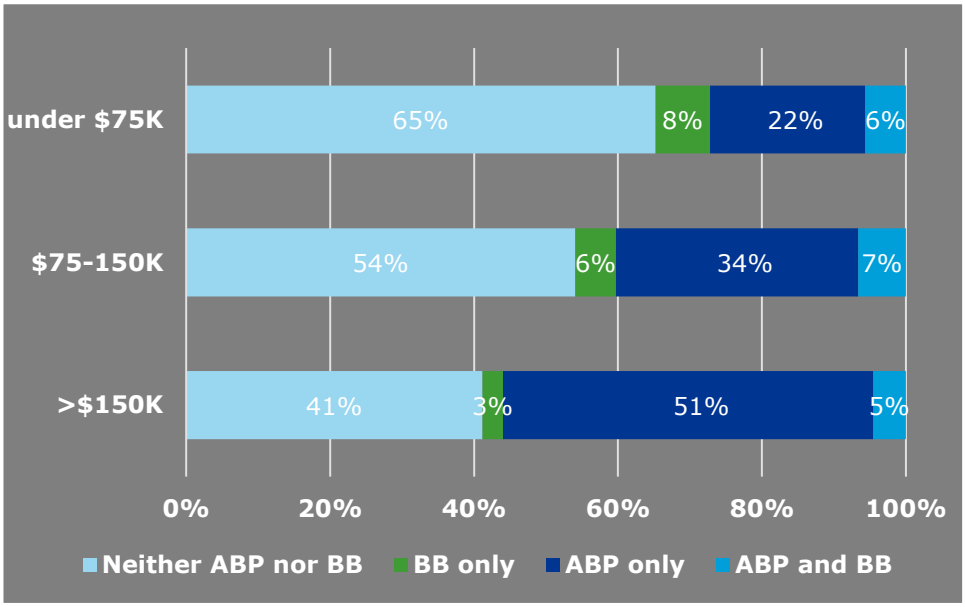


In fact, an analysis of ABP and BB use by income reveals that ABP use steadily increases with income, which may reflect access to technology, having a steady and sufficient income to easily make bill payments, or both. In comparison, BB use among those with annual household incomes under $75,000 is nearly three times as likely than those with incomes above $150,000 at 8% to 3% respectively (Figure 5).

[16] http://www.census.gov/prod/cen2010/doc/dpsf.pdf

[17] Average estimated from distribution of number of bedrooms in occupied housing units in CA, Census

Figure 5: Payment method by income



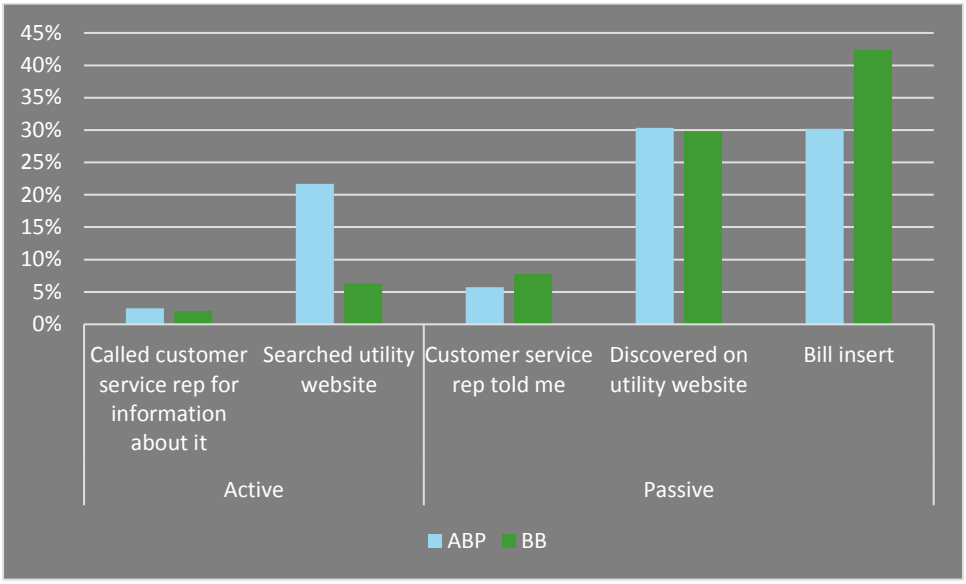
We find that ABP use is associated with higher levels of education and income in contrast with BB use which has a higher prevalence of customers with relatively lower incomes. BB users see a higher spike in consumption relative to ABP. Budget billing is currently marketed as a way for customers to have more manageable monthly payments. Our findings suggest a closer look at the inadvertent increase in consumption that accompanies BB use, especially given that a higher proportion of BB users have relatively lower incomes and can likely ill-afford the increased bills.

4.3.1.3 Channel - sources of Awareness of ABP and BB

Respondents were asked to indicate how they learned about ABP and BB payment options and allowed to indicate multiple channels for their awareness. A comparison of sources of awareness for ABP and BB reveals that respondents were far more likely to cite active sources of information for ABP such as searching the utility website for information or asking a customer representative about the program relative to BB (Figure 6).[18] While we asked about a few other sources, we focus here on the contrast between active and passive channels as sources of awareness for the two payment methods. In order to have searched for it, the respondent must have been aware that such an option might exist. This suggests that general awareness of balanced billing options is lower than for automatic bill pay.

[18] PG&E began marketing BB through bill inserts only in 2017. The high proportion of respondents indicating that they learned of BB through bill inserts could be due to a combination of issues with respondent recall and survey respondents comprisng a higher proportion of those who more recently enrolled in BB.

Figure 6: Sources of awareness for ABP and BB



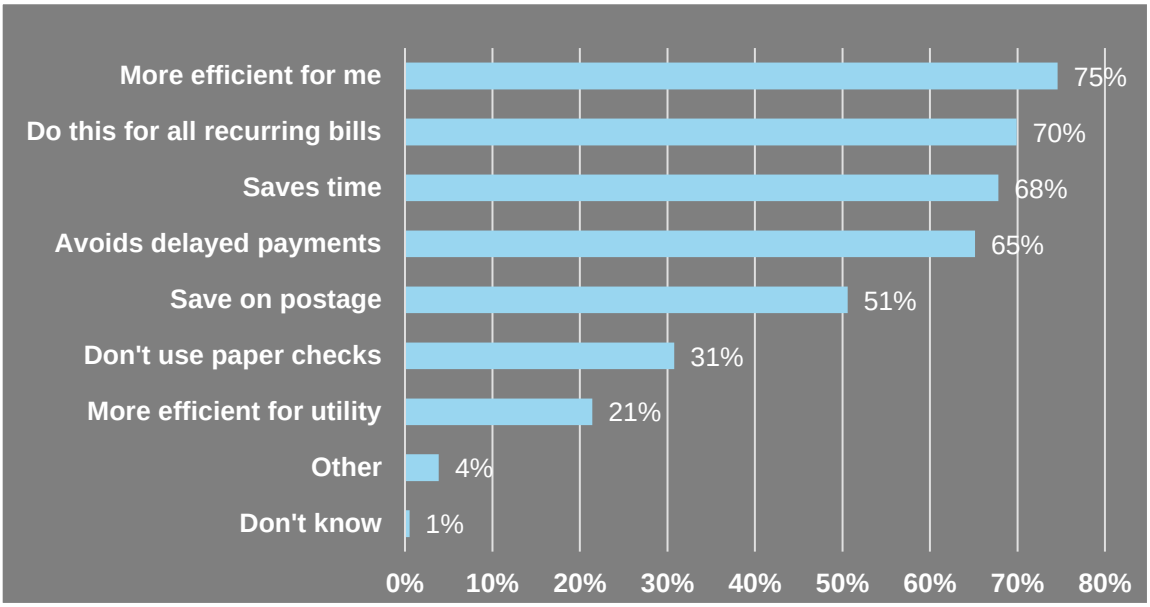
4.3.1.4 Motivators

Respondents were asked what motivated them to enroll in ABP and BB and were allowed to indicate multiple motivators. Efficiency and predictability rose to the top as motivators for enrollment in ABP and BB, respectively.

4.3.1.4.1 Motivators for using ABP

Efficiency for the bill payer emerges as the most mentioned from the list of potential motivators shown for ABP (Figure 7). Seventy percent of automatic bill payers indicated using the method for all their recurring bills. Saving time and avoiding delayed payments also ranked highly. Few respondents were concerned about the efficiency of their payment method for the utility (21%).

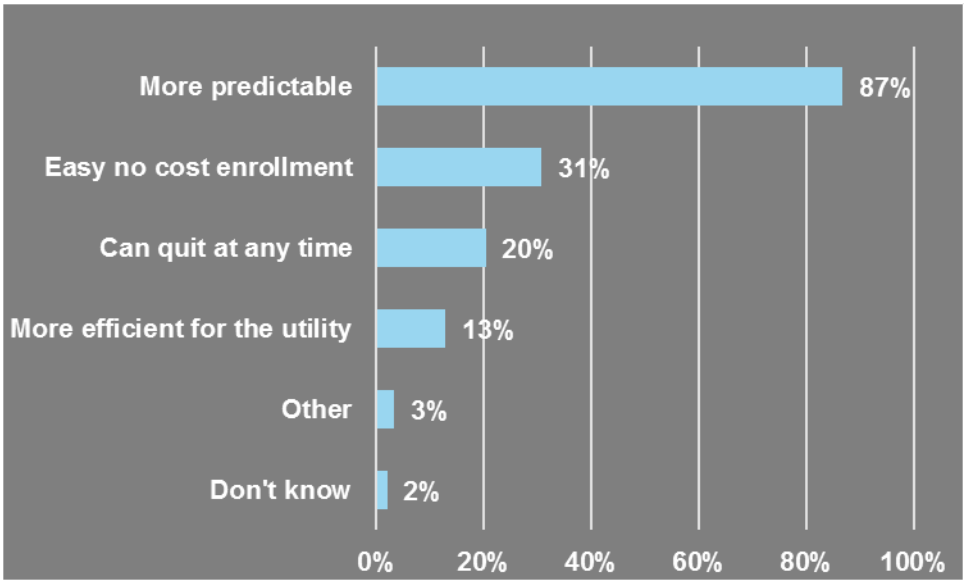
Figure 7: Motivators for using ABP



4.3.1.4.2 Motivators for using BB

By far, the most common motivation for using BB given by respondents participating in the program was the predictability of utility bills under the plan, cited by 87% of respondents who had used budget billing (Figure 8). Some also cited the easy no-cost enrollment (31%) and ability to quit at any time (20%) as motivating their decision to enroll in BB. As with ABP, concerns about the efficiency gains to the utility were mentioned by only a few respondents.

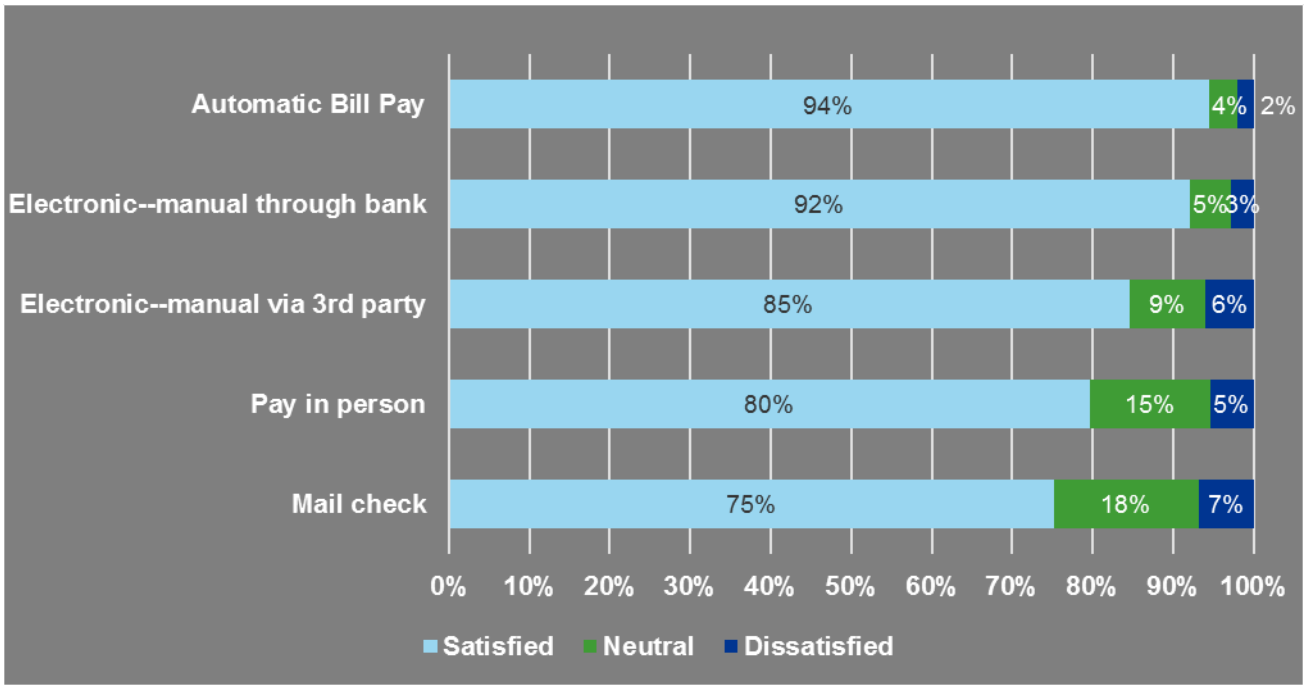
Figure 8: Motivators for using BB



4.3.1.5 Satisfaction with payment methods

Respondents were asked about their level of satisfaction with their most often used payment method. Automatic bill pay had the highest level of satisfaction (94%) and lowest level of dissatisfaction (2%) across all methods (Figure 9). Other electronic bill pay methods were also rated highly with above 80% satisfaction. Respondents sending checks were the least satisfied. BB was not included in this list as it was not a stand-alone payment method per se, but a bill management option that could be combined with any of the payment methods listed here.

Figure 9: Satisfaction with payment methods

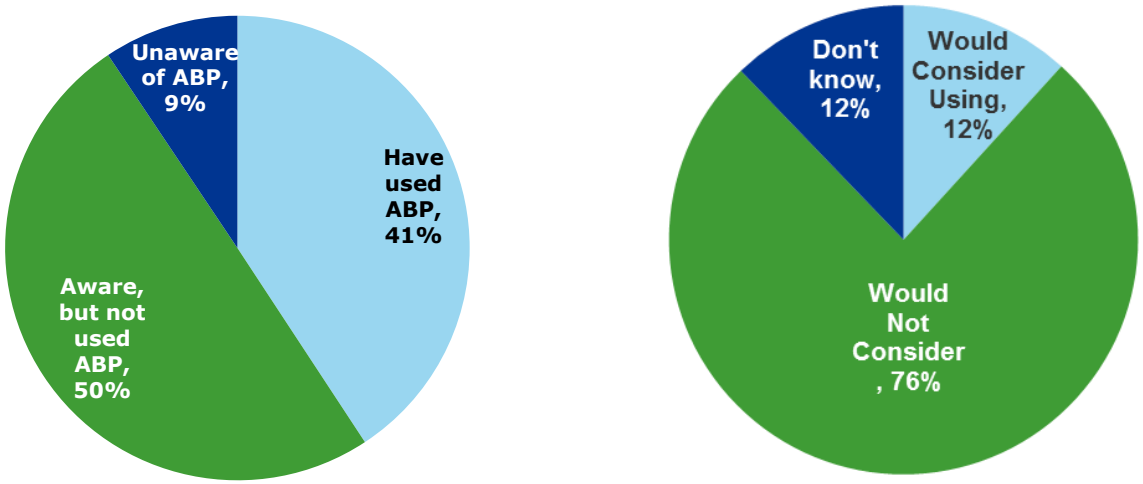


4.3.2 ABP and BB non-users

4.3.2.1 Awareness and consideration of ABP and BB among non-users

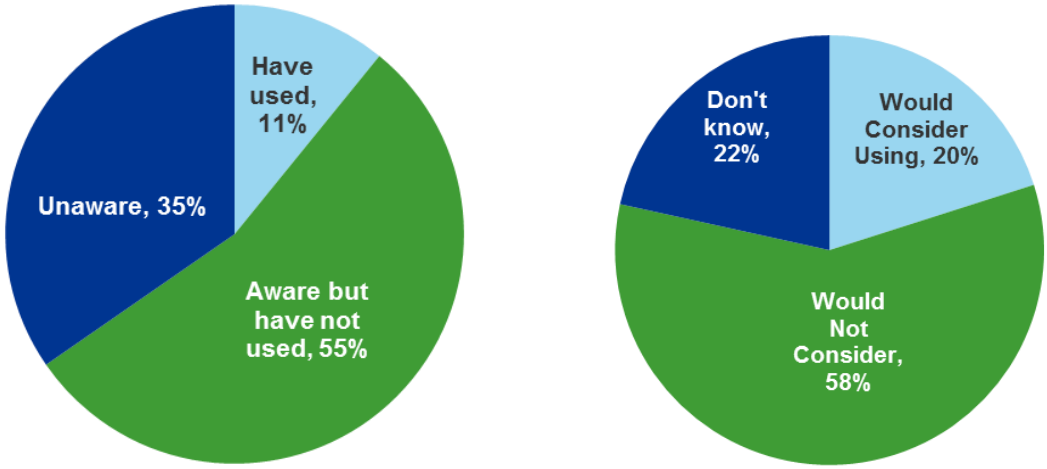
Among the nearly 60% of respondents who had not used automatic bill pay, only 16% (or 9% of all customers) were unaware of the payment method (Figure 10). Nonetheless, more than three quarters of ABP non-users (or 50% of all respondents) indicated that they would not consider using it. This suggests that lack of awareness is not the main driver of non-use of ABP, but that other factors are at play. More ABP non-users are aware of the option, and they are likely to have made an informed decision not to participate

Figure 10: Awareness of ABP and consideration of ABP among non-users



About 11% of respondents indicated using BB, 55% were aware of this payment option, but had not used it, and over one-third (35%) were unaware of BB (Figure 11). Among respondents not currently using BB, 20% indicated they would consider such a plan, 22% didn't know, and 58% stated that they would not consider using BB (Figure 11).

Figure 11: Awareness of BB and consideration of BB among non-users

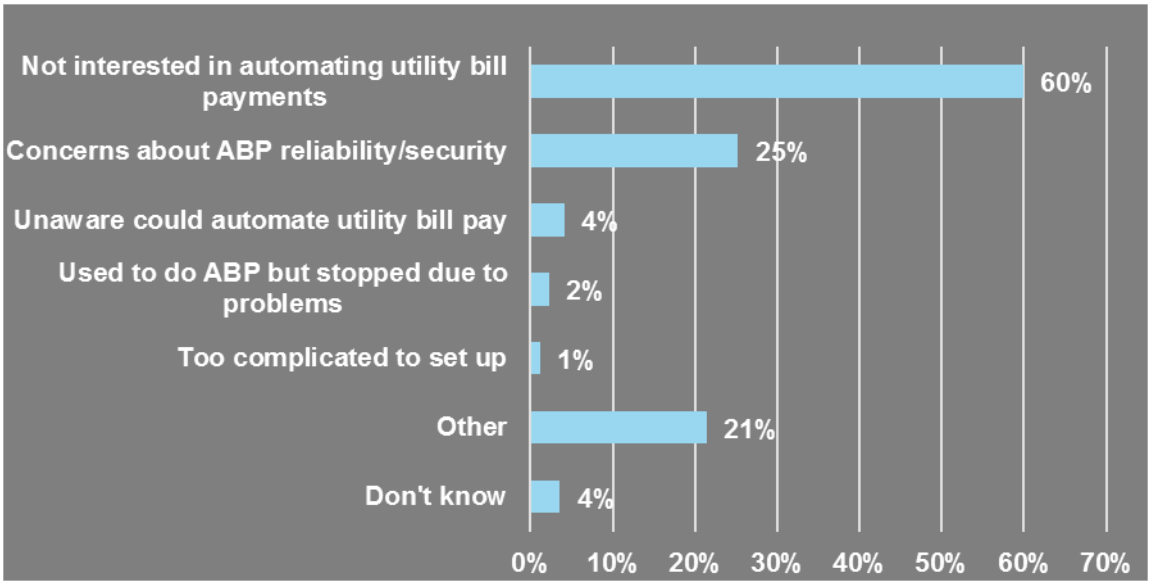


4.3.2.2 Reasons for non-use of ABP and BB

While respondents offered few concrete reasons for not using ABP, by far the most common response (60%) was simply that they were not interested in automating their utility bill payments (Figure 12). The survey did not dig into whether it was specifically their utility bill they did not want to automate, or whether they did not want to automate any bill payments. The second most common response (25%) was that they had concerns about ABP, for example its security or reliability. Other barriers cited related to control in one form

or another, such as timing or amount of payment. 5APPENDIX. B summarizes the verbatim responses provided to accompany the "other" response.

Figure 12: Barriers to using ABP



Over three-fourths of BB non-users indicated that the reason they had not enrolled/would not enroll in BB was that they preferred to pay for exactly what they used rather than an approximation.

5 CONCLUSIONS & RECOMMENDATIONS

This research provides evidence that ABP and BB programs are associated with increases in energy consumption by customers. The research also provides information on characteristics of program participants through the process evaluation. The ultimate intent of this research is to support insight on how ABP and BB may be modified to promote energy conservation. Below we propose opportunities to combine ABP and BB with other energy management technology options such as Home Energy Reports that mitigate the potential effects of ABP and BB services.

The results presented here provide further evidence to support Sexton's claim that there are consumption increases associated with participation in ABP and BB programs. Due to data constraints, our results only capture relatively short term effects, but despite this limitation we find consistent, statistically significant increases in electric consumption across two independent groups of PG&E customers. As might be expected given the shorter duration, the magnitudes of the effects that we identify are smaller than those reported by Sexton. While we replicate the spirit of Sexton's paper, we also find that the self-selection implications of the endeavour need further consideration, particularly for BB customers.

In an extension to Sexton's work, we also provide evidence that HERs at least partially claw back these increases in consumption associated with ABP or BB participation. While ABP and BB are hypothesized to decrease customers' awareness of their spending in any given month, HERs increase customers' awareness of consumption itself perhaps counteracting the loss of price salience. HERs counteracted 100% of the increased consumption associated with ABP, while reducing the much greater increases by BB customers by up to 30%.

The key recommendations from our evaluation are summarized below. These results have different implications for customers choosing to go onto the two different programs. The choice to go on ABP is based

on convenience. The customer prefers to forego that monthly hassle of paying the bill so automates the process. The effects that Sexton identifies and that we also find can be seen as a hidden cost of this service, whether tied to a loss of price salience or otherwise. Further, from a regulatory perspective, increased consumption due to loss of price salience is an unintended and possibly unnecessary side effect of the increased convenience of ABP. It would be appropriate to take action that attempts to limit the unnecessary effects of the ABP service.

These actions could include something like HERs that would help to maintain a focus on consumption level combatting loss of price salience. This analysis indicates that, at least in the short term, HER reports can fully counteract the consumption increases associated with participation in ABP.

BB, on the other hand, is a service that customers choose to even out utility payments over the year. The service directly separates consumption from its immediate price effect in terms of the utility bill that is received after a month of consumption. In this respect, during summer months, BB potentially offers a short term negative price effect. The effective cost of cooling has been substantially reduced in terms of the payment on summer bills. This could cause additional upward pressure on consumption in addition to the effect of loss of price salience. That an increase of this magnitude occurs in such a short span of time supports the possibility that more than loss of price salience is occurring.

Another way to understand the increase in consumption is that BB, by effectively lowering the immediate cost of cooling by spreading them over the full year, makes it easier for BB participants to meet their full comfort needs despite tight budgets. Both explanations flow from the same economic mechanism but put a different emphasis on the outcomes. As a result, the regulatory perspective on the BB effect may need to be more nuanced than for ABP.

In addition to receiving some type of HERs, which do address a portion of the consumption increase, HVAC program options offered to BB customers could be enhanced with additional incentives. This could facilitate BB customers meeting their comfort needs while still lowering their overall cooling consumption. It could also help target customers with substantial AC load and high potential AC savings with either a tune up or an EE unit replacement. We note that 23% of all BB customers in 2015 are also on CARE.[19] Thus, budget concerns of these customers will be partly addressed by the above energy saving recommendations.

Budget billing is currently marketed as a way for customers to have more manageable monthly payments. We found that BB use is associated with relatively lower levels of education and income in contrast with ABP use. Fewer customers reported actively searching for BB on the utility website in comparison with ABP. BB users also see a higher spike in consumption relative to ABP.

The above findings suggest a closer look at the inadvertent increase in consumption that accompanies BB use, especially given that a higher proportion of BB users have relatively lower incomes.

[19] Source: PG&E 2015 electric billing dataset

APPENDIX. A RECOMMENDATIONS

Study ID	Study Type	Study Title/Program	Study Manager
CPUC ED Res 11	Impact	Auto Bill Pay and Budget Billing Impact Evaluation – Residential	Gomathi Sadhasivan

Recommendations (Recipients – PG&E)	Summary of Findings	Additional Supporting Information	Best Practice / Recommendations
1	The choice to go on ABP is based on convenience. The customer prefers to forego that monthly hassle of paying the bill so automates the process. The effects that Sexton identifies and that we also find can be seen as a hidden cost of this service, whether tied to a loss of price salience or otherwise.	Sections 3.4.2 and 5	From a regulatory perspective, increased consumption due to loss of price salience is an unintended and possibly unnecessary side effect of the increased convenience of ABP. It would be appropriate to take action that attempts to limit the unnecessary effects of the ABP service. These actions could include something like a Home Energy Report (HER) that would help to maintain a focus on consumption level combatting loss of price salience. This analysis indicates that, at least in the short term, HERs can fully counteract the consumption increases associated with participation in ABP.
2	Customers choose BB to even out utility payments over the year. The service directly separates consumption from its immediate price effect in terms of the utility bill that is received after a month of consumption. In this respect, during summer months, BB potentially offers a short term negative price effect. The effective cost of cooling has been substantially reduced in terms of the payment on summer bills. This could cause additional upward pressure on consumption in addition to the effect of loss of price salience. That an increase of this magnitude occurs in such a short span of time supports the possibility that more than loss of price salience is occurring.	Sections 3.4.2 and 5	The regulatory perspective on the BB effect may need to be more nuanced than for ABP. In addition to receiving some type of HERs, which do address a portion of the consumption increase, HVAC program options offered to BB customers could be enhanced with additional incentives. This could facilitate BB customers meeting their comfort needs while still lowering their overall cooling consumption. It could also help target customers with substantial AC load and high potential AC savings with either a tune up or an EE unit replacement. We note that 23% of all BB customers in 2015 are also on CARE. Thus, budget concerns of these customers will be partly addressed by the above energy saving recommendations.
3	Budget billing promises customers more manageable monthly payments. We found that BB use is associated with relatively lower levels of education and income in contrast with ABP use. Fewer customers reported actively searching for BB on the utility website in comparison with ABP.	Sections 4.3.1 and 5	The above findings suggest a closer look at the inadvertent increase in consumption that accompanies BB use, especially given that a higher proportion of BB users have relatively lower incomes.

	BB users also see a higher spike in consumption relative to ABP.		

APPENDIX. B BARRIERS TO ABP USE – VERBATIMS

A selection of verbatim responses to barriers to ABP use is summarized here.

Table 14: Barriers to ABP—verbatim responses

Category	Examples
Financial control	*I like to control my money going in and out of my account.*
--General control	*I prefer the control of making payment myself*
--Monitoring, keeping tabs, review	*Want to track bill amount*
	Don't want to lose track of the bills - want to review.
--Use financial tracking system incompatible with auto pay	*Scared of change and of giving up control*
	Tracking payments in Quicken
Varying bill amount	*The bill varies, so I'd like to be able to monitor my spending*
--Monitoring changes to bill	*If its a large bill you were'nt expecting, that can cause problems for your bank account being overdrawn.*
--Overdraft concerns	*Want full control over amount of payment*
	I don't like to set up recurring payments from my chcking account when the amount varies each month
	dont trust auto bill pay because if its a large bill you wernt expecting, that can cause problems for your bank account being overdrawn.
	Not able to view bill before money is moved
Control timing of payment	*I like to control when the $ is leaving my account*
--Overdraft concerns	*Having lean financial times right now and want to control when funds leave my account*
--Paycheck timing vs. bill timing	*Not sure if funds would be there*
	Don't always have the money and have to juggle bills.
	Payroll varies each month
Prefer to use credit card	*Prefer to use credit card.*
--Consolidated payment	*I would use auto-pay via credit card.*

--Control timing of payment **--Credit card points** **--Credit card protections with respect to disputed charges**	*Don't want direct connect to my bank account. Have other utilities on autopay with credit card.* *Need to accept by credit card; I will not setup auto-pay through a checking account* *Want to get credit card points* *…unless they take VISA and I can dispute before I pay that one.*
Lack of Trust **--PG&E, specifically** **--Electronic transactions, generally**	*I dont trust you!!!!!* *PG&E are the last people I want to take automatic recurring payments from my bank account. It's called TRUST.* *I don't trust PG&E monthly bills, they cost too much* *They (PG&E) take too long to refund when they overcharge. Too hard to get customer service from them.* *I don't trust Cyber security breaches and my information saved in the cloud database.* *GLOBAL HACKING IS A PROBLEM. READ THE NEWS LATELY? [capitalization original]* *Doesn't seem secure*

APPENDIX. C SURVEY

INTRODUCTION

This survey is sponsored by the California Public Utilities Commission and supported by your utility.

The California Public Utilities Commission and your utility will use this information to help plan programs to benefit homeowners and save energy. Responses to this survey will be kept strictly confidential and reported only in the aggregate.

Please contact Peter Franzese at the California Public Utilities Commission, at Peter.Franzese@cpuc.ca.gov if you have any questions or concerns regarding this survey.

Thank you for taking the time to participate in this survey.

PAYMENT METHOD- Automatic Recurring Bill Pay

R1. Please indicate the various methods you have used to pay your utility bills. ***[, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]***

R2. Which payment method do you use most often?

	Payment methods	P1_# Have used at least once *[check all that apply]*	P2 Which payment method do you use most often? *[check one]*
1	**Electronically** – Automatically send payments each month from your bank account by setting up recurring auto bill pay		
2	**Electronically** – **Manually** authorize/send payment each month from your bank account		
3	**Electronically-Manually pay each month using**		
4	Send a check in the mail		
5	In person at a service center		
98	Don't know	T&T	T&T

R3. ***[If P2= 1,2,3,4,5]*** **How satisfied are you with this bill payment method***[P2_method selected]***?**

1. Very satisfied
2. Satisfied
3. Neutral

4. Dissatisfied
5. Very dissatisfied

98. Don't know

R4. ***[Shown if P3= 3,4,5]*** **Why do you say that?**

_____[OPEN END, RECORD RESPONSE]

R5. ***[Show if (not P1_1 or P2_1)] (electronic bill pay)]*** **Your utility offers customers the option to set up recurring automatic payments from their bank account to pay their energy bill. Before today, were you aware of this Auto Pay option?**

1. Yes
2. No

R6. ***[Show if (not P1_1 or P2_1)]*** **Would you consider setting up recurring automatic payments (Auto Pay) for your energy bill?**

1. Yes
2. No
3. Don't know

R7. ***[Show if P6 = 3, 4, 5]*** **Why do you say that?**

R8. ***[Show if P1 or P2=1]*** **What motivated you to set up recurring automatic payments (Auto Pay) for your energy bill [Check all that apply]**

1. Avoids delayed payments
2. Saves me time each month
3. Don't use paper checks any more
4. Saves on postage (cost of stamps)
5. It is more efficient for me
6. It is more efficient for the utility
7. I do this for all my recurring bills (e.g. water, cable, internet, etc.)
8. Don't know
9. Other

R9. How did you learn about the option to set up recurring automatic payments for our energy bill? balanced payment plan for your utility bill? ***[RANDOMIZE, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]***

1. I searched the utility website on how to set up BPP
2. Learned about when I was on the utility website for another reason
3. Called a customer service representative to learn more about it
4. Customer service representative told me about it
5. Bill insert promoting it
6. Friends/family/social network suggested I use it
7. Other
8. Don't know

R10. ***[Show if (not P1_1 or P2_1)]*** **Why have you not/why would you not set up recurring automatic payments for your utility bill? [CHECK ALL THAT APPLY]**

1. Didn't know I had an option to automate payments for my utility bill
2. Would like to, but it seems complicated to set it up
3. Have concerns regarding ABP (security, incorrect bill amount)
4. Used to do it, but opted out when I had a problem with in incorrect bill amount
5. Not interested in setting up automatic payments for my utility bill
6. Don't know
7. Other

R11. ***[Show if (not P1_1 or P2_1)]*** **Why have you not/ why would you not set up recurring automatic payments for your utility bill? [RANDOMIZE, CHECK ALL THAT APPLY]**

1. Didn't know about this option
2. Would like to, but it seems complicated to set it up
3. I prefer to pay for exactly what I use each month rather than an approximate average based on past use
4. Other (specify)
   98. Don't know

PAYMENT METHOD-Balanced Bill Pay

R12. **Your utility offers customers a bill pay option called a Balanced Payment Plan. This payment plan allows customers to pay the same amount each month on their utility bills. The utility averages the annual energy costs over a 12-month period to determine what the monthly payment amount should be. The payment amount is adjusted once every 4 months if the actual energy usage has significantly changed. Before today, were you aware of this balanced payment plan (also referred to as budget billing/level pay**)?

1. Yes, I already have it
2. Yes, I was aware of it but have not used it
3. No, I was unaware of this option

R13. ***[Show if P12_1]*** **What motivated you to enroll in the utility's Balanced Payment Plan? [CHECK ALL THAT APPLY]**

1. It is more predictable (no big spikes on my bills, can manage costs better)
2. Easy no cost enrollment
3. Can start or end program participation at any time
4. It is more efficient for the utility
5. Don't know
6. Other

R14. ***[Show if P12 is 1 or 2]*** **How did you learn about the Balanced Payment Plan?** ***[RANDOMIZE, CHECK ALL THAT APPLY]***

1. Searched the utility website on how to set up a balanced bill plan
2. Learned about BPP when I was on the utility website for another reason
3. Called a customer service representative to learn more about BPP
4. Customer service representative told me about BPP
5. Bill insert promoting BPP

6. Friends/family/social network suggested I use BPP
7. Other (specify)
98. Don't know

R15. ***[Shown if P12 is 2 or 3]*** **Would you consider enrolling in a Balanced Payment Plan for your energy bill?**

1. Yes
2. No
3.Don't know

R16. ***[Shown if P15 is 2 or 3]*** **Why have you not/why would you not set up the Balanced Payment Plan for your utility bill?** ***[RANDOMIZE, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]***

1. Didn't know about this option
2. Would like to, but it seems complicated to set it up
3. I prefer to pay for exactly what I use each month rather than an approximate average based on past use
4. Other (specify)
Don't know

PRICE SALIENCE

PR1. **Do you review your monthly utility bill for the amount you owe?**

1. Yes, regularly/without fail each month [continue to PR2]
2. Yes, occasionally/a couple times a year [continue to PR2]
3. No [Skip to section 5. Household]
4. Don't know [Skip to section 5. Household]

PR2. **About how much is your monthly (gas and electric) utility bill? Your best estimate is fine.**

Bill amount ($)	**PR2a. Highest monthly bill**	**PR2b. Lowest monthly bill**	**PR2c. Average/typical monthly bill**

PR3. **On average, would you say your monthly bill has increased, decreased, or largely stayed the same this year relative to previous year(s)?**

1. Increased
2. Decreased
3. Stayed the same ***[GO TO CH1]***

98. Don't know *[GO TO CH1]*

PR4. *[Show if PR3=1 ,2]* **On average, about what percent has your monthly bill <PR3> by? Your best estimate is fine.**

<PR3> by _____ % *[RECORD RESPONSE, %]*

PR5. *[Show if PR3=1 ,2]* **Would you say your bill changed…?**

1. Mostly in the summer months/cooling season
2. Mostly in the winter months/heating season
3. Both in summer and winter months/both heating and cooling season

98. Don't know

HOUSEHOLD CHANGES

CH1. Which of the following changes, in terms of your energy usage, if any, have you made in your home in the last year? If no changes made, scroll down and select the "No changes made" option. *[CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]*

Lighting	Using **more lighting**	Using **less lighting**
Cooling	Cooling **additional areas** in your home	Cooling **fewer areas** in your home
	Using **more cooling** in your home (i.e. turn down thermostat set-point in summer)	Using **less cooling** in your home (i.e. turn up thermostat set-point in summer)
Heating	Heating **additional areas** in your home	Heating **fewer areas** in your home
	Using **more heating** in your home (i.e turn up thermostat set-point in winter)	Using **less heating** in your home (i.e. turn down thermostat set-point in winter)
HVAC system	Had quality maintenance performed on existing HVAC system	
Water Use	Using **more** hot water (added a bathroom, upgraded to a spa bathroom to have multiple shower heads/water jets, doing more laundry etc.)	Using **less** hot water (washing in cold water, using low-flow showerheads, using faucet aerators, upgrading washing machine, upgrading water heater etc.)
Water Heater	Turned down the temperature on the water heater	
Laundry	Washing laundry in cold water	
	Line drying laundry	
Pool	Heat pool more	Heat pool less
Pool pump	Schedule pool pump to run more	Schedule pool pump to run less
Spa	Heat spa more	Heat spa less
Occupancy	Occupied your home for **more days in the year** compared to previous years	Occupied your home for **fewer days in the year** compared to previous years
	More people living in the home	**Fewer people** living in the home
No changes		

CH2. Which of the following changes, in terms of your <u>fixtures, appliances, and home's structure</u>, have you made completed in the last year? If none, please scroll down and select the "No changes made" option. ***[CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]***

Lighting	Purchased and installed energy efficient bulbs such as LED bulbs		
Programmable Thermostat	Installed a programmable or learning/smart thermostat (e.g. Nest or Ecobee)		
HVAC system change	Replaced old HVAC system with new system		
Refrigerator	Bought new **and kept running the old one** (in garage/basement)	Bought a new refrigerator and **got rid of old one**	**Got rid of an extra one** that had been in use
New Appliances	Bought/installed new energy efficient/energy star appliances (ex: dishwasher, clothes washer, clothes dryer)		
Water Heater	Bought/installed new water heater		
Pool	Added a pool	Eliminated/stopped using your pool	
Spa	Added a spa	Eliminated/stopped using your spa	
Windows	Upgraded your windows		
Insulation	Added insulation (floor, attic, or ceiling) to your home		
Solar Panels	Added a solar PV system to your home		
Electric Vehicle	Acquired an EV and began charging it in your home		
Living space	**Increased living area/square footage** of your home (finished basement to add media room or bedroom, for example)	**Decreased living area/square footage** of your home (converted a bedroom to a store room, for example)	
Energy Management	Installed a home automation system or home energy management system (e.g. Amazon's Echo/Alexa or Apple's Home Kit)		
No changes			

SEGMENTATION ITEMS

HH1. Which of the following do you have in your home?

1	Programmable thermostats
2	Motion detectors for your lights
3	Vent in your attic area to keep the attic cooler
4	Ceiling fans
5	None of the above

HH2. Have you heard of a carbon footprint?

1. Yes
2. No
98. Don't know

HH3. Please indicate your level of agreement with the following statements:

a. I compare prices of at least a few brands

b. I do not feel responsible for conserving energy because my personal contribution is very small (record response, slider)

1. Strongly Disagree
2. Disagree.
3. No opinion.
4. Agree.
5. Strongly Agree
98. Don't know

HH4. Which of the following is the ONE reason that would motivate you to save energy? CHECK ONE.

1. Saving money
2. Maintaining health
3. Protecting the environment
4. For the benefit of future generations
5. Reducing our dependence on foreign oil
6. Helping California lead the way on saving energy

TECHNOLOGY USE

T1. Which of the following electronic devices do you own? ***[RANDOMIZE, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]***

1. Smartphone
2. Cell phone
3. Tablet (e.g. iPad)
4. eBook Reader (e.g. Kindle)
5. Laptop computer
6. Desktop computer
7. Television
8. Gaming device (e.g.Playstation, Wii, PS4 etc.)
9. None of the above **[EXCLUSIVE]**

[ASK IF T1=01-03]

T2. Which of the following types of apps do you use? ***[RANDOMIZE, CHECK ALL THAT APPLY, CODE =1 if checked, =0 otherwise]*.** [RANDOMIZE 01-06]

1. Transportation (For example: Uber, Lyft, Via, etc.)
2. Navigation (For example: Waze, Google Maps, Apple Maps, etc.)
3. Social Media (For example: Facebook, Instagram, Snapchat, etc.)
4. Restaurant Reviews (For example: Yelp, Foursquare, Urbanspoon, etc.)
5. Banking and Finances (For example: Venmo, PayPal, Wells Fargo Mobile, etc.)
6. Location Sharing Apps (For example: Swarm, Find My Friends, etc.)
7. None of the above **[EXCLUSIVE]**
8. I do not use any apps **[EXCLUSIVE]**

RESPONDENT AND HOUSEHOLD CHARACTERISTICS

My last questions are used for statistical purposes only. All individual information is kept **completely confidential.**

HH1. What year was your home built?

[SINGLE RESPONSE]

1. Before the 1970s
2. 1970s
3. 1980s
4. 1990-1994
5. 1994-1999
6. 2000s
7. 2010s

98. Don't know

HH2. Has your home been remodeled?

1. Yes
2. No
3. Don't know

HH3. ***[Show if HH2 is 1]*** **When did this remodel occur? If your home has been remodeled more than once, please check all that apply.**

1. Before 1970s
2. 1970-1979
3. 1980-1989
4. 1990-1994
5. 1995-1999
6. 2000-2009
7. 2010 or after
8. Don't know

HH4. How long have you lived at this home (in years)? _____

HH5. Do you own or rent your home?

1. Own
2. Rent

HH6. How many bedrooms are there in your home?

[SINGLE RESPONSE]
1. Studio
2. 1
3. 2
4. 3
5. 4 or more

HH7. Roughly, how large is your home (in square feet)? _____

HH8. What is the highest level of education that you have completed?
1. Some high school or less
2. Graduated high school
3. Trade or technical school
4. Some college
5. College graduate
6. Post graduate work or degree
98. Prefer not to answer

HH9. How many people, including yourself, live in this home year-around?
[SINGLE RESPONSE]
1. 1
2. 2
3. 3
4. 4
5. 5
6. 6 or more
7. Prefer not to answer

HH10. Which of the following categories best describes your family's total household income in 2016 before taxes?
[SINGLE RESPONSE]
1. Under $25,000
2. $25,000 to under $50,000
3. $50,000 to under $75,000
4. $75,000 to under $100,000
5. $100,000 to under $150,000
6. $150,000 to under $200,000
7. $200,000 or more
8 Prefer not to say

APPENDIX. D RESPONSE TO PUBLIC COMMENTS MATRIX

Commenter	Page Number (as shown in Word document footer)	Comment	DNV GL Response
PG&E	Sect. 1.4, 1.5, 3.4.2, 5	PG&E requests that the report be updated to discuss in more depth the possibly implications of the self-selection bias associated with opt-in services like ABP and BB. Figures 2 and 3 highlight the fact that ABP and BB enrollees have different levels and patterns of usage throughout the year compared to non-enrollees, and these differences must be considered when trying to interpret the findings of this analysis. PG&E proposes that it would be more appropriate to discuss "associations" between ABP and BB and increased consumption, rather than stating that use of ABP/BB "result in" or "lead to" an increase.	Report has been updated.
PG&E	N/A	Is there any further analysis that DNV-GL can do with the study data to better understand the summer AC needs/patterns of BB participants, and to gain insight into how much of their increased consumption is driven by lowered price salience vs. the ability to cool to comfort by spreading the cost beyond the cooling season?	We undertook analysis by climate zone (inland vs coastal) to examine this further. The association between BB and consumption was similar across these two zones, which suggests that AC needs of BB customers is not the only factor that affects this relationship. This is despite differing load shapes of BB enrollees in these two climate areas (flatter coastal and peakier inland). We would need further research to identify the climate dependence of BB on consumption conclusively.

Commenter	Page Number (as shown in Word document footer)	Comment	DNV GL Response
PG&E	N/A	Given the diversity of climates across PG&E's territory, we look forward to DNV-GL's gas analysis to provide a more complete picture of how HVAC consumption and BB participation are related. For example, the differences between customers enrolling in BB to avoid single-season peak bills, and those enrolling to avoid two-season peak bills (of gas and electric), would be an important consideration in terms of messaging or marketing.	Noted.
PG&E	Recommendation 2	For your information, marketing of PG&E's ACQC program already targets the highest HVAC users.	Noted.
PG&E	Figure 6	We recognize the uncertainty associated with any self-report responses but feel it is important to point out that the approx. 43% of BB participants who indicated finding out about the service through a bill insert are mistaken - only in 2017 has PG&E started marketing BB through bill inserts.	Noted. Report has been updated.

Commenter	Page Number (as shown in Word document footer)	Comment	DNV GL Response
PG&E	General	There is a broader context to BB, and to price salience, than is described in the current draft report - and this context is needed for a more comprehensive understanding of this service. BB was first set up in 1982 in response to a CPUC Resolution and was designed to minimize monthly bill variation. BB updates every 4 months based on the previous 12 months of usage, so it can most accurately reflect recent usage and can adjust if that usage is higher or lower than was expected and calculated in the balanced amount. This 4-monthly update means that usage that is higher than expected would trigger an increase in the monthly bill amount, and this increase would serve as a price signal. In terms of targeted marketing, PG&E uses a propensity model to target communications to the customers who would benefit the most from the program. The propensity model looks at things like total bill amount, bill volatility and geography and suppresses customers with credit exclusions or those on non-compatible programs. PG&E marketing of BB is closely monitored in terms of customer segments, enrollment, de-enrollment, customer experience, and customer satisfaction. Panels are used to gather feedback on BB marketing messages and graphics, to ensure they are clear and informative as to how the service works and how it can benefit customers with high seasonal bill variation. If it would be useful, PG&E EM&V can arrange for a meeting between the Evaluators and PG&E marketing to ensure full understanding of the service, its marketing, and the data that is collected regarding customer enrollment, motivation, and satisfaction. The latter might be particularly useful to understand where the data aligns, and does not (per comment 5 above), with the survey responses collected as part of this study.	This report describes the program features per PG&E's website. What is shared in this comment does not contradict the contents of the report. This report makes a note of the fact that users of BB might not be aware of the inadvertent increase associated with use of BB.
PG&E	Fig 5 and Rec 3	Please can you indicate your definition of "low income"? Is it below $75k/yr, as shown in Figure 5?	Yes. We mean relatively "lower-income" (below $75k a year). Text has been updated to reflect this.

Commenter	Page Number (as shown in Word document footer)	Comment	DNV GL Response
SDG&E	Overarching Comments	This study provides an important contribution to understanding households' response to the billing information. Households typically receive monthly electricity bills, where all electricity use throughout the month is lumped together. The lack of direct and more frequent feedback mechanism, consumers often have difficulties to close the gap between price (or cost of electricity use) and actual behavior. They often have difficulties associating the price with particular action or investment. Some of the studies have already shown that people often don't pay much attention to their billing information. The consumption of electricity consuming services is salient to residential households, consumption of kWh or costs may not be. People often do not capture the actual cost of billing information, but rely on perceived information or biased cost perceptions (See Shin 1985, Ito 2014, Keefer and Rustamov 2017). This shows the acuteness of the inattention problem. Besides some technical comments, which we believe could be constructive; we must applaud the fact this report delves in investigating such an important area and subject.	Thank you.
SDG&E	Overarching Comments	Possible improvements and More Technical Comments: The design mechanism and self-selection issue require going beyond the pooled fixed effect analysis (1). That is these ABP and BB households are inherently different from non-participant. It appears that an ABP group is avoiding the information (2), and BB group is delaying to receive the true cost of their behavior (3). • The study doesn't show how they address or attempt to mitigate the selection bias, which is often the issue with observational studies. There are alternative approaches in the literature, i.e., variety of matching or/and difference-in-difference matching methods (see Imbens and Rubin, 2015, Morgan 2016). However, matching with non-participants does not mitigate the selection issue or reduce the overestimation. Thus, suggested application is	These are good points and given that this is a proof of concept/Phase 1 study, it is something we would like to explore in future research. However, we note here that while matching with future participants addresses some part of the self-selection issue, the noted increases in consumption associated with these payment plans reflect the confounding of the choice to participate based on inherent characteristics (non-observable and possibly non-measurable) and loss of price salience. Detangling these confounded effects requires the use

Commenter	Page Number (as shown in Word document footer)	Comment	DNV GL Response
		matching with non-participants but with future/later participants (see Sianesi 2004, 2008). • After matching, the report can also provide us the balance diagnostics, which would show the distribution difference between treatment and control groups before and after matching (Austin, 2011). • Report's explanation about selection issue falls short. For instance, in UAT, people are actively seeking information to correct their behavior and understand their shortcomings. And here, people are actively choosing to avoid information or delaying the true cost of the electricity use. However, methodologically we are treating UAT differently, and we put strong emphasis on selection issue. We are curious why we are not doing the same here i.e., not providing enough recognition to the active participation. • Also, it would have been interesting to evaluate not only the mean effect of the programs, but also distributional (heterogeneous treatment effects) effects as well, i.e., how lower tail or upper tails of the distributions respond to the treatment. This is could also be important for the targeting purposes as well. • I think the report can further look into "information avoidance" literature in behavioral economics. I think this could provide further explanation for results.	of special modeling beyond matching. (See, Goldberg et al. Upcoming IEPEC 2017 paper titled "Not Just Another Pretty Formula: Practical Methods for Mitigating Self-Selection Bias in Billing Analysis Regressions.").
SDG&E	Overarching Comments	We believe designing a survey is an important contribution of the study, which reveals interesting responses by the customers. Would it be possible to match the survey responders with their own usage data? We know that the sample size of the survey responders is relatively smaller, however, maybe there could be some additional lessons could be learned.	These are good points and out of scope for the current phase of the work.

About DNV GL

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