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BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of PACIFIC GAS AND ELECTRIC COMPANY for Authority to Increase Revenue Requirements to Recover the Costs to Upgrade Its SmartMeter™ Program (U 39 E)	Application No. 07-12-009 (Filed December 12, 2007)

COMPLIANCE FILING OF PACIFIC GAS AND ELECTRIC COMPANY (U 39 E) PURSUANT TO DECISION 09-03-026

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April 29, 2016

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COMPLIANCE FILING OF
PACIFIC GAS AND ELECTRIC COMPANY (U 39 E)
PURSUANT TO DECISION 09-03-026

Pursuant to Ordering Paragraph 10 of Decision (D.) 09-03-026, Pacific Gas and Electric Company (PG&E) hereby files its 2015 Program Year SmartMeter™ Program Enabled Demand Response and Energy Conservation Annual Report and its SmartMeter™ Enabled Programs Program Year 2015 Evaluation of Customer Web Presentment and Energy Alerts. As directed in Ordering Paragraph 10, PG&E's reports address the energy savings and associated financial benefits of all demand response, load control, and conservation programs enabled by PG&E's SmartMeter™. The reports are due in April of each year until 2019.

PG&E's 2015 Program Year SmartMeter ™ Program Enabled Demand Response and Energy Conservation Annual Report is provided as Attachment A. PG&E's SmartMeter™ Enabled Programs Program Year 2015 Evaluation of Customer Web Presentment and Energy Alerts is provided as Attachment B.

Respectfully submitted,

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ATTACHMENT A

PG&E's 2015 Program Year SmartMeter™ Program Enabled Demand Response and Energy Conservation Annual Report

PG&E 2015 PROGRAM YEAR SMARTMETER™ PROGRAM ENABLED DEMAND RESPONSE AND ENERGY CONSERVATION ANNUAL REPORT

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April 29, 2016

ABSTRACT

Pursuant to Ordering Paragraph 10 of Pacific Gas and Electric Company's (PG&E) SmartMeter Upgrade Decision (D.09-03-026), PG&E has prepared this report to provide a review of PG&E's program year 2015 ex post load impacts, energy conservation and financial benefits for the dynamic pricing, demand response and energy conservation programs and initiatives enabled by PG&E's SmartMeter™ program. The report provides a description of each program as well as the methodology adopted to estimate the load impacts, energy savings and associated financial benefits.

In 2015, PG&E operated the following SmartMeter enabled programs or initiatives: SmartRate™ and Peak Day Pricing (PDP), which are dynamic pricing programs designed to provide load response to pricing signals; Time of Use (TOU), which is a time varying program; and Customer Web Presentment (CWP), Energy Alerts, Bill Forecast, Home and Business Energy Reports, and Home and Business Area Network (HAN), which are energy conservation initiatives based on or enhanced by customer access to energy usage information. With methodologies evolving and more data becoming available in the future, more definitive findings can be expected in future Demand Response and Energy Conservation Reports under Ordering Paragraph 10 of D.09-03-026.

CONTENTS

LIST OF TABLES

INTRODUCTION

This report documents program year 2015 (PY 2015) ex post load impacts, energy conservation, and financial benefits for the PG&E SmartMeter™ enabled dynamic pricing, demand response (DR) and energy conservation programs and initiatives. It has been prepared pursuant to Ordering Paragraph 10 of PG&E's SmartMeter Upgrade Decision (D.09-03-026), which requires PG&E to report to the California Public Utilities Commission (CPUC):

> "…the energy savings and associated financial benefits of all demand response, load control, energy efficiency, and conservation programs enabled by advanced metering infrastructure (AMI), including programmable communicating thermostat (PCT) programs, Peak Time Rebate (PTR) programs, and other dynamic rates for residential customers."[1]

The demand response impacts contained herein are estimated in compliance with the Commission's adopted load impact protocols contained in Decision 08-04-050.[2]

[1] Ordering Paragraph 10, SmartMeter Upgrade Decision (D.09-03-026), page 196.
[2] Decision 08-04-050. Decision Adopting Protocols for Estimating Demand Response Load Impacts. April 24, 2008.

PROGRAM OVERVIEW

There were two categories of SmartMeter™ enabled programs and initiatives in operation during PY 2015. These are described below:

Demand Response and Dynamic Pricing (or Time Varying) Programs: These include SmartRate™, a residential Critical Peak Pricing (CPP) program; Peak Day Pricing (PDP), a non-residential Critical Peak Pricing program; and residential and non-residential Time-of-Use (TOU) rates.

Informational Energy Conservation Programs/Initiatives: These include Energy Alerts, Customer Web Presentment (CWP) of interval data, Home and Business Area Network (HAN), Bill Forecast, Home Energy Reports and Business Energy Reports.

2.1 SMARTMETER ENABLED DEMAND RESPONSE AND DYNAMIC PRICING PROGRAMS

2.1.1 SmartRate – Residential Critical Peak Pricing (CPP)

The SmartRate pricing structure is an overlay on top of PG&E's residential rate schedules. SmartRate pricing consists of an incremental charge that applies during the peak period on SmartDays™ and a per kilowatt-hour credit that applies for all other hours from June through September. For residential customers, the additional peak-period charge on SmartDays is 60¢/kWh, and applies between 2:00 pm and 7:00 pm. In return, SmartRate customers receive credits on non-peak usage from June through September. A credit of $0.024 per-kWh applies to all usage other than peak-period usage on SmartRate event days. For all SmartRate customers not on E-TOU-B, an additional credit of $0.0075 per-kWh applies to usage above 100% of customers' baseline allocation, regardless of time period. For E-TOU-B customers, an additional credit of $0.005 per-kWh applies to all usage, regardless of time period. Up to fifteen SmartDays can be called year round during non-holiday weekdays.

SmartRate customers are also allowed to enroll in PG&E's SmartAC™ program, which is an air conditioning load control program. For dually enrolled customers, PG&E automatically cycles their air conditioning systems during SmartDay events by controlling their SmartAC devices. Customers can choose to opt-out of the automatic AC cycling, but that requires action on their part. Based on the results of this and previous studies, this dual enrollment option increases load reductions for those customers during the SmartDay peak periods.

PG&E began offering the SmartRate program in May 2008 to residential and small and medium commercial customers with SmartMeters in the Bakersfield and greater Kern County area. Pursuant to CPUC Decision 10-02-032 (Peak Day Pricing Decision), SmartRate's small and medium commercial customers were transitioned to PG&E's non-residential PDP program on May 1, 2010.[3] The details of this transition are discussed in the Non-Residential PDP section that follows.

On January 14, 2011, PG&E filed a Petition for Modification of Decision 10-02-032 (PFM) and proposed a new timetable for transitioning customers to time-varying rates, including both residential and non-residential PDP. PG&E proposed the elimination of the requirement to implement a new residential PDP rate by November 1, 2011 and requested that SmartRate be retained as an option for residential customers until residential dynamic pricing options are considered again by the Commission. PG&E also proposed that the timing of default enrollment

[3] CPUC Decision 10-02-032. Decision on Peak Day Pricing for Pacific Gas and Electric Company. February 25, 2010 (Issued March 2, 2010). Page 10.

of residential customers onto time-varying rates be addressed in the PTR and Default Residential Rate Program applications (A.10-02-028 and A.10-08-008).[4]

On November 10, 2011, the CPUC issued a decision (D. 11-11-008) granting PG&E's PFM, with some exceptions.[5] Importantly, the CPUC granted "PG&E's proposal to eliminate the requirement to implement a new residential PDP rate, and, instead, to retain SmartRate™ as an option for residential customers until the Commission completes its pending review of default residential dynamic pricing rates in Application 10-08-005."[6] Subsequently the Commission has transferred its review of default residential rates to R.12-06-013, "Order Instituting Rulemaking on the Commission's Own Motion to Conduct a Comprehensive Examination of Investor Owned Electric Utilities' Residential Rate Structures, the Transition to Time Varying and Dynamic Rates, and Other Statutory Obligations." In July 2015, the CPUC formally adopted D. 15-07-001, which retained SmartRate with minor modifications to the participation credit structure to preserve revenue neutrality in light of the tier collapse approved in the same decision.

Approximately 25,000 customers dropped out of SmartRate over the period of analysis (October 2014 through September 2015), but 30,000 new customers enrolled, resulting in about 5,000 net new customers[7]. The total number of SmartRate-only customers has increased from approximately 83,000 and 89,000 in 2013 and 2014, to over 92,000 for the average event in 2015. The number of dually-enrolled customers has fallen somewhat, from approximately 38,300 in 2013 and 40,300 in 2014, to about 36,600 in 2015.[8,9] Fifteen events were called in 2015.

2.1.2 Peak Day Pricing – Non-Residential Critical Peak Pricing (CPP)

Peak Day Pricing[10] (PDP) is a CPP overlay on top of non-residential time-of-use rates. PDP's price signals are designed to encourage customers to reduce peak load during event days, which are typically temperature triggered, but can also be called for high market prices or extreme system conditions. Under the PDP tariff, PG&E targets a minimum of 9 and a maximum of 15 event days per year. On event days, PDP customers face higher charges for energy used during one of two on-peak periods: 2 PM to 6 PM or Noon to 6 PM. Events can be called seven days a week, all year-round. In return for the higher rates during event days, customers receive either per unit energy credits, capacity credits or both between May 1 and October 31, depending on their associated rate schedule. The adopted event-period price adder for customers varies by rate. For example, the CPP event-period adder is $0.60/kWh for the A-1 rate, $0.90/kWh for the A-10 rate, and $1.20/kWh for the E-19 and E-20 rates.

Pursuant to the CPUC's February 2010 PDP Decision (D.10-02-032), in May 2010, PG&E began defaulting large commercial and industrial customers (≥200 kW) that have met the eligibility criteria onto PDP.[11] PG&E provides bill protection during the first year on PDP to encourage customers to try it without risk.[12] The defaulted large customers have the ability to stay enrolled or opt-out by choosing the rate that works best for them. At the same time in May 2010, PG&E

[4] Application 09-02-022. Petition of Pacific Gas and Electric Company for Modification of Decision 10-02-032. January 14, 2011; Pg. 19.
[5] CPUC Decision 11-11-008. Decision Granting in Part and Denying in Part Petitions for Modification of Decision 10-02-032. November 10, 2011.
[6] Ibid, page 3-4.
[7] To be consistent, the enrollment figures for the DR and Dynamic Pricing programs included in this report have been taken from each program's load impact evaluation reports filed on April 1, 2016. These figures reflect the enrollment numbers for the program for PY 2015.
[8] Since SmartAC is not a SmartMeter enabled program, only the impacts for singly enrolled SmartRate participants are reported in Chapter 4.
[9] PG&E submitted its load impact analysis for SmartRate™ on April 1, 2016 in R.13-09-011. The title is *2015 Load Impact Evaluation of Pacific Gas and Electric Company's Residential Time-based Pricing Programs*.
[10] To be eligible for PDP, customers must have an interval meter with interval data, which does not have to be a SmartMeter. However, this report only includes the load reduction and energy savings of the customers with a SmartMeter.
[11] To be eligible for default as a large customer, bundled customers must have 12 months of valid interval electricity data, three consecutive months of peak demand of at least 200 kW, access to their interval data for at least 45 days and receive electricity service on an applicable tariff and may not be direct access, net-energy metered or participating in specific demand response programs. The default criteria for other customer classes (i.e. small and medium business as well as large agricultural customers with demand > 200kW) can change to reflect the appropriate minimum demand level and transition dates as ordered in D.10-02-032.
[12] Bill protection allows customers to try the PDP program risk free for one year. If at the conclusion of the first year on PDP, the customer's cumulative charges under PDP are higher than they would have been under their otherwise applicable tariff, they receive a bill credit for the difference.

was also required to both transition all existing non-residential SmartRate™ customers to PDP and make the rate available on a voluntary basis to small and medium agricultural, commercial and industrial (C&I) customers with SmartMeter™ that are interval-billed enabled.

On November 10, 2011, the CPUC issued a decision (D. 11-11-008) granting PG&E's Petition for Modification, with some exceptions. In this decision, the CPUC ordered that beginning March 1, 2013, PG&E's small and medium agricultural customers that have access to at least 12 months of interval billing data will default to mandatory TOU.[13] The decision also stipulated that small and medium business customers who have had interval-billed electric SmartMeters for at least 12 months default to mandatory TOU rates beginning November 1, 2012. Subsequently, once these small and medium business customers had at least 24 months experience on TOU rates, PG&E defaulted them to opt-out PDP rates beginning November 1, 2014. Small and medium agriculture customers are not automatically transitioning to PDP, but the rate option is available to them. As with the large customers, all of the small and medium non-residential customers on PDP are safeguarded by twelve months of bill protection.

In November of 2015 a large group of SMB customers defaulted onto PDP. PG&E estimates that approximately 33,118 medium and 184,027 small customers will remain on the rate at the start of 2016.

During 2015, most active PDP customers had been defaulted onto PDP from a pre-existing TOU rate. The PY 2015 evaluation report focused both on these defaulted customers and the customers who opted in.[14] Defaulted customers include large C&I customers, some of which enrolled in the legacy voluntary CPP program prior to the default in 2010 or were defaulted to CPP and remained on CPP even though their load dropped below 200 kW. The average number of large C&I default CPP customers participating in the 15 events in 2015 was 2,093. The number of SMB defaulted customers who remained enrolled in 2015 was 148,782, on average, during the year. There were also 11,348 small and medium business customers that opted into PDP voluntarily, most of whom enrolled in response one of PG&E's targeted early enrollment campaigns.

2.1.3 Residential and Non-Residential Time-Of-Use (TOU) Rates

PG&E has had TOU rates in place for many years for both residential and non-residential customers. Schedules E-6 and E-7 are residential TOU rates.[15] E-7 is a two-period, five-tier schedule, closed to new enrollment since 2006. It was replaced by E-6, which is a three-period, four-tier TOU rate. Prices during peak periods are substantially higher than during off-peak periods, particularly during summer months (May-October), encouraging customers to shift electricity use away from peak hours.

In 2015 the California Public Utilities Commission (CPUC) passed D. 15-07-001, which approved the full closure of E-7, the closure of E-6 to new enrollment, and the establishment of E-TOU-A and E-TOU-B, two new residential TOU rates featuring pricing structures that are simpler and more closely aligned with the cost of service. PG&E began offering these two optional rates beginning in 2016. Customers currently on E-6 will be allowed to remain on the rate until its complete closure in 2022. Customers on E-7 will be defaulted to the new E-TOU-A rate, but will be given the option of moving to any other available rate for which they are eligible.

For purposes of the load impact evaluation, PG&E's current residential TOU customers are classified into three categories:

1. Non-NEM E-6 incremental (newly enrolled customers who signed up for E-6 between October 2014 and September 2015, and whose load impacts are therefore new, or incremental in 2015);

[13] CPUC Decision 11-11-008. Decision Granting in Part and Denying in Part Petitions for Modification of Decision 10-02-032. November 10, 2011, page 3

[14] *2015 Load Impact Evaluation of California's Statewide Non-residential Critical Peak Pricing Program,* Nexant: 2016.

[15] Rate schedules EL-6 and EL-7 are Residential Care Program Time-Of-Use Service rates for single-family dwellings where the Applicant qualifies for California Alternate Rates for Energy (CARE) program.

2. Non-NEM E-6 and E-7 embedded (those customers who enrolled in E-6 or E-7 prior to October 2014, and whose load impacts are therefore already embedded in their 2015 loads); and
3. E-6 and E-7 NEM (customers who have signed up for either of the TOU rates and for net energy metering).

The load impact evaluation excluded the impacts of net-metered customers. Therefore, the 2015 ex post evaluation just considers the 7,762 E-6 Embedded customers, the 6,469 E-6 incremental customers and the 47,777 E-7 Embedded customers.

As discussed in the previous section, TOU rates became mandatory for small and medium business customers starting in November 2012[16] for customers meeting default eligibility, although customers could have voluntarily enrolled on those tariffs prior to the default date. Beginning November 2014, small and medium business customers who were previously on a TOU rate for at least two years started being enrolled onto opt-out PDP. Some of the TOU rates have both time varying energy and demand charges. Both types of charges provide customers an incentive to reduce demand during peak hours and shift their consumption.

PG&E has been transitioning small and medium business (SMB) and agricultural customers to mandatory TOU rates since 2012, with cohorts of approximately 225,000 SMB customers transitioned in November 2012, and 144,000 in November 2013. Similarly, cohorts of 17,500 agricultural customer accounts were transitioned in March of 2013. The Load Impact study concerns customers transitioned to TOU rates in November 2014 and March 2015, of which there were 61,000 SMB and 8,300 agricultural customers.

2.1.4 Programmable Communicating Thermostat (PCT) Program

In A.07-12-009, PG&E assumed the new Title 24 building code air conditioning standards, which included PCTs, would be effective in 2012. The Title 24-compliant PCTs, whether installed by third parties or customers, would have been available for enrollment in a PG&E direct load control program. However, shortly after PG&E submitted the application, the California Energy Commission withdrew its Title 24 building code air conditioning standards recommendation and the plans for a PCT direct load control program were put on hold. PCTs have not been incorporated as a mandatory measure into 2013 Title 24 and subsequently, PG&E will continue to monitor the market and assess opportunities for PCTs in load control programs.

2.1.5 Peak Time Rebate (PTR) Program

In A.10-02-028, PG&E filed a proposal for a two-part PTR (with and without enabling technology) in compliance with D.09-03-026, which addressed PG&E's application for approval of its proposed SmartMeter™ Program Upgrade (A.07-12-009). This original proposal requested a staged rollout of PTR to eligible customers beginning on May 1, 2011. PG&E filed updated testimony on October 28, 2011[17] proposing a two-year staged rollout of the PTR program with May 1, 2013 as the earliest possible start date. This schedule assumed that the Commission would issue a final decision in September 2012.

Meanwhile, after both San Diego Gas and Electric (SDG&E) and Southern California Edison (SCE) rolled out default PTR in 2012, disappointing results reported in 2013 caused the CPUC (in D.13-07-003) to direct these two utilities to revise their PTR programs from default to opt-in programs. On November 1, 2013, PG&E and ORA jointly filed a Joint Motion for Leave to Withdraw PG&E's default PTR proposal. On January 27, 2014, an ALJ Ruling and Amended Scoping Memo denied the Joint Motion and required PG&E to file updated testimony by April 1 supporting an opt-in PTR program, in a reopened proceeding. On February 21, 2014, PG&E and ORA filed a Joint Motion requesting that the CPUC immediately suspend the schedule set in the

[16] Effective November 1, 2014, new customers establishing service on Schedule A-1 where a Smart Meter™ is already in place will be charged Schedule A-1 TOU rates

[17] The Administrative Law Judge in Application 10-02-028 revised schedule in an August 2011 Scoping Memo included an updated filing from PG&E in October 2011.

January 27, 2014 Ruling, and then, either reject default PTR on the merits or dismiss without prejudice. On March 6, 2014, the ALJ issued a ruling granting the stay, and indicated that there would be a decision on the substance of the Motion in the near future. On July 23, 2015 the CPUC (in D.15-07-008) dismissed PG&E's PTR application without prejudice.

2.1.6 Real Time Pricing Rate (RTP)

This program was not approved by the CPUC and the proceeding has been closed. A brief regulatory update on the program decision is provided. On March 22, 2010, PG&E filed its RTP rate proposal with the Commission (Application (A.) 10-03-014) in which a new voluntary RTP tariff option was proposed for all customer classes.[18] Thereafter, the Division of Ratepayer Advocates, the Utility Reform Network and other interveners filed motions requesting that consideration of RTP be suspended until the Commission provided further guidance regarding dynamic pricing options. On March 3, 2011, ALJ Pulsifer granted those parties' joint motion and ruled that "Real Time Pricing issues are deferred pending further notice." The CPUC subsequently closed A.10-03-014 via D.12-10-004, without any further action on PG&E's RTP showing. The Commission has not provided any further guidance related to RTP.

2.2 INFORMATIONAL ENERGY CONSERVATION PROGRAMS AND INITIATIVES

2.2.1 Customer Web Presentment (CWP)

The CWP functionality provides online access to bills, energy usage, interval usage data and energy management and diagnostics tools tailored to customers with PG&E SmartMeters™ and interval data. It is available through PG&E's online portal, known as My Energy. Once an installed SmartMeter is being read remotely, customers may log onto My Energy to check their energy usage on previous days and learn about ways to save energy.[19] The My Usage tab within My Energy provides customers with a variety of tools, which are made possible by the interval data collected by the SmartMeter. These resources include an overview of the customer's interval (hourly or 15-minute), daily, monthly and yearly energy usage characteristics and energy costs, comparisons with the previous month's bill or the bill from twelve months prior, comparisons with similar homes and efficient homes, and comparisons of usage with the weather.

Beginning in 2010, PG&E has marketed the CWP functionality to customers via the following channels: pre-installation bill inserts to customers who were about to receive a SmartMeter; the SmartMeter Welcome Kit which was replaced by a Transition Booklet; direct mail; email; and an outreach banner on PG&E's home page. For each past campaign, the customer data and resources associated with CWP were marketed as a feature of My Energy. In August 2013, PG&E changed to a new paper bill format that includes a graphic similar to My Usage and encourages customers to go online and see their usage information. In addition, PG&E redesigned the My Energy website in December 2013, which made it easier for customers to connect to other tabs, such as My Usage and Energy Alerts.

In November 2011, PG&E changed vendors for the My Energy website, moving from Aclara to Opower. PG&E did not have visibility into how specific service accounts used the My Energy website in 2012. Therefore, the PY 2012 evaluation estimated the number of participants in CWP based on trends from prior program years. The details on customers who accessed My Usage in 2013 and the number of times they viewed the data during the year was made available for the 2013 evaluation. However, the data gap in 2012 still presents challenges since it is impossible to know which customers were first time participants in 2013.

During 2015, PG&E did not have specific CWP or My Energy marketing efforts, but PG&E wove My Energy awareness into a number of other product and program marketing campaigns,

[18] Large Commercial and Industrial Customers; Medium Business Customers; Small Business Customers; Large Agricultural Customers; Small Agricultural Customers, and; Residential Service Customers

[19] Customers without a SmartMeter can still access My Energy to view their billed usage and create a customized energy savings plan.

including considerable marketing throughout the year for digital services, such as electronic billing, which require customers to set up a My Energy account.

A total of 786,687 customers used the "My Usage" feature to view their interval data at least one time during the 2015 calendar year. For the purpose of the evaluation, we consider only those customers (who view their usage at least once during 2015) to be participants in CWP. In addition, the impact analysis in the evaluation report uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate™ or SmartAC™ participants. A significant number of the CWP participants are also dually enrolled in Energy Alerts. The impacts reported here are based on an analysis population of 667,731 singly enrolled CWP participants and 51,746 participants dually enrolled in CWP and Energy Alerts.

2.2.2 Energy Alerts Program

The Energy Alerts Program became operational in June 2010 as an option for PG&E customers with an installed SmartMeter™ that is being read remotely.[20] The program allows customers to receive advance warning via email, phone, or text message if their electricity usage is projected to move into higher pricing tiers by the end of the current billing cycle. Projected usage is calculated on the eighth day of the customer's billing cycle, and Energy Alerts are subsequently sent out to those customers whose total usage for the billing cycle is likely to enter the higher (e.g. third or fourth) pricing tiers. Energy Alerts are also sent out when the customer's usage has actually entered any of the higher pricing tiers, with a maximum of four Energy Alerts per service agreement in a billing cycle. In PY 2015 Energy Alerts launched a dollar amount threshold alert where customers can set their own dollar amount.

Customers can enroll in Energy Alerts online via the My Energy web site. During the past few years, PG&E has marketed Energy Alerts in a similar manner as CWP and often in parallel with CWP and My Energy communications. In December 2013, the My Energy homepage was redesigned, which made it easier for customers to connect to other often-used functions, such as analyzing usage, comparing rate plans, and signing up for Energy Alerts. In 2014 and 2015, there were no direct marketing efforts for Energy Alerts, but enrollments continued to increase, most likely due to greater customer awareness of PG&E's digital services accessible through the My Energy website.

As of December 31, 2015, there were 112,941 customers enrolled in Energy Alerts. The evaluation considers a customer enrolled in Energy Alerts if they receive one or more alerts during 2015. Of those enrolled, 65,085 were singly enrolled and 47,856 also viewed their My Usage data in 2015 and, therefore, were considered dually enrolled in Energy Alerts and CWP. As described for CWP, the impact analysis in the evaluation report uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate or SmartAC participants. The impacts reported here are based on a population of 38,526 singly enrolled Energy Alerts participants and 51,746 participants dually enrolled in CWP and Energy Alerts.

2.2.3 Home and Business Area Network (HAN) Platform

Under the SmartMeter Upgrade filing (D.09-03-026), PG&E developed a Home and Business Area Network (HAN) platform for technology enablement whereby HAN devices within a customer's premise securely connect to the HAN gateway on the customer's SmartMeter to obtain near real time usage and cost information and, ultimately, time-based pricing and demand response event notification. This information gives customers the ability to monitor and manage their home energy usage to balance between comfort and cost. The HAN pilot was carried out over three phases, each of which is described below.

In 2012, PG&E began implementing the Initial Rollout phase of its HAN platform, also referred as the Demand Response Enablement phase, pursuant to Ordering Paragraph 11 of CPUC decision

[20] PG&E implemented the program in 2010 prior to the CPUC's order to provide these services to customers under the Privacy Decision D.11.07.056.

11-07-056. In this phase, 423 In-Home Displays (IHD) were installed in customer homes. The purpose of the Initial Rollout was to determine how customers engage with the device and obtain feedback on the processes and ways to optimize and improve the customer experience. The Initial Rollout phase was evaluated in 2013 by Freeman, Sullivan & Co.[21]

In mid-January of 2013, PG&E began the second phase of the HAN platform, which is referred to as the Early Adopter phase or Self Service model. Phase 2 was funded through the SmartMeter™ Upgrade decision. In this phase, interested customers went to the HAN website and PG&E checked their eligibility for participating. If eligible, customers were advised to purchase their own device through retail channels. During the first year of Phase 2 rollout, PG&E was directly involved in manually loading devices to the system, pairing the devices to the customers' meters, and then enabling the devices.

Phase 3, referred to as the HAN Demand Response Integration phase, was authorized under a separate advice letter dated March 22, 2013 (Advice 4119-E-A). For eligible rates, real-time usage, pricing, messaging and DR event alerts were provided through the SmartMeter to HAN devices, presenting energy pricing over time (time-based rates) or pricing tiers (standard tiered rates). Capabilities included a daily message notifying customers of their estimated costs to date and estimated monthly bill forecast based on actual usage patterns and forecasting algorithms. Demand response event alerts were also sent to the HAN devices. During a technology assessment conducted in the summer of 2014, PG&E provided 1,700 test customers with devices; PG&E made this functionality available to all residential and small medium business customers at the end of 2014. Phase 3 was evaluated in 2014 by Nexant.[22]

The pilot is now closed. As of February 2014, the HAN device eligibility and registration process is fully automated through the My Energy web portal, which allows the platform to scale and support requests at volume. Though there is no formal program, customers may still log into My Energy, link to their Home and Business Area Network Dashboard, and can register and pair their device to the SmartMeter to receive real-time data using the self-service portal. As of December 2015, 3,527 devices had connected to the HAN platform.

2.2.4 Bill Forecast Tool

The Bill Forecast tool is one of several tools made available through PG&E's online portal, known as My Energy. Residential customers with SmartMeters that are read remotely can log into My Energy, navigate to My Dashboard, and use the Bill Forecast tool. The Bill Forecast tool has two functions – an estimated bill of the energy consumed to date and a forecast of the total bill amount at the end of the current billing cycle. These estimates are based on the interval data collected by the SmartMeter.

While the Bill Forecast tool has been available since November 2011, PG&E does not actively market the tool.

2.2.5 Home and Business Energy Reports

The SmartMeter data is also used to support and enhance specific features of the Home Energy Reports (HERs) and Business Energy Reports (BERs) offered to residential customers and to PG&E's small and medium business customers respectively. PG&E worked with Opower to begin offering Home Energy Reports to their customers in August 2011. Small and medium business customers were also offered Business Energy Reports beginning in January 2014. Printed reports are mailed to the participating service addresses approximately 7 times per year and contain similar information for both Residential and Business customers. The reports present information that allows participants to track their energy use over time, and compare their energy usage to similar homes and businesses in the area. The reports also include different tips to help participants reduce consumption.

[21] *Pacific Gas and Electric Company's Home Area Network (HAN) Pilot – Final Report*, Freeman, Sullivan & Co., San Francisco, CA: Nov. 11, 2013. http://calmac.org/publications/HAN_Final_Report_FINAL.pdf.
[22] HAN Phase 3 Impact and Process Evaluation Report, Nexant, December 2014. http://www.calmac.org/publications/HAN_Impacts_and_Savings_Report_FINAL2.PDF

PG&E's Home Energy Reports (HER) program mails reports on a periodic basis to customers included in the treatment groups of its series of randomized control trials (RCTs). Each report consists of two key "neighbor comparison modules" that provide recipient households with comparisons of energy use to that of similar neighbors. These "neighbor comparison" modules are included with every report. Each of these neighbor comparison modules is explained below:

1. The last month comparison shows how recipient's energy use in the prior month compared to similar homes. This information is based on billing data.
2. The last 12 months household comparison shows how recipient's energy use in the prior twelve months compared to similar homes. This information is based on billing data.

There are other modules in the HERs as well. These modules are rotated in and out and do not appear in every report.

3. Modules that promote PG&E's energy efficiency measures.
4. The "Average day last month" module that shows average consumption over the course of weekdays in the prior month. This information is based on interval data. This module is also available to SMB customers through the BER. While SmartMeter™ data is not currently required for the delivery of the all of the modules of the reports, the modules are significantly enhanced by it.

Since only module #3 currently uses interval data and there is no separate evaluation done for module #3 (it is rotated in and out), the corresponding savings are not reported out in the table at the end of the report.

2.2.6 Customized Rate Comparison Report

In 2016 PG&E will begin mailing all qualified residential customers a customized rate comparison report. This report is similar to the one that is available online via MyAccount and will also include behavioral tips. Approximately 3 million customers will receive reports beginning in September and October 2016, subject to CPUC approval. The effects of the customized rate comparison reports are not currently being evaluated.

METHODS AND ASSUMPTIONS

This section provides a high-level discussion of the methods and assumptions that are used to calculate the energy savings, demand response load impacts and associated financial benefits for the two categories of SmartMeter™ enabled programs. The PTR, RTP, and PCT programs are not included in this discussion since those programs have not been approved or implemented.

3.1 SMARTMETER ENABLED DEMAND RESPONSE AND DYNAMIC PRICING PROGRAMS

The CPP (SmartRate™ and PDP), and TOU (residential and non-residential) programs are enabled or supported by the SmartMeter infrastructure and encourage PG&E customers to temporarily reduce loads during periods in which demand might outstrip supply or the system is constrained. The reported aggregate load impacts are equal to the number of enrolled service accounts multiplied by the per-customer demand response load impacts by program.

Table 1 in Chapter 4 of this report provides the number of participating service accounts, estimated demand response (MW), energy savings (MWh), and financial benefits (in thousands of dollars) associated with the programs. The following sections describe the measurement methods and inputs that are used in developing the results.

3.1.1 Service Accounts

During the PG&E SmartMeter deployment period, the number of service accounts available for program participation will be dependent on a billing-ready PG&E SmartMeter. A billing-ready PG&E SmartMeter is defined as a meter which has been installed, communicating, tested, cut-over to operations to allow for billing using interval data.

At the end of 2015, PG&E had approximately 133,000 active enrollments in SmartRate. Of those customers, 92,288 were singly enrolled in SmartRate and 36,598 were dually enrolled in SmartRate and SmartAC™.[23] PG&E also had about 2,093 large non-residential customers and 148,782 defaulted SMB customers enrolled on the PDP tariff in 2015. In addition about 6,595 small and medium business customers were also enrolled on the PDP tariff through early enrollment campaigns in 2014 and 2015. For the PY 2015 evaluation period, there were also 62,008 non-net metered residential TOU customers and 317,926 non-residential TOU customers with SmartMeters.

3.1.2 Demand Response

The demand response load impacts were estimated based on the number of participating service accounts and the per customer load impacts for each program. The load impact reflects the performance of the demand response events in 2015—i.e., ex post load impacts, estimated in a manner consistent with the Load Impact Protocols approved in D.08-04-050. The analysis may incorporate a number of variables including the location of customers by CASIO-defined local capacity areas, weather zones, and customer types. PG&E performed a load impact analysis for all SmartMeter enabled demand response resources. The protocols require that an evaluation plan be developed for each program's load impact evaluation and submitted to the Demand Response Measurement and Evaluation Committee (DRMEC) prior to execution. Load Impact

[23] Since SmartAC is not a SmartMeter enabled program, only the impacts for singly enrolled SmartRate participants are reported in Chapter 4.

evaluation reports for PY 2015 were filed on April 1, 2016 for each active demand response program: SmartRate™, PDP, and residential and non-residential TOU.[24,25]

For singly enrolled SmartRate participants, the load impact was 0.21 kW per customer averaged across the fifteen SmartDay™ events in 2015, or a 13% reduction in per customer load. The aggregate load impact for the program was 19.5 MW for SmartRate-only customers.

For PDP, the evaluation of ex post impacts focused on the large commercial and industrial customers who had been defaulted onto the PDP tariff, small and medium defaulted customers, and the small and medium business EEG participants. The average aggregate load impact across the fifteen events in 2015 was 29.8 MW for the defaulted large commercial and industrial customers. This represents a 5.3% load reduction relative to the reference load; the load impact averaged per large customer was 14.2 kW. For the 148,782 defaulted SMB customers, the average aggregate load impact across the fifteen events in 2015 was 5.8 MW. This represents a 0.8% load reduction relative to the reference load; the load impact averaged per customer was 0.0 kW.

The residential TOU impacts were calculated for non-net metered customers during on-peak hours for the analysis period of October 1, 2014 through September 30, 2015. The estimated average per-customer load reduction was 0.06 kW for E-6 Incremental customers, and 0.15 kW for E-7 Embedded customers on average monthly system peak days during the summer. The per customer impacts correspond to an 8% and 12% reduction from the reference load, respectively. In addition, the aggregate load reduction for the tariffs during the average monthly summer system peak days was estimated to be 0.28 MW for E-6 incremental customers and 7.1 MW for E-7 embedded customers. While PG&E estimated the impacts of E-7 embedded customers, these estimates are not included in the table below because many of these customers enrolled onto the rate prior to the installation of SmartMeters™.

For small and medium business customers, implementation of mandatory TOU rates resulted in a 19.0 MW demand reduction during the average weekday on-peak hours and a 21.9 MW demand reduction during an average monthly system peak day in 2015. In addition, the mandatory TOU rates yielded 45.2 GWh in energy savings in 2015. These impacts are for the approximately 61,000 SMB and 8,300 agricultural customers that switched to TOU rates in November 2014 and March 2015.

3.1.3 Financial Benefits

Financial benefits will be calculated by adding financial benefits associated with the demand reduction and the energy savings for each program. The demand reduction financial benefits will be calculated by multiplying the demand response times the most recently accepted avoided generation capacity cost. PG&E's most recent GRC Phase 2 settlement value for the avoided marginal generation capacity cost is $57.09/kW-year, publicly submitted on July 16, 2014 in Appendix A to the "Settlement Agreement on Marginal Cost and Revenue Allocation in Phase II of the Pacific Gas and Electric Company's General Rate Case" as part of PG&E's A13-04-012. Once the Commission adopts new values for the avoided marginal generation capacity costs in a subsequent proceeding, PG&E will use those adopted values to quantify the financial benefits in the annual report. To the extent that the Commission requires different (than those indicated above) marginal generation costs to be used for various programs, PG&E will use the latest approved value to calculate the financial benefits.

3.2 SMARTMETER ENABLED INFORMATION ENERGY CONSERVATION PROGRAMS AND INITIATIVES

The PG&E SmartMeter enabled Customer Web Presentment, Energy Alerts Program, Bill Forecast Tool and Home and Business Area Network platform provide information to the participant on

[24] *2015 Load Impact Evaluation of Pacific Gas and Electric Company's Residential Time-based Pricing Programs*, Nexant: 2016.
[25] *2015 Load Impact Evaluation of California's Statewide Non-residential Critical Peak Pricing Program,* Nexant: 2016.

their daily energy usage by leveraging interval data, thereby empowering the participant to take steps to reduce to conserve energy.

The energy impacts were evaluated according to the guidelines presented in the California Energy Efficiency Evaluation Protocols.[26]

Table 2, located in Chapter 4 of this report, provides the number of service accounts, energy conservation (MWh), and financial benefits (in thousands of dollars) associated with the PG&E SmartMeter™ project enabled energy conservation programs and initiatives on an ex post basis. The following sections describe the measurement methods and assumptions used in developing the energy conservation results.

3.2.1 Service Accounts

During the PG&E SmartMeter deployment period, the number of service accounts will be dependent on a billing ready PG&E SmartMeter meter. The impact analysis in the evaluation report uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate™ or SmartAC™ participants. The impacts reported here are based on a population of 667,731 singly enrolled CWP participants, 38,526 singly enrolled Energy Alerts participants, and 51,746 participants dually enrolled in CWP and Energy Alerts.

HAN service accounts are determined based on the number of devices (e.g., In-Home Displays) registered with PG&E. For the HAN Phase 1 Pilot, a total of 423 HAN devices were installed in participants' homes. For the HAN Phase 3 Pilot, a total of 1,685 customers agreed to participate, where 1,001 were recruited from the SmartRate target base, and 584 were recruited from the TOU target base. In addition to the participants being recruited through these two Pilots, there were additional residential customers who voluntarily chose to install an IHD or a Gateway device using PG&E's HAN platform. The total number of customers using the HAN platform as of December 31, 2014, was 3,043 (including the Pilot participants).

The Business Energy Reports trial included approximately 73,000 small- and medium-size non-residential customers. Treatment included a welcome report and six industry-focused, bi-monthly progress reports. The trial began in January 2014 and is ongoing, with the initial savings evaluation concluded in January 2015. Roughly 150,000 Business Energy Reports were sent over the course of 2015.

The Home Energy Reports was first launched in August 2011 and there were seven discrete experiments launched—and currently in-field—for the Home Energy Reports program. There are approximately 1.5 million residential households who get the Home Energy Report. Roughly 10 million reports were sent over the course of 2015.

3.2.2 Energy Savings

For the CWP and Energy Alerts programs, ex post energy savings for 2015 were estimated by multiplying average per-participant energy savings for appropriate subpopulations of customers by the corresponding number of participating service accounts for those subpopulations. Impacts for the subpopulations were then combined to develop overall impacts for three groups: 1) singly enrolled CWP participants; 2) singly enrolled Energy Alerts participants; and 3) participants dually enrolled in CWP and Energy Alerts. AEG's evaluation report in Attachment A provides detailed descriptions of the statistical methods used for estimating CWP and Energy Alerts impacts and presents results at the subpopulation and program levels. The estimated aggregate energy savings impacts are 3,310 MWh for singly enrolled Energy Alerts participants, and 4,496 MWh for dually enrolled participants. The evaluation did not find any statistically significant savings for singly enrolled CWP participants.

[26] California Energy Efficiency Evaluation Protocols, prepared for the California Public Utilities Commission, April 2006.

3.2.3 Financial Benefits

Financial benefits will be calculated using the same methodology as the demand response financial benefits described previously. However, instead of using an avoided marginal generation *capacity* cost, the calculation for conservation programs will use an avoided *generation* energy costs of $42.66/MWh.[27]

[27] Appendix A from the Settlement Agreement on Marginal Cost and Revenue Allocation in Phase II of Pacific Gas and Electric Company's 2014 General Rate Case (c).

RESULTS

Table 1 and Table 2 provide the PY 2015 demand response and energy conservation results, respectively.

Table 1 PG&E SmartMeter™ Program Enabled Demand Response Programs Subscription Statistics: December 31, 2015

		Demand Reduction		Energy Savings		
Demand Response Program	**Service Accounts[28]**	**Aggregate Load Impact[29] (MW)**	**Financial Benefits[30] (thousands)**	**Energy Savings[31] (MWh)**	**Financial Benefits[32] (thousands)**	**Total Financial Benefits (thousands)**
Singly enrolled SmartRate™	92,288[33]	19.5[34]	$1,113	0	$0	$1,113
PDP (large C&I)	753[35]	7.8[36]	$445	0	$0	$445
Default PDP (SMB)	148,782	5.8	$328	0	$0	$328
Opt-In PDP (SMB)	11,348	3.1	$179	0	$0	$179
Residential TOU	4,430[37]	0.6[38]	$32	0	$0	$32
Non-residential TOU	69,788[39]	21.9[40]	$1,249	45,162[41]	$1,927	$3,176
Total	**327,389**	**58.6**	**$3,346**	**45,162**	**$1,927**	**$5,273**

[28] Number of service accounts enrolled in the program who have a billing ready PG&E SmartMeter meter (installed, communicating, and cut-over to operations to allow for billing using interval data).
[29] Program MWs equal the sum of each enrolled participant's interruptible/curtailable load.
[30] Financial benefits (in thousands of dollars) = total DR load reduction (kW) x accepted avoided marginal generation capacity costs per kW-year ($57.09/kW-year). This cost figure comes from Appendix A of the Settlement agreement on marginal Cost and Revenue Allocation in Phase II of Pacific Gas and Electric Company's 2014 general Rate Case (A.13-04-012).
[31] Energy savings will be calculated based on the results of the Annual Load Impact Analysis for each program.
[32] Financial benefits = energy savings (kWh) x avoided generation energy costs (in thousands of dollars).
[33] Only the impacts for singly enrolled SmartRate participants are included here. Dually enrolled SmartRate and SmartAC™ impacts are excluded since SmartAC is not a SmartMeter enabled program.
[34] The aggregate load impact represents the average load reduction during the event period across all event days during the season.
[35] The PDP customer counts and impacts reported here exclude accounts that do not have SmartMeters.
[36] The aggregate load impact represents the average load reduction during the event period across all event days during the season.
[37] The number includes incremental, non-net metered, E-6 accounts. The average enrollment over the course of the study period is provided.
[38] The aggregate load impact is the average load reduction on monthly system peak days during the summer months (May through October).
[39] The number represents the accounts with SmartMeters that transitioned to mandatory TOU rates from November 2014 onwards. This enrollment number and the impacts reported in this table exclude those customers who defaulted prior to November 2014 or who had been on non-residential TOU rates before the SmartMeter deployment.
[40] The aggregate load impact of represents the average load reduction on monthly system peak days during the summer months (May through October).
[41] The value represents the 2015 annual energy savings for non-residential customers with SmartMeters who transitioned to a TOU rate from November 2014 onwards. We have included the energy savings only for Non Res TOU and not for any other Dynamic Pricing program, because the energy savings associated with Non Res TOU were substantial.

Table 2 PG&E SmartMeter™ Program Enabled Energy Conservation Programs Subscription Statistics: December 31, 2015

Energy Conservation Program	Service Accounts	Energy Savings		Demand Reduction		Total Financial Benefits (thousands)
		Energy Savings (MWh)	Financial Benefits[42] (thousands)	Load Impacts[43] (MW)	Financial Benefits[44] (thousands)	
Singly enrolled CWP	667,731[45]	0	$0	0	$ 0	$0
Singly enrolled Energy Alerts	38,526[46]	3,310	$141.2	0	$0	$141.2
Dually enrolled CWP and Energy Alerts	51,746[47]	4,496	$191.8	0	$0	$191.8
Total	**758,003**	**7,806**	**$333.0**	**0**	**$0**	**$333.0**

[42] Financial benefits = energy savings (kWh) x avoided generation energy costs (in thousands of dollars). The avoided generation energy cost used in the calculation in Table II above is $42.66/MWh. This cost figure comes from Appendix A of the Settlement agreement on marginal Cost and Revenue Allocation in Phase II of Pacific Gas and Electric Company's 2014 general Rate Case (A.13-04-012).

[43] Demand reductions for the energy conservation programs will be calculated based upon an analysis consistent with that required by the Energy Efficiency Measurement and Evaluation Protocols.

[44] Financial benefits (in thousands of dollars) = total load reduction (kW) x accepted marginal avoided generation capacity costs per kW-year.

[45] Number of Customer Web Presentment service accounts will be calculated based on number of customer sign-ups for access to interval data on PG&E's web site. The impact analysis uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate™ or SmartAC™ participants. The number of participants presented in Table 2 represents the number of participants in the restricted population. The actual population of CWP customers who viewed the My Usage webpage in 2015 was 786,687. Of these, 720,810 were singly enrolled in CWP.

[46] Number of Tier Notifications Program service accounts will be determined by the number of program enrollments. The impact analysis uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate or SmartAC participants. The number of participants presented in Table 2 represents the number of participants in the restricted population. The actual population of Energy Alerts customers in 2015 was 112,941; of those, 47,064 were singly enrolled in Energy Alerts.

[47] The impact analysis uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate or SmartAC participants. The actual population of dual participants was 65,877 in 2015.

ATTACHMENT **A**

PACIFIC GAS AND ELECTRIC COMPANY'S SMARTMETER™ ENABLED PROGRAMS: PY 2015 EVALUATION OF CUSTOMER WEB PRESENTMENT AND ENERGY ALERTS

ATTACHMENT B

PG&E's SmartMeter™ Enabled Programs Program Year 2015 Evaluation of Customer Web Presentment and Energy Alerts

Pacific Gas and Electric Company's SmartMeter™ Enabled Programs: Program Year 2015 Evaluation of Customer Web Presentment and Energy Alerts

CALMAC ID PGE0379

Final Report

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Abstract

Customer Web Presentment (CWP) and Energy Alerts are two SmartMeter™ enabled informational energy conservation programs available to Pacific Gas and Electric Company (PG&E) customers. Customer Web Presentment of interval electric usage data is available to customers though PG&E's My Energy web portal. The My Energy website is a single, multi-functional, customer-facing portal that provides customers with tools to help manage their energy usage. The relevant aspect of the portal is the My Usage tab which allows customers who are SmartMeter read and billed to view their electricity usage at a daily or hourly level. Energy Alerts is a program in which participants elect to receive notifications during the billing cycle regarding their electricity usage.

The purpose of this report is to present the ex post energy and demand savings for 2015. The impact analysis in the evaluation report uses a restricted population to estimate savings to avoid double-counting impacts for customers who are also SmartRate™ or SmartAC™ participants. The impacts reported here are based on a population of 667,731 singly-enrolled CWP participants, 38,526 singly-enrolled Energy Alerts participants, and 51,746 participants dually-enrolled in CWP and Energy Alerts.

For the CWP and Energy Alerts programs, per customer segment-level ex post energy savings for 2015 were estimated using a statistical difference in difference approach, followed by a regression based approach to refine the estimates. Impacts for the subpopulations were then combined to develop overall impacts for three groups: 1) singly-enrolled CWP participants; 2) singly-enrolled Energy Alerts participants; and 3) participants dually-enrolled in CWP and Energy Alerts. The estimated aggregate energy savings impacts are 3,310 MWh for singly-enrolled Energy Alerts participants, and 4,496 MWh for dually-enrolled participants. The evaluation did not find any statistically significant savings for singly-enrolled CWP participants.

The estimated aggregate demand savings are 2.0 MW for singly-enrolled Energy Alerts participants, and 2.6 MW for dually enrolled participants. Again, the evaluation did not find any statistically significant savings for singly-enrolled CWP participants.

Executive Summary

Customer Web Presentment and Energy Alerts are two SmartMeter™ enabled informational energy conservation programs available to Pacific Gas & Electric (PG&E) customers.

- Customer Web Presentment (CWP) of interval electric usage data is available to customers though PG&E's My Energy web portal. The My Energy website is a single, multi-functional, customer-facing portal that provides customers with tools to help manage their energy usage. The relevant aspect of the portal is the My Usage tab which allows customers who are SmartMeter read and billed to view their electricity usage at a daily or hourly level.
- Energy Alerts is a program in which participants elect to receive notifications during the billing cycle regarding their electricity usage. PG&E residential customers are billed according to an increasing block rate structure, where successively higher tiers of electric usage are billed at successively higher per-kWh rates. Energy Alerts customers are notified for the first time if their bill forecast, calculated on the 8th day of their billing cycle, projects that they will cross into Tiers 3, 4, or 5. Customers are subsequently notified after they cross each of those three tiers for a maximum of four alerts in each billing cycle.

This report presents the program year 2015 (PY2015) evaluation of ex-post electricity savings associated with each of these programs.

Approach

The evaluation was conducted in five basic steps:

1. Characterize the participants in each program by examining both enrollment data and level of engagement. Identify customers with dual participation in both CWP and Energy Alerts.
2. Design the treatment samples for single enrollment in each program and for dual participation by segmenting the population according to the aspects of participation that have been shown to be correlated with savings in previous evaluations and then by stratifying based on energy use within relevant population segments. For CWP, the segmentation aspects include duration of participation and number of times a participant views the web tools; for Energy Alerts, they include the manner in which participants receive alerts and the number of alerts received during the 2015 program year.
3. Match the treatment customers with non-participant control customers using a stratified matching strategy employing both demographic and pretreatment energy usage data. Conduct matching in two stages: first with monthly billing data to obtain a three-to-one control-to-participant match and second with hourly on-peak and off-peak interval data to create a one-to-one control-to-participant match for a series of day types.
4. Estimate the energy savings for each program at the segment and population levels for each month and the entire program year first using a statistical difference in difference (DID), then refining the estimates using a regression approach.
5. Estimate the demand savings for each program at the segment and population levels for each day type first using a statistical difference in difference (DID), then refining the estimates using a regression approach.

Key Findings and Recommendations for Future Program Years

Findings

Total annual energy savings from both CWP and Energy Alerts are presented below in **Error! Reference source not found.**. These savings estimates are very consistent with previous evaluation years. In total, the participants across all programs saved just over 7.8 GWh of energy in 2015. Singly-enrolled Energy Alerts participants saved an average of 86 kWh per customer, while dually-enrolled participants saved an average of 87 kWh per customer. We were unable to obtain statistically significant savings estimates for Singly-enrolled CWP participants at the population level.

Table E-1 Total Annual Energy Savings: All Participants

Subpopulation	Number of Participants	Annual Savings (kWh per customer)	Total Savings (MWh)
Singly-enrolled CWP Participants	667,731	0	0
Singly-energy Alerts Participants	38,526	85.93	3,310
Dually-enrolled Participants	51,746	86.88	4,496
Total Energy Savings	**758,003**	**10.36**	**7,806**

The total annual demand savings from both CWP and Energy Alerts are presented below in **Error! Reference source not found.**. Again, the demand savings are consistent with previous evaluation years. In total, the participants across all programs provided approximately 4.5 MW of demand reduction in 2015. Singly- and dually-enrolled Energy Alerts participants saved an average of 0.05 kW per customer. We were unable to obtain statistically significant savings estimates for singly-enrolled CWP participants at the population level.

Table E-2 Total Annual Demand Savings: All Participants

Subpopulation	Number of Participants	Annual Savings (kW per customer)	Total Savings (kW)
Singly-enrolled CWP Participants	667,731	0	0
Singly-enrolled Energy Alerts Participants	38,526	0.052	1,999
Dually-enrolled Participants	51,746	0.049	2,582
Total Energy Savings	**758,003**	**0.006**	**4,582**

Customer Web Presentment Findings

- Based on our analysis for 2015, it appears that singly-enrolled CWP participants are not saving any energy. One possibility is that CWP participants are saving energy but we were simply unable to detect those savings due to the variability inherent in the data. In addition, the large gap between the pre and post treatment periods for our continuing customers may have introduced bias into our matching process and prevented us from detecting savings in the CWP population.
- One additional hypothesis that may explain why we were unable to detect savings for the CWP participants is the very large number of participants. This may at first sound counterintuitive since having a large number of participants is often an advantage. However, in this case it may be that many more customers are viewing the website out of curiosity but fewer customers are actually engaging with and making modifications in behavior based on the information provided. We see some evidence of this when we look at the distribution of participants across engagement levels, with the highly engaged customers making up only about 3% of the total CWP population.
- At the segment level, we have seen consistently across evaluation years that the highly engaged participants save energy, and the less highly engaged participants do not. While some individual months may be statistically significant (either positive or negative) among the less engaged

participants, the overall pattern of the savings estimates does not suggest consistent positive or negative savings for those groups. In contrast, the savings estimates for the highly engaged participants do show consistent positive and significant savings estimates across most months. This pattern indicates that those customers are actively engaging with the website and saving energy as a result.

Energy Alerts Findings

- Nearly all of the savings for the Energy Alerts program are attributable to participants who receive five or fewer alerts in 2015. In this group, we saw consistent positive savings estimates across nearly all the months of 2015.
- We did not see any positive, statistically significant annual savings for those participants who receive more than five alerts per year. In fact, we saw some small negative significant savings estimates among those participants during one or two months. We believe, based on the pattern of the savings that we saw, these negative estimates to be the result of random variations in usage between the treatment and control group that are not indicative of true positive or negative savings. Another possible explanation is that participants become indifferent after they receive a threshold number of alerts. In many cases, those customers with large homes or high AC use due to location, are unable to move out of the higher tiers, yet will continue to receive alerts regardless of any changes made in the home.
- If we compare the savings between participants that receive alerts by email and those that receive alerts by SMS/phone, we find that those receiving alerts by email save more on average.
- Relative to 2014, savings among singly-enrolled customers decreased slightly, while savings among dually-enrolled customers increased slightly. In addition, this year singly- and dually-enrolled customers saved about the same amount at the annual level.
- Singly-enrolled Energy Alerts participants saved a total of 3,310 MWh during 2015, or 86 kWh per participant, for an average annual impact of 1.2%.
- Singly-enrolled Energy Alerts participants have an average demand savings of 0.052 kW (2.95%) on a hot summer day. The singly-enrolled Energy Alerts participants achieved a demand savings of 1.9 MW in 2015.

Dually-enrolled Customer Findings

- Dually-enrolled CWP participants saved a total of 4,496 MWh in 2015, or 87 kWh per participant, for an average annual impact of 1.10%.
- Dually-enrolled CWP participants have an average demand savings of 0.049 kW (or 2.6%) on a hot summer day. The dually-enrolled participants achieved a demand savings of 2.5 MW in 2015.
- Dually enrolled CWP participants are saving energy; however, we believe the majority of the savings in the dually enrolled population to be attributable to Energy Alerts vs. CWP.
- The incremental effect of CWP participation for an Energy Alerts participant appears to be negligible at the program level.

Recommendations

The following were identified as recommendations for future program years:

- The high participation rate for CWP suggests that customers are receiving value from the program, even if savings cannot be attributed directly to those customers. Therefore, we recommend that PG&E continue to offer and enhance their customer interface, even if we cannot attribute savings directly to those customers.
- Energy Alerts appears to be a successful program. However, we have not accounted for the possibility of double counting between Energy Alerts and PG&E's other conservation and Energy Efficiency programs. It is very likely that participants that are interested in Energy Alerts would

also be interested in other PG&E programs. Therefore some portion of the savings we attribute to Energy Alerts may be attributable to other programs.

- Given the proportion of program savings attributable to participants receiving fewer than five alerts, we would recommend marketing Energy Alerts to customers with a monthly usage that borders Tiers 2 and 3 several months out of the year. These are the participants that seem to be able to most effectively take advantage of the Energy Alerts.
- The Energy Alerts population has been fairly consistent and stable over the last three evaluation years. Therefore, we conclude that Energy Alerts participants are not only saving energy but getting value from the program.

Contents

List of Figures

List of Tables

Introduction

This report includes the ex post evaluation of Pacific Gas and Electric Company's (PG&E's) SmartMeter™ Enabled Programs for the Program Year 2015 (PY2015). The two programs are summarized below.

Customer Web Presentment. In this program, interval electric usage data is available to customers though the Customer Web Presentment (CWP) pages of PG&E's My Energy web portal. The My Energy website is a single, customer-facing portal with many different functions and tools beyond the scope of this evaluation. The relevant aspect of the portal is the My Usage tab which allows customers who are SmartMeter read and billed to view their electricity usage at the daily or hourly level.

Energy Alerts. In this program, customers can sign up for Energy Alerts to receive notifications during the billing cycle about energy usage. PG&E customers are billed according to an increasing block rate, where successively larger tiers of energy usage are billed at successively higher per-kWh rates. Energy Alert customers are notified for the first time if their bill forecast, calculated on the 8th day of their billing cycle, projects that they will cross into Tiers 3, 4, or 5. Customers are subsequently notified after they cross each of those three tiers for a maximum of four alerts in each billing cycle.

Additional information is provided in Section 2.

Research Objectives

The four research objectives for this project are as follows:

- **Estimate ex post energy conservation for customer web presentment**. It is hypothesized that customers who are aware of how much energy they are using on a daily basis will be more effective in managing their energy consumption. Therefore, the first research objective was to estimate the effect on customers' monthly energy usage of viewing daily or hourly energy use during the billing cycle both at the program level and within subpopulations that use the website more frequently and are more likely to conserve energy.
- **Estimate ex post energy conservation for energy alerts**. Because PG&E charges customers for energy use on an inverted block rate schedule, it is hypothesized that if customers know when they cross into a higher priced tier, they will conserve energy in response to the higher price. The second research objective was to estimate the effect of Energy Alerts on customers' monthly energy usage both at the program level and within subpopulations that are more likely to conserve energy.
- **Estimate effects of dual participation**. The third research objective was to quantify the incremental impact of dual participation in both Energy Alerts and CWP on the energy savings relative to single participation in one program or the other. By studying dual participation, we can assess whether these more highly engaged participants conserve more energy.
- **Estimate Daily Load Shapes and Hourly Savings**. The fourth objective was to investigate how participation in Energy Alerts and/or CWP influences average on-peak and daily consumption.

Key Issues

There are some unique challenges associated with meeting the research objectives defined in this project for PY2015:

- **Lack of Formal Control Group –** In a pilot setting, it is often possible to use an experimental design with randomized treatment and control groups to control for self-selection bias. However, when a program is fully deployed, as are CWP and Energy Alerts, a randomized control group is no longer an option.
- **Very Small Impacts Relative to Total Usage –** Evaluations from the past four program years have indicated that changes in energy use resulting from the programs are small and difficult to detect, falling somewhere in the range of 1% to 3% at the population level.
- **A Wide Variety of Levels of Involvement with Critical Information** – In each program, the level of engagement varies widely across the participants. In addition, a large portion of the participant population is dually-enrolled in both the CWP and Energy Alerts programs. Consideration of the different levels of involvement requires careful consideration in the estimation of savings for both programs.
- **Dual Participants between Programs –** The presence of two related programs and the opportunity for dual participation has caused us to modify our approach over time. During the 2011 evaluation we discovered that there is significant overlap between the two participant populations. We handled this by post-stratifying both samples to account for dual participants within each sample. During the 2012 evaluation we could not address this issue due to a lack of data for CWP. In the 2013-2015 evaluations we addressed the overlap between programs by looking at each population separately: singly-enrolled CWP participants, singly-enrolled Energy Alerts participants, and dual participants.
- **Data Availability for Customer Web Presentment –** During 2011, PG&E selected a new vendor to handle the web presentment of SmartMeter™ interval usage data. Due to contractual issues with the new vendor, no participant data was available for the 2012 program year. Therefore, we did not know who the 2012 participants were, nor did we have information on how frequently they accessed their interval data in 2012. However, we did have visibility into the participants and their access to the web portal for 2013 through 2015. The data gap in 2012 still presents a challenge in that we cannot be sure who was a participant, and who was not during our preferred pretreatment period for some participants.

While it is important to acknowledge the challenges associated with these issues, continual refinement of evaluation methods each year has improved our ability to match treatment and control customers and to detect savings from the programs. However, because we are only able to match treatment to control customers based on observable characteristics, we will never be able to completely duplicate the results of a designed experiment and, consequently, the matching process will inevitably have some degree of bias. This, in turn, will always lead to uncertainty in the savings estimates. These uncertainties must be associated with the evaluation's context, not necessarily the effectiveness of the program.

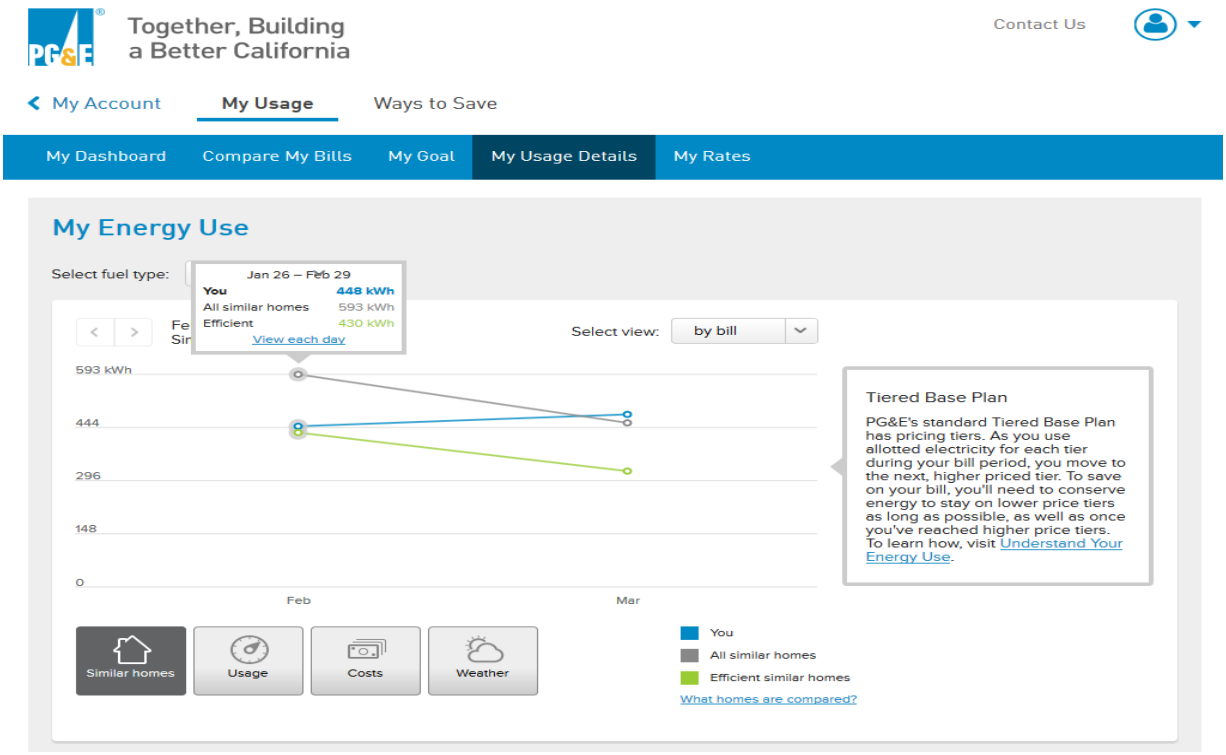
In addition, we did not account for participation in PG&E's many Energy Efficiency (EE) programs. This may introduce bias in our estimates. The bias is present only to the extent that CWP and Energy Alerts participants are more likely than their matched controls to sign up for and participate in EE programs. In this case, we would overstate the savings attributable to CWP or Energy Alerts because some of those savings would already be counted in other EE evaluations.

Program Details

Customer Web Presentment

The CWP functionality provides online access to bills, energy usage, interval usage data, and energy management and diagnostics tools tailored to residential and small business customers with PG&E SmartMeters™ and interval data. It is available through PG&E's online portal, known as My Energy, which is a single customer-facing portal with many different functions and tools. Once an installed SmartMeter is read remotely, customers may log onto My Energy to check their energy usage on previous days and learn about ways to save energy.[1] The My Usage tab within My Energy provides customers with a variety of tools, which are made possible by the interval data collected by the SmartMeter. These resources include an overview of the customer's interval (hourly or 15-minute), daily, monthly, and yearly energy usage patterns and energy costs, comparisons with the previous month's bill or the bill from twelve months prior, comparisons with similar homes and efficient homes, and comparisons of usage with the weather. Figure 2-1 shows an example of one of the customer facing views.

Figure 2-1 My Usage Tab View: "My Usage Details"



CWP marketing has evolved since it began in 2010:

- Beginning in 2010, PG&E has marketed the CWP functionality to customers via the following channels:
    - pre-installation bill inserts to customers who were about to receive a SmartMeter;

[1] Customers without a SmartMeter can still access My Energy to view their billed usage and create a customized energy savings plan.

  - the SmartMeter™ Welcome Kit which was replaced by a Transition Booklet;
  - direct mail;
  - email; and
  - an outreach banner on PG&E's home page.
- For campaigns run between 2010 and mid-2013, the customer data and resources associated with CWP were marketed as a feature of My Energy.
- In August 2013, PG&E changed to a new paper bill format that includes a graphic similar to My Usage and encourages customers to go online and see their usage information. In addition, PG&E redesigned the My Energy website in December 2013, which made it easier for customers to connect to other tabs, such as My Usage and Energy Alerts.
- During 2014 and 2015, PG&E did not have specific CWP or My Energy marketing efforts, but PG&E wove My Energy awareness into a number of other product and program marketing campaigns, including considerable marketing throughout the year for digital services, such as electronic billing, which require customers to set up a My Energy account.

Evaluation Considerations

Because our objective was to estimate the effect on customers' monthly energy usage of viewing daily or hourly energy use through the web tools, only the functions or tools that display customer interval usage data from the SmartMeter system were evaluated within the scope of this project. In addition, to be consistent with PY2010 through PY2014 evaluations, the PY2015 analysis focused exclusively on residential customers.[2]

Participants

There were 786,687 CWP participants in 2015, including customers singly-enrolled in CWP and those enrolled in other PG&E programs such as Energy Alerts, SmartRate™ and SmartAC™. SmartRate is PG&E's residential dynamic pricing rate, and SmartAC is PG&E's Residential AC Load Control program. Of those, 488,679 were new (first time) participants and 298,008 were continuing participants from previous years. While nearly 500,000 new participants may seem like a large increase, it is similar to increases we have seen in previous years as PG&E continues to promote My Energy to customers.

Analysis Population

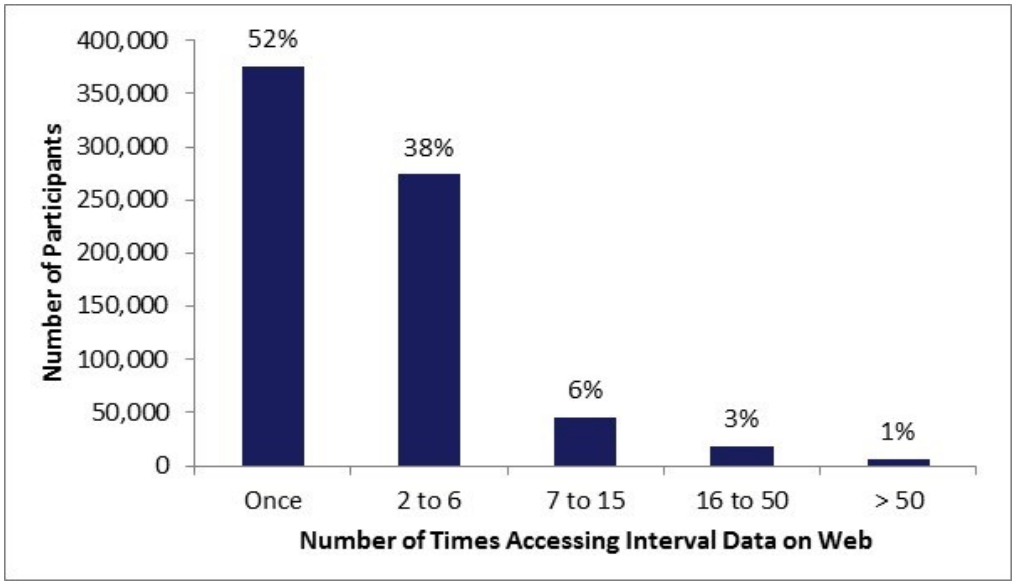
The CWP population we used for analysis is a subset of the CWP participant population. To avoid double-counting, the analysis population excludes SmartAC and SmartRate customers since their impacts are captured in the evaluation of those programs. We also segment the analysis population into singly-enrolled CWP participants and participants dually-enrolled in CWP and Energy Alerts. As a result, the CWP analysis population consists of 667,731 singly-enrolled participants and 51,746 dually-enrolled participants, for a total of 719,477 CWP participants. From this point forward, unless otherwise stated, the term "participants" refers to only those included in the analysis population.

Level of Engagement

Figure 2-2 and Table 2-1 show the distribution of analysis population according to their engagement with the program. About half of the participants (52%) viewed their CWP data only once. Another sizeable block of participants (38%) viewed their data between two and six times. The remaining 10% of the participants viewed their data seven or more times in 2015, including the 1% who were very active with 50 or more views. The engagement distribution is consistent with what we have seen in previous evaluations.

[2] Small and medium business customers and agricultural customers can also participate in CWP. When detailed participation data is available for all CWP participants, future evaluations of the program will include these customers at PG&E's request.

Figure 2-2 CWP Engagement - Number of Customer Logins in PY2015



In Table 2-1 we also present the total customer count and percentage of customers in each group. By far the largest group is new customers viewing the web only one time, while the smallest groups are new and continuing customers viewing the web more than six times.

Table 2-1 Distribution of CWP Participants by Engagement Level

Number of Visits	Participant Count (New)	Participant Count (Continuing)
1 visit	276,600 (40%)	98,693 (13%)
2 to 6 visits	151,897 (21%)	121,894 (16%)
7 to 15 visits	16,459 (2%)	28,826 (4%)
More than 15 visits	7,612 (1%)	17,496 (2%)

Energy Alerts

The Energy Alerts Program became operational in June 2010 as an option for PG&E customers with a SmartMeter™.[3] The program allows customers to receive advance warning via email, phone, or text message if their electricity usage is projected to move into higher pricing tiers by the end of the current billing cycle. Projected usage is calculated on the eighth day of the customer's billing cycle, and Energy Alerts are subsequently sent out to those customers whose total usage for the billing cycle is likely to enter the higher (e.g. third or fourth) pricing tiers. Energy Alerts are also sent out when the customer's usage has actually entered any of the higher pricing tiers, with a maximum of four Energy Alerts per service agreement in a billing cycle. CARE[4] customers are only charged for usage on three tiers and are therefore notified only as they cross into Tier 3. In PY 2015 Energy Alerts launched an additional alert that warns customers when they reach a specified dollar amount threshold. Customers can set a monthly bill alert amount of their choice. They are then sent an alert when they are on pace to exceed that amount. Energy Alerts are only available for residential customers who are SmartMeter read and billed.

Customers can enroll in Energy Alerts online via the My Energy web site. During the past few years, PG&E has marketed Energy Alerts in a similar manner as CWP and often in parallel with CWP and My Energy communications. In December 2013, the My Energy homepage was redesigned, which made

[3] PG&E implemented the program in 2010 prior to the CPUC's order to provide these services to customers under the Privacy Decision D.11.07.056.

[4] The California Alternate Rates for Energy (CARE) program provides discounted energy rates for low-income residential customers who qualify for the program based on the number of people living in the home and the household's total annual income.

it easier for customers to connect to other often-used functions, such as analyze usage, compare rate plans, and sign up for Energy Alerts. In 2014 and 2015, there were no direct marketing efforts for Energy Alerts, but enrollments continued to increase, most likely due to greater customer awareness of PG&E's digital services accessible through the My Energy website.

Participants

There were 112,941 Energy Alerts participants in 2015, including customers singly-enrolled in Energy Alerts and those enrolled in other PG&E programs such as CWP, SmartRate™, and SmartAC™. Of those, 65,085 were new (first time) participants and 47,856 were continuing participants from previous years.

Analysis Population

The Energy Alerts population we used for analysis is a subset of the Energy Alerts participant population. As with CWP, to avoid double-counting, the analysis population excludes SmartAC and SmartRate customers since their impacts are captured in the evaluation of those programs. We also segment the analysis population into singly-enrolled Energy Alerts participants and participants dually-enrolled in CWP and Energy Alerts. As a result, the Energy Alerts analysis population consists of 38,526 singly-enrolled participants and 51,746 dually-enrolled participants, for a total of 90,272 Energy Alerts participants in 2015. From this point forward, unless otherwise stated, the term "participants" refers to only those included in the analysis population.

Level of Engagement

Figure 2-3 shows the number of Energy Alerts dispatched to the analysis population throughout 2015, normalized on a per-participant basis. The graph displays peaks in the number of alerts in summer and winter months, which is expected due to seasonal impacts on energy usage. The peak winter month for alerts was December, with 0.75 alerts per participant, which is lower than the 2014 December peak of 1.03 alerts per participant. The peak summer month for alerts was August, with 0.86 alerts per participant, also lower than 2014's summer peak in August of 1.21 alerts per participant. In general, these trends are consistent with what was observed for 2014.

Figure 2-3 Energy Alerts – Average Number per Participant in PY2015

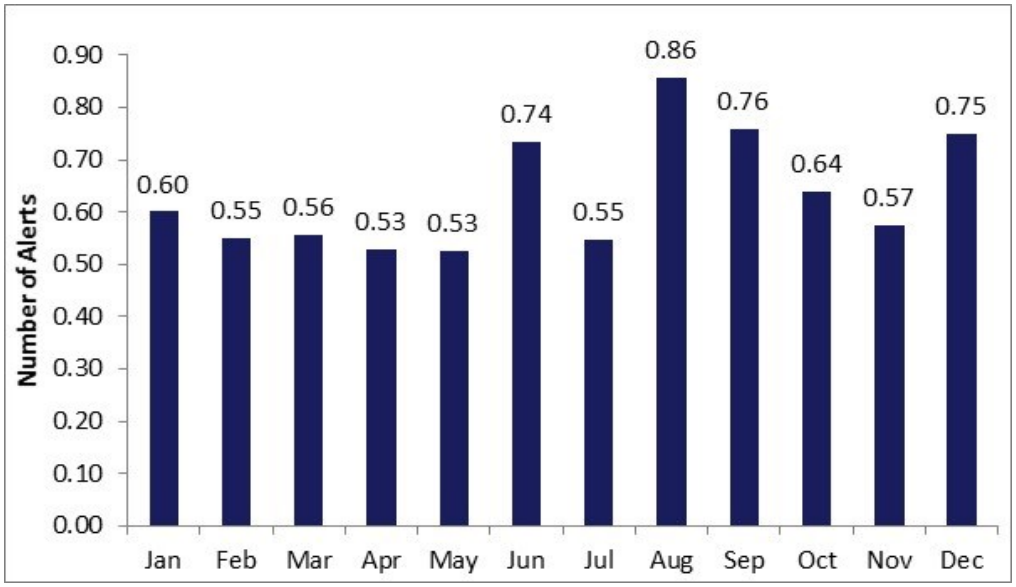


Table 2-2 summarizes the distribution of Energy Alerts participants in the analysis population by the number of alerts received annually and the notification type. About two-thirds of participants received more than five alerts in 2015. More than half of participants (60%) were notified by email.

Table 2-2 Distribution of Energy Alerts Participants by Number of Alerts

Number of alerts received annually	Participant Count (E-mail)	Participant Count (SMS/phone)
5 or less	17,900 (20%)	14,201 (15%)
More than 5	33,921 (40%)	24,250 (25%)

Dual Enrollment

A large percentage of participants are enrolled in both CWP and Energy Alerts. For the CWP program, a customer is considered to "enroll" the first time they view their interval data on the web. For Energy Alerts, enrollment has the more traditional definition of the date the participant signed up for the program. Of the 786,687 customers who viewed the website at least once in 2015, 65,877 were dually-enrolled in Energy Alerts.

Analysis Population

The analysis population for customers dually-enrolled in CWP and Energy Alerts, excluding those enrolled in SmartAC™ and SmartRate™, is 51,746 customers.

Level of Engagement

Figure 2-4 shows the distribution of dual-participating customers that engaged with the CWP program at various levels during 2015 compared to all CWP participants. Clearly, dual participants are more highly engaged with the CWP portal, viewing their interval data more often that the singly-enrolled participants:

- About 46% of dual participants viewed their data between 2 and 6 times in 2015, compared to 38% viewed of CWP-only participants.
- About 22% of dual participants viewed their data seven or more times compared to only 10% of CWP-only participants.

Figure 2-4 Comparison of CWP Program Engagement- PY2015

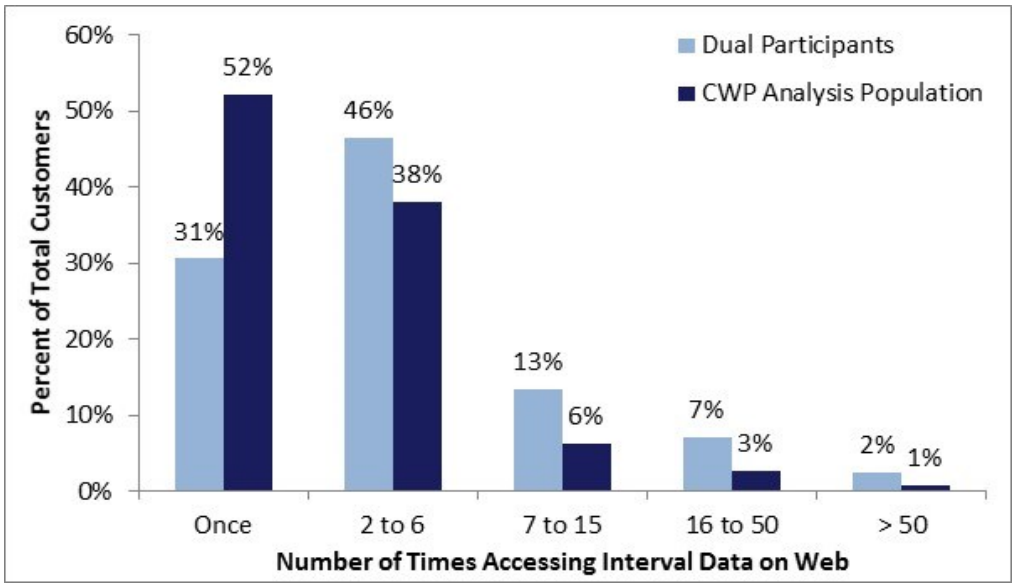
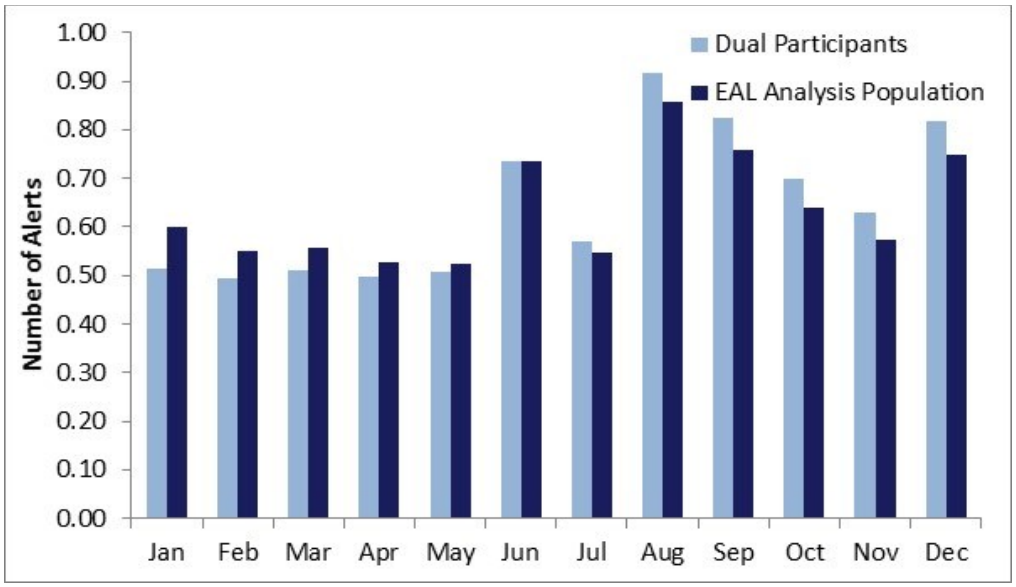


Figure 2-5 shows the average number of Energy Alerts dispatched to dual participants as compared to all participants in the Energy Alerts program throughout 2015. Seasonality again plays a role in the results. For January through May, dual participants on average received a lower number of alerts than Energy Alerts participants as a whole. In June, the number was roughly equivalent for the two

groups, with an average of 0.74 alerts. In July through December, dual participants on average received a greater number of alerts than the whole group indicating that dual participants tend to be higher users than singly-enrolled participants.

Figure 2-5 Comparison Energy Alerts per Participant in PY2015



Analysis Methodology

This section describes the analysis methodology for the evaluation of the CWP and Energy Alerts programs. First, we describe the sample design process and the matching strategy used to match sample treatment customers to control customers. Next, we describe the analysis techniques we used to estimate the impacts of the two programs.

Sample Design

In previous evaluations, we found that by using very large samples we were able to detect small impacts with increased precision. Based on this experience, we selected large samples for the PY2015 analysis. In addition, we focused on optimizing the sample sizes for the individual subpopulations of interest to improve our ability to achieve statistically valid results within each subpopulation. As part of the optimization process, we stratified some population segments to reduce the variance of the estimates while keeping overall sample sizes manageable. For other subpopulations, we analyzed a census of participants, meaning that we included all participants who passed the data screening process.

We designed three different samples – one for single enrollment in CWP, another for single enrollment in Energy Alerts, and the last for dual participation. We segmented each sample into several subpopulations of interest which correspond to subpopulations for which we have estimated impacts in past years:

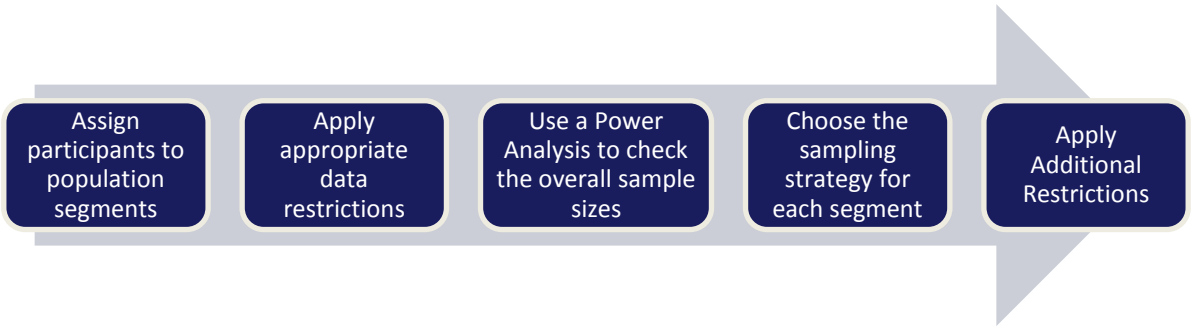
- **Singly-enrolled in CWP** (8 segments)
  - Level of engagement measured by number of times the participant viewed their usage data online (1 view, 2-6 views, 7-15 views, 16+ views)
  - Continuing versus new user
- **Singly-enrolled in Energy Alerts** (4 segments)
  - Notification type (email, SMS/phone)
  - Number of alerts during the year (5 or fewer, greater than 5)[5]
- **Dual Participation in both Energy Alerts and CWP** (32 segments)
  - Notification type (email, SMS/phone)
  - Number of alerts (5 or fewer, greater than 5)
  - Level of engagement (1 view, 2-6 views, 7-15 views, 16+ views)
  - Continuing versus new user

Since there are 32 population segments for dual participants, we only present dual participation results at the CWP or Energy Alerts level in this report.

Figure 3-1 illustrates this sample design process. Following these steps allowed us to optimize the sample sizes and mitigate excessive interval data processing. More importantly, this optimization process helped to ensure that even small savings, if present, would be detected with statistical significance at both the population level and within the desired subpopulations.

[5] During the 2012 evaluation we conducted a survey of Energy Alerts participants to try to determine which customers were more likely to take action. We found that those that received fewer than 5 alerts, likely with usage that is on the borderline of Tiers 2 and 3, were most likely to take actions to conserve in response to alerts.

Figure 3-1 Illustration of Sample Design Process



The steps are described in more detail below:

- **Assign each participant to the appropriate segment**. This step consists of classifying the participants into the population segments defined above for each of the three samples. It also includes categorizing participants by enrollment period.
- **Apply restrictions and exclude data where necessary.** We apply nine types of restrictions to ensure we have sufficient data for the analysis and to exclude customers who also participated in other programs to avoid double counting the impacts. The restrictions are as follows:
  - Energy Alerts participants who un-enrolled before October 1, 2015
  - Participants that started (Energy Alerts enrollment date or CWP first visit) on or after June 1, 2015[6]
  - Participants who participated in SmartAC™ or SmartRate™ during the pretreatment period or 2015[7]
  - Participants without demographic data
  - Participants with billing data identified as problematic during our cleaning process
  - Participants without at least seven months of 2015 billing data
  - Participants without at least seven months (212 days) of 2015 interval data
  - Participants without nine months of pretreatment billing data
  - Participants without nine months (270 days) of pretreatment interval data
- **Power analysis.** To check the statistical power of each sample we used a power analysis tool that AEG developed for PG&E. This tool uses a statistical power calculation to determine the sample size needed to detect statistically significant monthly savings for a given effect size. This will provided us a confirmation that the total sample size for each sample should be able to detect an effect size of 1% with and alpha level of 0.05 and beta level of 80%.[8]
- **Choose the sampling strategy and select the sample**. For each segment in each of the three samples, we select either a usage-based stratified sample, a simple random sample, or a census based on our past evaluation results and the number of participants in the segment.
- **Apply additional restrictions**. Finally, we excluded any participants with interval data identified as problematic during our cleaning process.

[6] In addition to having limited analysis data for these customers in the treatment period, we believe we cannot accurately assign them to a proper segment. For example, if a customer started participating in November 2014 and received two alerts through the end of the year, we don't know how many more alerts they would have received had they started participating earlier.

[7] We exclude participants that participated in SmartAC and SmartRate to avoid double counting of savings. When savings are estimated for the other programs, the savings attributable to CWP or Energy Alerts would be embedded in those estimates, if we count them again here, we would count the CWP or Energy Alerts savings for those customers twice.

[8] The alpha level is our significance, we will have a 95% change of detecting an effect of the given effect size given that it exists. The beta level is the probability of a type II error, or failing to detect an effect that is present.

The subsections below describe the sample design results for singly-enrolled participants of CWP, singly-enrolled participants of Energy Alerts, and dual participants of both CWP and Energy Alerts.

Singly-enrolled CWP Sample Design

We first divide the CWP analysis population into the eight segments listed previously and apply the data restrictions.[9] We began with a pool of 667,731 participants, after applying all the data restrictions the total analysis pool shrinks to 285,998 which is 43% of the total original pool. The majority of participants are removed due to lack of sufficient pre-treatment interval data and/or pretreatment billing data. Recall that the participation start dates range from 2010 – 2015 with many customers having pretreatment periods that reach back several years in time. The farther back the pretreatment period is, the more likely a participant is to be excluded based on lack of interval or billing data. See Appendix A Potential Sample Bias for an exploration of the bias this may introduce.

Table 3-1 shows the breakdown of the number of participants in the sample for each CWP population segment. Of the eight CWP population segments, we concluded that six would be best suited for energy usage-based stratification (shaded in light blue). For the remaining two, we determined it was necessary to use the entire population of screened participants. The total sample size for the singly-enrolled CWP participants was 15,625.

Table 3-1 Singly-enrolled CWP Sample Breakdown

Number of Visits	Participant Count (New)	Participant Count (Continuing)	Total Participants
1 Visit	1,500	1,500	3,000
2 to 6 Visits	1,500	1,500	3,000
7 to 15 Visits	2,627	3,000	5,627
More than 15 Visits	998	3,000	3,998
Total	6,625	9,000	15,625

Singly-enrolled Energy Alerts Sample Design

Similarly, we divide the EAL analysis population into the four segments listed previously and apply the data restrictions.[10] We began with a pool of 38,526 participants, after applying all the data restrictions the total analysis pool shrinks to 19,265 which is 50% of the total original pool.[11]

Table 3-2 shows the breakdown of the number of participants in the sample for each Energy Alerts population segment. We concluded that it was necessary to sample two of the four Energy Alerts population segments (again shaded in light blue). These two cells were sampled primarily to keep overall sample sizes manageable. The total sample size for the singly-enrolled Energy Alerts participants was 9,874.

[9] Our analysis pool consists of all singly-enrolled CWP participants (i.e., they are not also enrolled in Energy Alerts) who viewed data at least once in 2015, and are not enrolled in SmartRate™ or SmartAC™.
[10] Our analysis pool consists of all singly-enrolled EAL participants (i.e., they are not also enrolled in CWP) who received at least one alert in 2015, and are not enrolled in SmartRate or SmartAC.
[11] The majority of participants are removed due to lack of sufficient pre-treatment interval data and/or pretreatment billing data. Recall that the participation start dates range from 2010 – 2015 with many customers having pretreatment periods that reach back several years in time. The farther back the pretreatment period is, the more likely a participant is to be excluded based on lack of interval or billing data. See Appendix A Potential Sample Bias for an exploration of the bias this may introduce.

Table 3-2 Singly-enrolled Energy Alerts Sample Breakdown

Number of Alerts	Participant Count (E-mail)	Participant Count (SMS/phone)	Total Participants
5 or less	2,508	1,366	3,874
More than 5	3,000	3,000	6,000
Total	5,508	4,366	9,874

Dual Participation Sample Design

Similarly, we divide the Dual participation analysis population into the 32 segments listed previously and apply the data restrictions.[12] We began with a pool of 51,746 participants, after applying all the data restrictions the total analysis pool shrinks to 18,499 which is 36% of the total original pool.[13]

For the dual participants we take a slightly different approach, and use a simple random sample in any cell that exceeds 400 remaining participants. Because we do not look at the results in each segment individually, but rather combine the smaller segments to analyze the results as either CWP, or EAL impacts, we use a simple random sample instead of a stratified sample. This allows us to keep the sample size manageable without overcomplicating the analysis. Table 3-3 shows the breakdown of the number of participants in the sample for each Dual population segment; sampled cells are highlighted in light blue. The total sample size for the dually-enrolled participants was 8,807.

Table 3-3 Dual Participation Sample Breakdown

Number of Alerts	Number of Visits	New Participant Count (E-mail)	New Participant Count (SMS/phone)	Continuing Participant Count (E-mail)	Continuing Participant Count (SMS/phone)	Total Participants
5 or less	1 Visit	400	302	400	280	1,382
	2 to 6 Visits	400	368	400	400	1,568
	7 to 15 Visits	59	41	224	116	440
	More than 15 Visits	35	26	151	65	277
More than 5	1 Visit	400	400	400	400	1,600
	2 to 6 Visits	400	400	400	400	1,600
	7 to 15 Visits	160	143	400	400	1,103
	More than 15 Visits	79	59	400	299	837
Total		1,933	1,739	2,775	2,360	8,807

Creating the Matched Control Groups

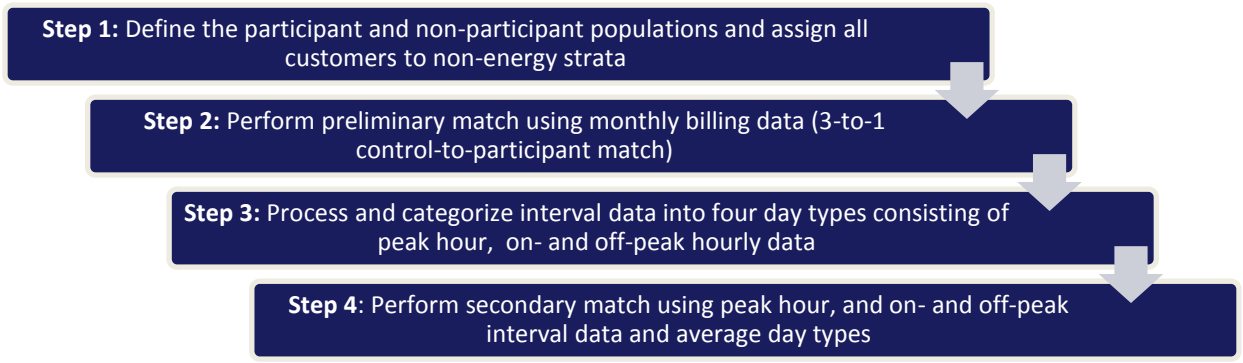
We estimated the energy savings for each program by comparing the energy use of participating customers with a carefully selected control group of non-participating customers who are also My Energy users. We used a stratified matching technique to construct a control group that is very similar to the participant group in all observable ways, except for being exposed to the program treatment.[14] Figure 3-2 and the subsequent text describe the four key steps in the matching process.

[12] Our analysis pool consists of all singly-enrolled CWP participants (i.e., they are not also enrolled in Energy Alerts) who viewed data at least once in 2015, and are not enrolled in SmartRate™ or SmartAC™.

[13] The majority of participants are removed due to lack of sufficient pre-treatment interval data and/or pretreatment billing data. Recall that the participation start dates range from 2010 – 2015 with many customers having pretreatment periods that reach back several years in time. The farther back the pretreatment period is, the more likely a participant is to be excluded based on lack of interval or billing data. See Appendix A Potential Sample Bias for an exploration of the bias this may introduce.

[14] In a pilot setting it is often possible to use an experimental design with randomized assignment to treatment and control groups to control for self-selection bias. Self-selection bias is the presence of systematic differences between customers who volunteer for a program or treatment and those who do not. Self-selection bias is problematic because the estimates of

Figure 3-2 Illustration of Matching Process



Step 1 is to define non-participant population and the treatment and pre-treatment periods for each participant. We limited the non-participant pool to those customers that signed up for My Energy, but did not participate in CWP, Energy Alerts, or any other excluded PG&E program. This ensures that potential control group customers have internet access and actively engage with PG&E through their website, making them more similar to CWP and Energy Alerts participant than those that would not have those characteristics.

Defining the treatment and pre-treatment periods for each participant is a little be more complex. Both CWP and Energy Alerts are fully deployed programs in which participants can enroll or un-enroll freely. This means that pretreatment periods are customer specific. In order to avoid creating too many groups based on enrollment, we created several distinct enrollment windows and defined the pretreatment period as the 12 months immediately prior to the start of the enrollment window. To keep summer months together, we split the years into two six-month blocks, from December to May and from June to November, where all months but December belonged to the same year.

Once the non-participant population is identified, both the treatment and candidate control group pools were assigned to strata or filters that are categorical in nature. We used PG&E defined weather zones, Community Choice Aggregation (CCA) status, housing type (single family vs. multi-family), and net energy metering (NEM) status as filters. This ensures that customers in similar regions and with similar home types will be matched to one another capturing some of the unobservable attributes that affect the way customers use energy. After developing strata based on their region, home type, CCA and NEM status, all of the customers, both participants and the non-participant pool, were assigned to a specific group based on their strata. At this stage, we ensured that there were enough control customers in each strata. Usually, a ratio of 10 control customers to each treatment customer is sufficient.

Step 2 is to perform the preliminary match based on billing data. To determine how close each treatment customer is to a potential match, we used a Euclidean distance metric. The Euclidean distance is defined as the square root of the sum of the squared differences between the matching variables. Any number of relevant variables can be included in the Euclidean distance. For this preliminary match, we included twelve months of pre-treatment calendarized billing data with a rolling pre-treatment window based on the participant's start date. The Euclidean distance for this set of variables can be calculated by Equation 1 below.

$$ED = \sqrt{(jan_{Ti} - jan_{Ci})^2 + (feb_{Ti} - feb_{Ci})^2 + \ldots + (nov_{Ti} - nov_{Ci})^2 + (dec_{Ti} - dec_{Ci})^2} \quad (1)$$

After calculating the distance metric within each group for each possible combination of treatment and control customer, the control customer with the smallest distance is matched to each treatment

savings cannot be separated from the systematic differences between treatment and control customers. Matching participants to the control group can help eliminate bias for any observable characteristic. Using only those customers who have accessed My Energy for the control group also helps reduce bias, since this captures some of the unobservable characteristics of online users. However, because we cannot fully duplicate the results of a designed experiment through matching, the matches will necessarily have some level of bias, and the estimates will also have some level of uncertainty.

customer without replacement. We selected the three closest matches for each of our treatment customers creating a smaller control group pool with a 3-to-1 ratio of control to treatment customers.

Step 3 is to use pre-treatment interval data for both the treatment and control customers to create new variables that can be used to create a one-to-one match that will be suitable for hourly modeling. In this case, we want the control and treatment customers to have not only similar energy usage, but have similar daily and seasonal load shapes. For the secondary match, we included the following variables in the distance metric.

- Summer Weekday: average on-peak kWh, average off-peak kWh, maximum on-peak kW
- Summer Weekend: average on-peak kWh, average off-peak kWh, maximum on-peak kW
- Winter Weekday: average on-peak kWh, average off-peak kWh, maximum on-peak kW
- Winter Weekend: average on-peak kWh, average off-peak kWh, maximum on-peak kW

We also weight the variables to reflect the relative importance of the estimates, with maximum on-peak variables having the most weight and off-peak variables having the least weight.

Step 4 is to use the same process described above in Step 2 to generate a one-to-one match of treatment to control customers out of the pre-matched pool based on the seasonal and day-type variables described above.

Estimating Energy Savings

Once the matching process is complete, we estimated the monthly and daily on and off-peak impacts first using a statistical DID approach, and second, using a fixed-effect regression approach. This two-step process allows us to obtain preliminary estimates of savings that are unconstrained by the assumptions of a regression model. Then, we refine those estimates using the regression approach. Both the statistical DID and regression based approaches are described below.

Statistical DID Approach – Estimating Preliminary Impacts

The difference-in-differences method compares the daily or monthly usage of the treatment customers to the matched control group customers, both during the participation period (treatment period) and for a time before participation started (pretreatment period). Comparison during the treatment period gives an unadjusted estimate of the impacts. This estimate is then corrected using the difference during the pretreatment period to adjust for any preexisting differences between the participant and control groups.

The DID method consists of the following steps for each of the three samples.

- **Input source data** – Start with either monthly or hourly interval data for the treatment and pretreatment periods for participating customers and a control group.
- **Create average load shapes for the daily analysis** – For each participant and matched control group customer, calculate the average load shape for each day type during the pretreatment and treatment periods. Then, average the load shapes across all customers for both the pretreatment and treatment periods.
- **Calculate first difference** – For the daily analysis, calculate the difference between the control group's average load and the participant group's average load for each day type, in the treatment period and in the pretreatment period. The result of the difference during the treatment period is the first difference, which represents the unadjusted impact. For the monthly analysis calculate the difference between the control and treatment group's monthly usage in the treatment and pretreatment period.
- **Calculate second difference** – The result of the difference during the pretreatment period is the pretreatment difference. Subtract pretreatment difference for each day type or month from the unadjusted impact to get the adjusted or corrected impact for each population segment. This

second difference represents the estimated savings impacts for each day type or month corrected for the pre-participation differences between the treatment and control groups.

- **Estimate impacts for subpopulations** – Aggregate the results for each population segment to determine average monthly and annual impacts. Estimate demand and energy impacts for each day type using the day type estimates. Estimate the monthly and annual savings for the program using the monthly estimates.
- **Estimate program-level impacts for the population** – Apply the appropriate weights to the population segment results to expand them to the entire population.
- **Determine statistical significance** – Create 95% confidence intervals around the savings estimates. If we determine that the difference in consumption is statistically significant, this indicates that we can be 95% certain that the actual savings value for the subpopulation or population falls within the confidence interval and is not equal to zero.

Equation 2 shows a simplified form of the mathematical calculations used in the difference-in-differences analysis to estimate energy savings for each day type or month.

$$Savings = (Cntl_{after} - Tx_{after}) - (Cntl_{before} - Tx_{before}) \quad (2)$$

Where

$Cntl_{after}$ is the average control group customer energy use in the treatment (after) period

Tx_{after} is the average participant group (also referred to as the treatment group) customer energy use in the treatment (after) period

$Cntl_{before}$ is the average control group customer energy use in the pretreatment (before) period

Tx_{before} is the average participant group customer energy use in the pretreatment (before) period

Fixed Effect Regression Approach – Refining the Estimates

The models include the treatment and control customers in both the treatment and pre-treatment periods. This type of data is generally referred to as panel data and can be modeled in several different ways. However, it is important to recognize that panel data has some inherent issues:

- Panel data tends to be auto correlated, which simply means that the variables are correlated through time. For example, electricity use during a particular hour on one day is likely to be highly correlated with electricity use in that hour on the prior day.
- Panel data is also often heteroskedastic, which means that the variances associated with the variables are not constant. For example, customers that use more electricity are likely to have larger variances, and those that use less electricity are likely to have smaller variances.

The presence of these issues introduces additional considerations into the modeling approach. A fixed-effect model introduces indicator variables for each participant which are used to capture and control for unobservable customer-specific effects. The robust error correction adjusts the standard errors and t-statistics to account for autocorrelation and heteroskedasticity that would otherwise bias these values.

Monthly Ex Post Impacts

Equation 3 presents a simplified version of the model we used to estimate the monthly savings for each of the programs. The models were developed at the segment level and included the application of the stratum weights in the analysis.

$$kwh_{it} = \alpha_i + [\gamma_{1t} + \gamma_{2t}P(x)]Month_t + [\gamma_{3t} + \gamma_{4t}P(x)]CDD_t + \beta_t P(x)T(x)Month_t + \varepsilon_{it} \quad (3)$$

Where the variables and their coefficients are defined as:

kwh_{it}	Consumption of customer i in month t
α_i	A fixed effect for each customer i
$[\gamma_{1t} + \gamma_{2t}P(x)]Month_t$	A vector of monthly indicator variables where $P(x)$ is an indicator variable that takes on a value of one during the treatment period
$[\gamma_{3t} + \gamma_{4t}P(x)]CDD_t$	The cooling effect of month t where $P(x)$is an indicator variable that takes on a value of one during the treatment period
$\beta_t P(x)T(x)Month_t$	A vector of monthly indicator variables where $P(x)$ is an indicator variable that takes on a value of one during the treatment period and $T(x)$ is an indicator variable that takes on a value of one if a customer i is a program participant
ε_{it}	The error for customer i during month t

The model output allowed us to estimate the effect of the programs in each month of 2015. We then calculated the savings from the coefficients estimated in the model both at the segment and program level. Finally, we used a statistical software package to output the standard error of each of the impact estimate. The standard errors are used to calculate confidence intervals for the point estimates. Please see Appendix B Model Selection and Validation for a discussion of our model validation process.

On- and Off-Peak Ex Post Impacts

We developed eight day types for the average on- and off-peak impact analysis. These day types are consistent with the day types developed in previous evaluations and will allow us to produce comparable results across years. We used the distribution of temperatures in each weather station to establish cut-offs for the different day types at the 85th and 15th percentiles. Below we present the eight day types:

- Hot summer weekday – an average of approximately 8 to 12 days on which average temperature exceeds the 85th percentile for that weather station
- Typical summer weekday – all summer weekdays not already defined as "hot" or "cold"
- Cool summer weekday – an average of approximately 8 to 12 days on which average temperature falls below the 15th percentile for that weather station
- Summer weekend – an average of all summer weekends.
- Warm winter weekday – an average of approximately 8 to 12 days on which average temperature exceeds the 85th percentile for that weather station
- Typical winter weekday – average of all winter weekdays not defined as "warm" or "cold"
- Cold winter weekday – an average of approximately 8 to 12 days on which average temperature falls below the 15th percentile for that weather station
- Winter weekend – an average of all winter weekends.

While we developed on-peak and daily models at the segment level to estimate the savings, we were unable to achieve consistent statistically significant estimates at the program level due to the very small savings estimates. Therefore, we used the DID results to estimate the on-peak and daily impacts for each segment and program.

Accounting for Dual Participation

When we estimate the savings for each program, it is important to account for dual participation. We do this by estimating the savings in two pieces: first, for the singly-enrolled participants, and second, for the dually-enrolled participants. The savings estimates for the singly-enrolled participants

represent the impacts from the treatment program only, while the savings estimates from the dually-enrolled participants tell us what the additional, or incremental, savings attributable to the second program are for the dually-enrolled treatment customers. It is important to note that the estimate of savings for the secondary program is indicative of savings only for dually-enrolled customers, since we cannot be sure if their participation in the first program influences their savings from the second program and vice-versa.

Impact Results

We estimated savings for singly-enrolled CWP participants, singly-enrolled Energy Alerts participants, and dual participants participating in both CWP and Energy Alerts. First we provide the matching results and then we present the energy impacts for single participation in each program and dual participation. The dual participation results tell us the incremental effect of participating in both programs on the impacts for CWP and Energy Alerts.

Matching Results

Before estimating the savings, it is important to check the quality of the match between the treatment and control customers. We do this by plotting average hourly pretreatment energy use of the treatment and control customers on the same graph and comparing the load shapes for each day type in each enrollment window. We used four matching day types using season and day of the week—summer weekday, winter weekday, summer weekend, and winter weekend. Summer is defined as the months May through October. Comparing usage gives us a good idea of how well customers are matched.

Figure 4-1 through Figure 4-3 show examples of matching results for singly-enrolled CWP participants, singly-enrolled Energy Alerts participants, and dual participants, respectively. The graphs compare average hourly energy use for treatment and control customers during the pretreatment period on summer weekdays. The blue line represents the participant load shape and the orange line represents the control group load shape. The dotted red line that runs along the bottom of the graph represents the difference between the treatment and control groups. The results in the figures are for the enrollment window that corresponds to December 2014 through May 2015.

The figures illustrate that the matching process performed very well, with similar energy usage between treatment and control customers during the pretreatment periods for each of the three participant populations. In general, the closeness of these matching results for the December 2014 through May 2015 enrollment window is representative of what we observed for the other enrollment windows. An exception is the first enrollment window (December 2009 to May 2010), for which the CWP match was not as close.

Figure 4-1 Pretreatment Usage Comparison for Singly-enrolled CWP Sample: Enrollment Window December 2014 through May 2015, Summer Weekday

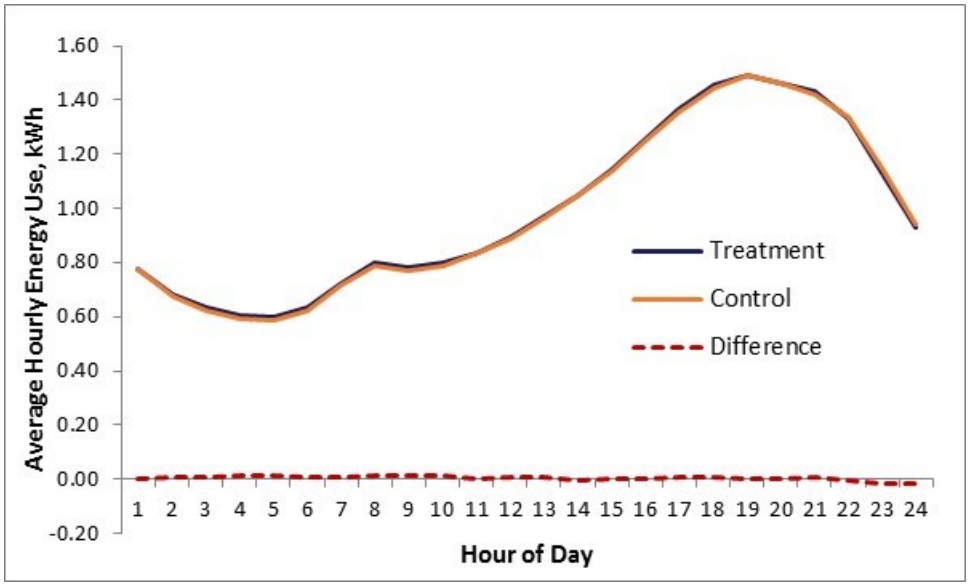


Figure 4-2 Pretreatment Usage Comparison for Singly-enrolled Energy Alerts Population: Enrollment Window December 2014 through May 2015, Summer Weekday

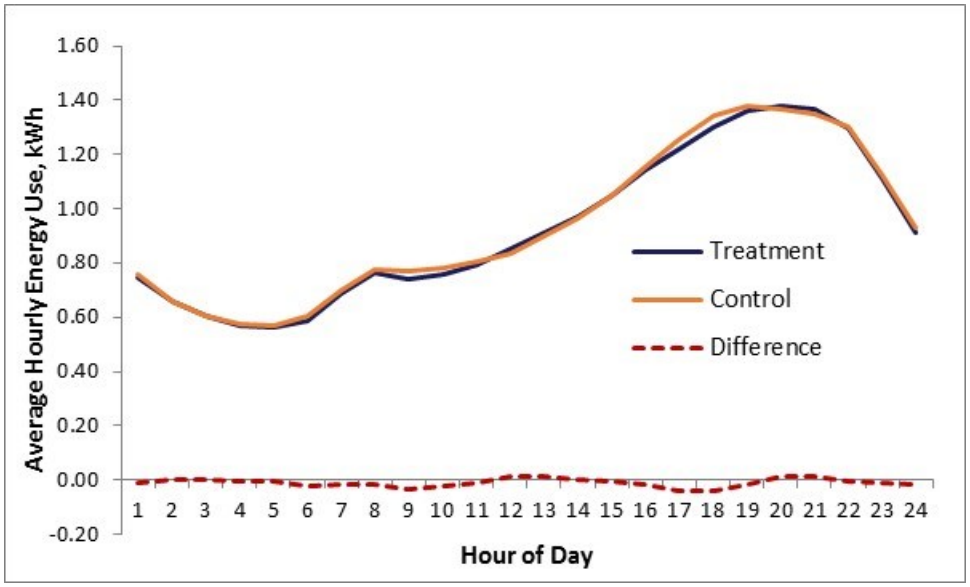
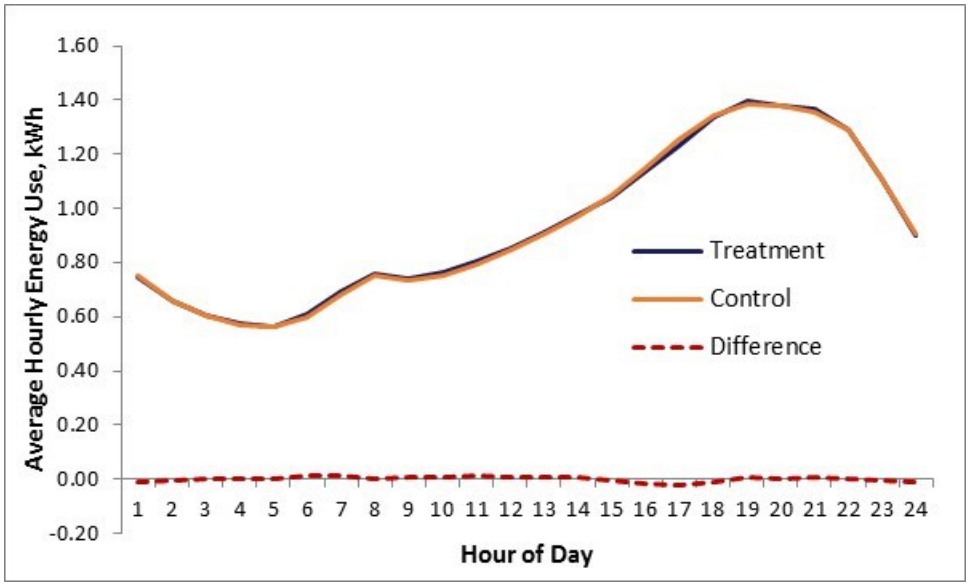


Figure 4-3 Pretreatment Usage Comparison for Dual Participation Population: Enrollment Window December 2014 through May 2015, Summer Weekday



To quantify the degree to which pretreatment energy usage between the treatment and control customers was different, we ran hourly two-sample t-tests for each of the four day types in each of the enrollment windows for singly-enrolled CWP participants, singly-enrolled Energy Alerts participants, and dually-enrolled participants. For each of the three samples in the June 2015 through November 2015 enrollment window, we conducted 24 hourly t-tests by day type. That corresponds to 288 comparisons, only one of which was significant at the 90% level, but just barely (p-value = 0.0949). For succinctness, we only show t-tests comparing *daily* energy during summer and winter weekdays for the three program groups in the June 2015 through November 2015 enrollment window in Table 4-1 below. None of the daily comparisons are statistically significant implying that the differences between control and treatment groups are not significant.

It should be noted that while in the section above we use a single enrollment window as an example to illustrate the matching results, we found that the results were very similar across all enrollment windows. We performed the hourly comparisons for each program, day type, and hour for each of the twelve enrollment windows. In total, 3,456 comparisons were made. Overall, across all programs only 0.01% of hours are statistically significantly different from their matches.

Table 4-1 Comparison of Average Daily Energy: Enrollment Window June 2015 through November 2015

Subpopulation	Day Type	Control	Treatment	p-value
Singly-enrolled CWP	Summer Weekday	30.45	30.54	0.88
	Summer Weekend	32.07	32.24	0.79
	Winter Weekday	23.92	24.02	0.82
	Winter Weekend	24.92	24.99	0.88
Singly-enrolled Energy Alerts	Summer Weekday	23.11	23.18	0.77
	Summer Weekend	24.38	24.44	0.76
	Winter Weekday	18.89	18.98	0.49
	Winter Weekend	19.77	19.85	0.79
Dually-enrolled	Summer Weekday	24.20	24.06	0.99
	Summer Weekend	25.69	25.79	0.88
	Winter Weekday	19.51	19.54	0.95
	Winter Weekend	20.52	20.61	0.73

Customer Web Presentment Results

CWP Energy Savings

In order to assess annual energy savings, we estimated savings at the monthly level using both the difference in differences and regression approaches with comparable results. The results presented throughout this chapter are based on the regression results, for a comparison of the two methods please see Appendix B, Model Selection and Validation.

The analysis results in average per-participant savings estimates for each month in 2015. The annual total is simply the sum of each statistically significant point estimate and the associated percentage impact is based on the total estimated usage for the year—that is, the adjusted control group load.

Table 4-2 summarizes our findings for CWP, for both singly- and dually-enrolled participants. For singly-enrolled CWP participants, we were unable to detect statistically significant savings 2015. Later in this chapter, as we look at the segment-level results, we find that participants in highly-engaged segments, who view their usage online more than six times, have some significant positive savings however because at the program level those savings are very small, they could not be detected by either approach.

Dually-enrolled CWP participants, on the other hand, show positive savings across the year, and statistically significant savings during the summer and fall months. We saw a slight increase in the savings for dually-enrolled participants in 2015, from approximately 0.38% at the program level last year, to a little over one percent at the program level this year. It is important to note that the savings for the dually-enrolled customers appears to be driven primarily by Energy Alerts participation rather than CWP participation.

The program level savings for singly-enrolled CWP participants is 0%. Dually-enrolled participants are saving, on average, 1.10% across PY 2015.

Table 4-2 Average Per-Participant Energy Savings: All CWP Participants

Month	All Singly-enrolled Participants n= 667,731			All Dually-enrolled Participants n= 51,746		
	Savings (kWh)	90% CI	% Impact	Savings (kWh)	90% CI	% Impact
January	-3.75	6.77	-0.97%	-4.50	28.15	-1.07%
February	-10.60	26.88	-2.66%	5.04	16.61	0.93%
March	-9.49	19.59	-2.20%	5.07	14.59	0.88%
April	-3.38	16.56	-0.86%	7.45	12.55	1.36%
May	-0.33	15.42	-0.10%	1.02	12.91	0.18%
June	-6.08	17.05	-1.17%	8.96	18.24	1.14%
July	-4.38	17.80	-0.77%	21.01	20.67	2.43%
August	0.90	16.52	0.14%	23.85	18.55	2.79%
September	4.84	14.80	0.88%	25.37	14.89	3.43%
October	6.97	14.15	1.46%	16.65	12.82	2.65%
November	3.06	16.32	0.63%	11.83	13.00	1.90%
December	-17.11	25.16	-3.47%	-4.49	28.97	-0.62%
Annual Total	**0.00**		**0.00%**	**86.88**		**1.10%**

Blue indicates statistically significant savings.

In order to estimate the overall energy savings for the CWP program, we multiply the average annual per participant savings by the total number of singly- and dually-enrolled participants. We can then sum the energy savings for the two subpopulations. It is important to note that savings for dual participants will also be counted in the Energy Alerts section. We present the overall program level energy savings below in Table 4-3.

Table 4-3 Total Annual CWP Energy Savings: All CWP Participants[15]

Subpopulation	Number of Participants	Annual Savings (kWh per customer)	Total Savings (MWh)
Singly-enrolled Participants	667,731	0	0
Dually-enrolled Participants	51,746	86.88	4,496
Total CWP Energy Savings	**719,477**	**86.88**	**4,496**

Segment Level Results

We also performed a monthly analysis at the segment level (identical to the program level analysis above) for each of the 16 CWP segments; however, full presentation of the monthly segment level results in the body of the report is prohibitive.

In Table 4-4 below, we show the estimated annual segment level savings for singly- and dually-enrolled program participants. The program level savings estimates on the far right of the table were calculated by summing all of the statistically significant segment level estimates for both the dually and singly-enrolled participants. The total annual savings based on the segment level estimates are different from the overall program savings shown above. This is because while we cannot always estimate statistically significant savings at the program level because of the variation among

[15] We do not include confidence intervals for the total annual savings estimates. We perform the analysis at the monthly level, and then we add the point estimates that are statistically significant across the months. This provides us with a valid estimate of the annual savings, and valid confidence intervals at the monthly level, however, we cannot similarly add the confidence bands across months to obtain an annual confidence interval. One must take into account the covariance between months. Given the complexity of the calculation, we did not estimate the annual confidence intervals here taking into account the covariance. However, one can be sure, given that each individual month is statistically significant, that the overall estimate will also be statistically significant.

customers, we are often able to estimate the savings at the segment level. We present these estimates to provide insight into which customers are saving more or less across segments only; we use estimates in Table 4-3 above when we claim savings for the CWP program as a whole.

Overall, in the continuing group, highly engaged participants save more energy than less engaged participants, which is consistent with the results of previous evaluations. In addition, continuing participants tend to save more than new participants. We were unable to detect any statistically significant savings in any group that viewed the web only one time in 2015. Among singly-enrolled customers, we see significant positive savings in the highest engagement groups and some very small negative savings in the new segments. Given the extremely small savings, and smaller samples in these groups, the negative savings may be an artifact of random variation rather than true savings.

In contrast for the dually-enrolled customer, we see significant savings in the less engaged groups. It should be noted that all four segments did show positive point estimates in all months of similar magnitude, unfortunately the sample sizes in the highly engaged groups were too small to show significant savings. For the dually-enrolled continuing participants, we see statistically significant positive savings in the most highly engaged segment and statistically significant negative savings for the least engaged group.

Table 4-4 2015 CWP Segment Level Annual Energy Savings

Segment	Number of participants	Per-customer annual savings (kWh)	Annual percent savings	Total segment level savings (kWh)
Singly-enrolled				
Continuing: 1 View	91,221	NS	NS	NS
Continuing: 2 to 6 Views	108,032	(23)	-0.48%	(2,509,658)
Continuing: 7 to 15 Views	24,156	164	3.21%	3,955,696
Continuing: More than 15 Views	13,888	468	6.34%	6,494,954
New: 1 View	268,249	NS	NS	NS
New: 2 to 6 Views	141,739	(59)	-0.98%	(8,358,197)
New: 7 to 15 Views	14,159	(110)	-1.58%	(1,563,024)
New: More than 15 Views	6,287	124	1.76%	777,713
Total / Average	**667,731**	**(2)**	**-0.02%**	**(1,202,516)**
Dually-enrolled				
Continuing: 1 View	7,472	(31)	-0.40%	(234,101)
Continuing: 2 to 6 Views	13,862	NS	NS	NS
Continuing: 7 to 15 Views	4,670	NS	NS	NS
Continuing: More than 15 Views	3,608	441	4.52%	1,589,481
New: 1 View	8,351	221	2.96%	1,845,486
New: 2 to 6 Views	10,158	129	1.68%	1,314,092
New: 7 to 15 Views	2,300	NS	NS	NS
New: More than 15 Views	1,325	NS	NS	NS
Total / Average	**51,746**	**87**	**1.01%**	**4,514,958**

All the savings values shown are statistically significant. Insignificant values were replaced with "NS."

CWP Demand Savings

In addition to the monthly analysis, AEG evaluated the daily impacts of the CWP program. We created eight specific day types, shown in the following table, and provide information about the on- and off-peak savings estimates for each day type. The day types were based on the distribution of average daily temperatures in each participant and control group customer's representative weather station. The development of the day types is described in more detail above in Chapter 3. The on-

peak period is defined as the hours between 12:00p and 6:00p. When we calculate the per-participant demand savings in the tables in this section, we include all hours regardless of significance.[16]

At the program level, we were unable to detect statistically significant savings across any day type for the singly-enrolled participants. For the dually-enrolled participants, by contrast, we were able to detect statistically significant savings across several day types during the on-peak period. Still, the savings presented for the dually-enrolled participants below in Table 4-5 are small, in the 3% range, with a magnitude of less than 1/10th of a kW.

Table 4-5 Average Per-Participant Demand Savings: All Dually-enrolled Participants

	All Dually-enrolled Participants n = 51,746			
Day Type	Average On-peak kW Reduction	Average On-peak % Impact	Average Off-peak kW Reduction	Average Off-peak % Impact
Hot Summer	0.0499	2.69%	0.228	1.04%
Typical Summer	0.0416	3.70%	0.118	0.73%
Cool Summer	0.0141	1.89%	-0.025	-0.19%
Summer Weekend	0.0456	3.40%	0.117	0.68%
Cold Winter	0.0112	1.11%	0.182	1.00%
Typical Winter	0.0061	0.75%	-0.011	-0.07%
Warm Winter	0.0172	2.25%	-1.015	-0.11%
Winter Weekend	0.0116	1.17%	0.080	0.50%

Blue indicates statistically significant savings.

In order to estimate the overall demand savings for the CWP program on a hot summer day, we multiply the average annual per participant savings by the total number of singly- and dually-enrolled participants. We can then sum the energy savings for the two subpopulations. It is important to note that savings for dual participants will also be counted in the Energy Alerts section. We present the overall program level energy savings in Table 4-6.

Table 4-6 2015 CWP Program Level On-peak Demand Savings: Hot Summer Days

Subpopulation	Number of Participants	Average Impact (kW per customer)	Total Impact (kW)
Singly-enrolled Participants	667,731	0	0
Dually-enrolled Participants	51,746	0.0499	2,582
Total CWP Energy Savings	**719,477**	**0.0499**	**2,582**

Segment Level Results

Overall, looking at on- and off-peak savings across all CWP segments, we conclude the following:

- We were unable to detect consistent and meaningful statistically significant savings by day type for the less engaged participants. More specifically, those customers that viewed the website less than seven times in 2015 (both the singly- and dually-enrolled groups) displayed near zero savings estimates for all day types.

[16] We included all hours in the estimate of the on peak impact, regardless of statistical significance, because each is still a valid estimate. The on peak impact is the sum of the estimates, which are each random variables with a mean and a variance. The mean of the sum of the random variables is equal to the sum of the means of the random variables. The drawback of this approach is that because the estimates are correlated, they are not independent, so calculating the variance (and therefore the confidence interval or the significance) of that sum requires the use of all the covariances between all the estimates. The complexity of this process made it impractical here. However, if all or most of the individual estimates are significant, then it is very likely that their sum will also be significant.

- Consistent with the monthly results and analyses from previous years, we were able to estimate statistically significant savings more often for the highly engaged participants – those that viewed the website more than 15 times – particularly on "hot" and "typical" summer days.

Based on these high level findings, we have included on- and off-peak impacts and average daily load shapes for participants that viewed the web 15 or more times during 2015, on "hot" and "typical" summer days in the subsections below.

CWP Engagement Segment: More than 15 views

This section focuses on the most highly engaged participants, those with more than 15 views in 2015. Table 4-7 below shows the on- and off-peak impacts on both the "hot" and "typical" summer weekdays by CWP segment. While the estimates for the dually-enrolled new customers are not significant, both the magnitude and the consistent positive savings estimate suggest savings, unfortunately, our sample size is too small to achieve significance. For both the singly- and the dually-enrolled participants, the on-peak impacts on hot and typical days ranges from 7% to about 14% with the continuing, singly-enrolled customers saving the least, and the new, dually-enrolled customers saving the most. It is important to note that the savings for the new dually-enrolled customers represents only 105 participants (out of 1,325) and may be overstating the estimates for the true population. During the off-peak period, the savings are smaller and insignificant, with point estimates ranging from 2% to 7% for dually and singly-enrolled customers.

Table 4-7 Average Per-Participant Demand Savings CWP Participants: More than 15 Views[17]

			More than 15 Views			
Segment		Day Type	Average On-peak kW Reduction	Average On-peak % Impact	Average Off-peak kW Reduction	Average Off-peak % Impact
Singly	Continuing	Hot Summer	0.146	7.87%	0.059	4.95%
		Typical Summer	0.120	10.26%	0.048	5.38%
	New	Hot Summer	0.122	7.48%	0.041	3.72%
		Typical Summer	0.080	7.45%	0.015	1.76%
Dually	Continuing	Hot Summer	0.266	11.23%	0.108	7.33%
		Typical Summer	0.139	9.80%	0.056	5.28%
	New	Hot Summer	0.176	8.82%	0.034	2.66%
		Typical Summer	0.164	14.33%	0.047	4.92%

Blue indicates statistically significant savings.

Below in Figure 4-4 and Figure 4-5 we present the average per customer savings and load shapes for singly- and dually-enrolled CWP participants that viewed the website more than 15 times during 2015 on an average hot summer day.[18] These shapes are representative of the impacts on hot summer days presented in Table 4-7 above. The graph on the left shows the savings shape (or the second difference) and associated confidence intervals. The graph on the right shows the adjusted control group load and the treatment load shape.

When we look at the two figures below we see a clear separation between the treatment and control group load, particularly during the on-peak period. We also see a corresponding savings shape that is above the zero line for much of the day with several statistically significant hours of savings during the on peak period.

[17] Note that we included all of the hours during the on- and off-peak periods in the estimate of kW savings regardless of significance, see footnote 12 above for a more detailed explanation.

[18] We include only the load shapes for the singly-enrolled participants in order to illustrate the load shapes and savings shapes. We do not include load shapes for the dually-enrolled participants in the body of the report, but all load shapes and savings shapes can be accessed in the spreadsheet attachment accompanying this report.

Figure 4-4 Average Per-Participant Savings: Hot Summer Day, Singly-enrolled, Continuing Participants, More than 15 Views

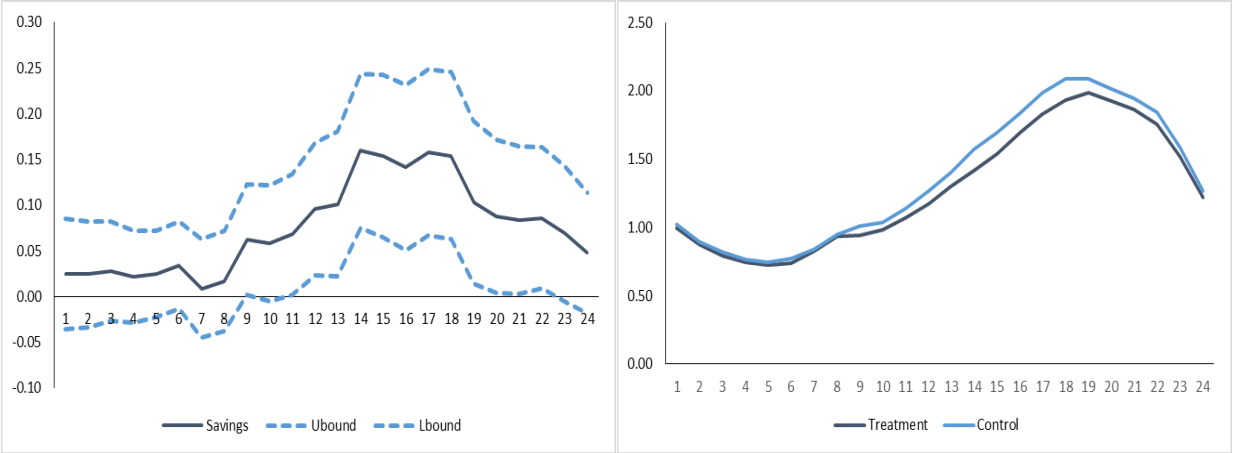
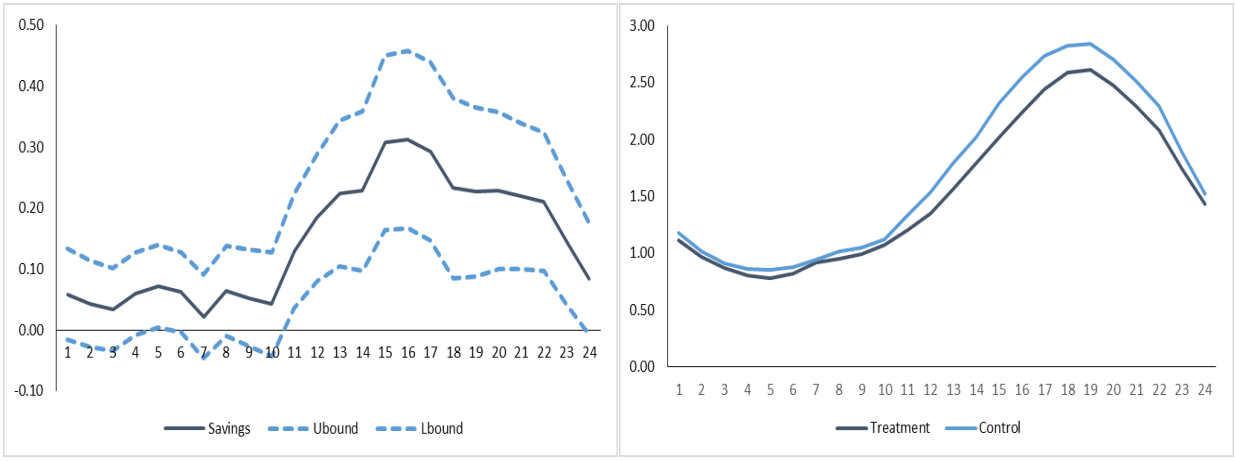


Figure 4-5 Average Per-Participant Savings: Hot Summer Day, Dually-enrolled, Continuing Participants, More than 15 Views



We do not include the load shapes for the newly-enrolled participants; however they are similar to those for continuing participants presented above.

We were also interested in quantifying the total on-peak demand impacts on the most relevant day type – the hot summer days. We estimated this impact by summing all of the statistically significant segment level estimates for both the dually and singly-enrolled participants. We estimate the impacts in this manner because while we cannot always estimate statistically significant savings at the program level because of the variation among customers, we are often able to estimate the savings at the segment level.

In Table 4-8 below, we present the statistically significant estimated on-peak kW impacts for each CWP segment and the total impact for that segment. At the bottom of the table, we sum the significant on-peak impacts across segments for singly- and dually-enrolled participants to estimate the impacts for the entire program.[19]

As with the segment level energy savings, the demand savings estimates are different from the program level estimates. This is because while we cannot always estimate statistically significant savings at the program level because of the variation among customers, we are often able to

[19] We determined whether to consider an estimate significant based on the percentage of significant hours within each period. An estimate had to have at least three significant intervals and all intervals had to have the same sign, i.e. all positive or all negative in order to be included in the table above as significant. By doing this we are assuming that if we were to explicitly estimate confidence intervals for the on-peak period in questions, they would maintain overall significance, even though some individual hours may not be significant on their own.

estimate the savings at the segment level. We present these estimates to provide insight into which customers are saving more or less across segments only, we use estimates in Table 4-6 above when we claim savings for the CWP program as a whole.

Table 4-8 2015 CWP Segment Level On-peak Demand Savings: Hot Summer Days

Segment	Number of Participants	Average On-peak Impact (kW)	Total Estimated Impact (kW)
	Singly-enrolled Participants		
Continuing: 1 View	91,221	NS	NS
Continuing: 2 to 6 Views	108,032	NS	NS
Continuing: 7 to 15 Views	24,156	0.0953	2,302
Continuing: More than 15 Views	13,888	0.1461	2,029
New: 1 View	268,249	NS	NS
New: 2 to 6 Views	141,739	NS	NS
New: 7 to 15 Views	14,159	NS	NS
New: More than 15 Views	6,287	0.1522	957
Total	**667,731**	**0.008**	**5,288**
	Dually-enrolled Participants		
Continuing: 1 View	7,472	NS	NS
Continuing: 2 to 6 Views	13,862	NS	NS
Continuing: 7 to 15 Views	4,670	0.1367	NS
Continuing: More than 15 Views	3,608	0.2663	961
New: 1 View	8,351	NS	NS
New: 2 to 6 Views	10,158	0.107	1,087
New: 7 to 15 Views	2,300	0.2272	NS
New: More than 15 Views	1,325	NS	NS
Total	**51,746**	**0.737**	**2,048**

All the savings values shown are statistically significant. Insignificant values were replaced with "NS."

Energy Alerts Results

Energy Alerts Energy Savings

Program Level Results

Customers participating in Energy Alerts show statistically significant savings for all 12 months during 2015. Dually-enrolled customers only show statistically significant savings for five out of 12 months. The monthly savings in kWh and as a percentage are presented below in Table 4-9. The savings for both the singly-enrolled and dually-enrolled participants are lower in 2015 than they were in 2014. When we examine the segment level results, we will see that this decrease was driven primarily by Energy Alerts participants, who received fewer than five emails.

Table 4-9 Average Per-Participant Energy Savings: All Energy Alerts Participants

	All Singly-enrolled Participants n = 38,526			All Dually-enrolled Participants n = 51,746		
Month	Savings (kWh)	90% C I	% Impact	Savings (kWh)	90% CI	% Impact
January	14.00	12.09	2.37%	-4.50	28.15	-1.07%
February	11.05	9.75	2.30%	5.04	16.61	0.93%
March	10.64	9.54	2.11%	5.07	14.59	0.88%
April	11.78	8.65	2.44%	7.45	12.55	1.36%
May	13.41	9.32	2.61%	1.02	12.91	0.18%
June	8.25	12.95	1.24%	8.96	18.24	1.14%
July	12.88	14.74	1.78%	21.01	20.67	2.43%
August	10.66	13.08	1.50%	23.85	18.55	2.79%
September	10.10	10.85	1.63%	25.37	14.89	3.43%
October	12.17	9.87	2.26%	16.65	12.82	2.65%
November	12.88	11.02	2.32%	11.83	13.00	1.90%
December	6.95	16.88	1.08%	-4.49	28.97	-0.62%
Annual Total	**85.93**		**1.22%**	**86.88**		**1.10%**

Blue indicates statistically significant savings.

To estimate the overall energy savings for the Energy Alerts program, we multiply the average annual per participant savings by the total number of singly- and dually-enrolled participants. We can then sum the energy savings for the two subpopulations. Note that savings for dual participants were also presented in the CWP section. We present the overall program level energy savings below in Table 4-10.

Table 4-10 Total Annual Energy Alerts Energy Savings: All Energy Alerts Participants[20]

Subpopulation	Number of Participants	Annual Savings (kWh per customer)	Total Savings (MWh)
Singly-enrolled Participants	38,526	85.93	3,310
Dually-enrolled Participants	51,746	86.88	4,496
Total Energy Alerts Energy Savings	**90,272**	**86.47**	**7,860**

Segment Level Results

We also performed a monthly analysis at the segment level (identical to the program level analysis above) for each of the eight Energy Alerts segments; however presentation of the monthly segment level results in the body of the report is prohibitive.

In Table 4-11 below, we show the estimated annual segment level savings for singly- and dually-enrolled program participants. The estimates were calculated by summing all of the statistically significant segment level estimates for both the dually and singly-enrolled participants. The total annual savings based on the segment level estimates are different from the overall program savings shown above. This is because while we cannot always estimate statistically significant savings at the program level because of the variation among customers, we are often able to estimate the savings at the segment level. We present these estimates to provide insight into which customers are saving

[20] We do not include confidence intervals for the total annual savings estimates. We perform the analysis at the monthly level, and then we add the point estimates that are statistically significant across the months. This provides us with a valid estimate of the annual savings, and valid confidence intervals at the monthly level, however, we cannot similarly add the confidence bands across months to obtain an annual confidence interval. One must take into account the covariance between months. Given the complexity of the calculation, we did not estimate the annual confidence intervals here taking into account the covariance. However, one can be sure, given that each individual month is statistically significant, that the overall estimate will also be statistically significant.

more or less across segments only; we use estimates in Table 4-10 above when we claim savings for the Energy Alerts program as a whole.

Table 4-11 2015 Energy Alerts Segment Level Annual Energy Savings

Segment	Number of Participants	Annual Savings (kWh)	Annual Percent Savings	Total Estimated Savings (MWh)
		Singly-enrolled		
Email: Fewer than 5 Alerts	7,767	713	12.72%	5,535
Email: More than 5 Alerts	15,568	NS	NS	NS
SMS/phone: Fewer than 5 Alerts	5,600	586	8.10%	3,280
SMS/phone: More than 5 Alerts	9,591	(64)	-0.77%	(618)
Total	**38,526**	**213**		**8,197**
		Dually-enrolled		
Email: Fewer than 5 Alerts	10,133	701	13.06%	7,108
Email: More than 5 Alerts	18,353	(40)	-0.44%	(737)
SMS/phone: Fewer than 5 Alerts	8,601	402	6.80%	3,455
SMS/phone: More than 5 Alerts	14,659	(110)	-1.11%	(1,619)
Total	**51,746**	**159**		**8,206**

All the savings values shown are statistically significant. Insignificant values were replaced with "NS."

For both the singly- and dually-enrolled groups, participants receiving five alerts or fewer show larger statistically significant savings on an annual basis, ranging from 8.10% to 13.06%. These are very similar to the 2014 results which ranged from 8% to 18% for participants receiving five alerts or fewer. For those receiving more than 5 alerts, the 2015 estimates show significant negative savings for three of the four segments.

Energy Alerts Demand Savings

Program Level Results

In addition to the monthly analysis, AEG evaluated the daily impacts at the program level by using the difference in differences methodology on hourly data. The development of the day types shown in the following tables is described in more detail above in Chapter 3. The on-peak period is defined as the hours between 12:00p and 6:00p. When we calculate the per-participant demand savings in the tables in this section, we include all hours regardless of significance.[21] Blue highlighted cells are statistically significant.[22]

[21] We included all hours in the estimate of the on peak impact, regardless of statistical significance, because each is still a valid estimate. The on peak impact is the sum of the estimates, which are each random variables with a mean and a variance. The mean of the sum of the random variables is equal to the sum of the means of the random variables. The drawback of this approach is that because the estimates are correlated, they are not independent, so calculating the variance (and therefore the confidence interval or the significance) of that sum requires the use of all the covariances between all the estimates. The complexity of this process made it impractical here. However, if all or most of the individual estimates are significant, then it is very likely that their sum will also be significant.

[22] We considered an estimate to be significant if more than 50% of the individual estimates were statistically significant.

Table 4-12 Average Per-Participant Demand Savings: All Singly-enrolled Participants

Day Type	All Singly-enrolled Participants n = 38,526			
	Average On-peak kW Reduction	Average On-peak % Impact	Average Off-peak kW Reduction	Average Off-peak % Impact
Hot Summer	0.0519	2.95%	0.018	1.60%
Typical Summer	0.0325	3.03%	0.013	1.46%
Cool Summer	0.0187	2.61%	0.020	2.79%
Summer Weekend	0.0276	2.16%	0.011	1.19%
Cold Winter	0.0186	1.86%	0.021	2.10%
Typical Winter	0.0182	2.36%	0.017	2.17%
Warm Winter	0.0228	3.04%	0.016	2.17%
Winter Weekend	0.0134	1.39%	0.015	1.77%

Blue indicates statistically significant savings.

Table 4-13 Average Per-Participant Demand Savings: All Dually-enrolled Participants

Day Type	All Dually-enrolled Participants n = 51,746			
	Average On-peak kW Reduction	Average On-peak % Impact	Average Off-peak kW Reduction	Average Off-peak % Impact
Hot Summer	0.0499	2.69%	0.013	1.04%
Typical Summer	0.0416	3.70%	0.007	0.73%
Cool Summer	0.0141	1.89%	-0.001	-0.19%
Summer Weekend	0.0456	3.40%	0.006	0.68%
Cold Winter	0.0112	1.11%	0.010	1.00%
Typical Winter	0.0061	0.75%	-0.001	-0.07%
Warm Winter	0.0172	2.25%	-0.001	-0.11%
Winter Weekend	0.0116	1.17%	0.004	0.50%

Blue indicates statistically significant savings.

In order to estimate the overall demand savings for the Energy Alerts program, we multiply the average annual per participant savings by the total number of singly- and dually-enrolled participants. We can then sum the energy savings for the two subpopulations. Note that savings for dual participants were also presented in the CWP section. We present the overall program level energy savings below in Table 4-14.

Table 4-14 Total Annual On-Peak Energy Alerts Demand Savings: Hot Summer Days

Subpopulation	Number of Participants	Average Impact (kW per customer)	Total Impact (kW)
Singly-enrolled Participants	38,526	0.0519	1,999
Dually-enrolled Participants	51,746	0.0499	2,582
Total Energy Alerts Energy Savings	**90,272**	**0.0507**	**4,582**

Segment Level Results

Overall, looking at on- and off-peak savings across all Energy Alerts segments we concluded the following:

- For Energy Alerts, we were unable to detect consistent and meaningful statistically significant savings by day type for those participants receiving more than 5 alerts in 2015. This is true of

both singly- and dually-enrolled participants, and is consistent with the monthly savings results presented in the previous section.

- Consistent with the monthly results and analysis results of 2014, we were able to estimate statistically significant savings across all day types for those customers that received 5 alerts or fewer.

Based on these high level findings, we have included on- and off-peak impacts and average daily load shapes for participants that received alerts 5 or fewer times during 2015. We include only the results for "hot" and "typical" summer days to allow for comparison with the CWP results presented earlier in this chapter.

Energy Alerts Engagement Segment: 5 or fewer Alerts

This section focuses on the participants that received 5 alerts or fewer during 2015. Table 4-15 below shows the on- and off-peak impacts on both the "hot" and "typical" summer weekdays for both singly- and dually-enrolled participants receiving fewer than 5 alerts by delivery segment (SMS/phone vs. Email). Overall the on-peak impacts range from 6% to 20% on a hot summer day, with the Singly-enrolled customers saving less than the dually-enrolled customers. In addition, those customers that receive alerts by email save more on a percentage basis, than those that receive alerts via SMS/phone.

Table 4-15 Average Per-Participant Energy Alerts Demand Savings: 5 or Fewer Alerts

Segment		Day Type	5 or Fewer Alerts: Average On-peak kW Reduction	Average On-peak % Impact	Average Off-peak kW Reduction	Average Off-peak % Impact
Singly	SMS/ phone	Hot Summer	0.086	6.33%	0.049	5.33%
		Typical Summer	0.051	6.10%	0.038	5.50%
	Email	Hot Summer	0.065	6.16%	0.041	5.51%
		Typical Summer	0.047	6.93%	0.033	5.76%
Dually	SMS/ phone	Hot Summer	0.149	11.97%	0.072	8.43%
		Typical Summer	0.093	12.01%	0.049	7.66%
	Email	Hot Summer	0.200	17.41%	0.103	13.56%
		Typical Summer	0.133	18.79%	0.083	14.34%

Blue indicates statistically significant savings.

Below in Figure 4-6 and Figure 4-7 we present the average per customer savings and load shapes for singly-enrolled Energy Alerts participant receiving 5 or fewer alerts in 2015 on an average hot summer day.[23] These shapes are representative of the impacts on hot summer days presented in Table 4-15 above. The graph on the left shows the savings shape (or the second difference) and associated confidence intervals. The graph on the right shows the adjusted control group load and the treatment load shape.

As the point estimates in the table would suggest, the graphs for the singly-enrolled participants, show a large and distinct separation between the treatment and control group lines in the load shapes on the right. We also see savings shapes well above the zero line, with more savings concentrated during the on-peak period, but still some very significant savings during the off-peak period.

[23] We include only the load shapes for the singly-enrolled participants in order to illustrate the load shapes and savings shapes. We do not include load shapes for the dually-enrolled participants in the body of the report, but all load shapes and savings shapes can be accessed in the spreadsheet attachment accompanying this report.

Figure 4-6 Average Per-Participant Savings: Hot Summer Day, Singly-enrolled, SMS/Phone, 5 or Fewer Alerts

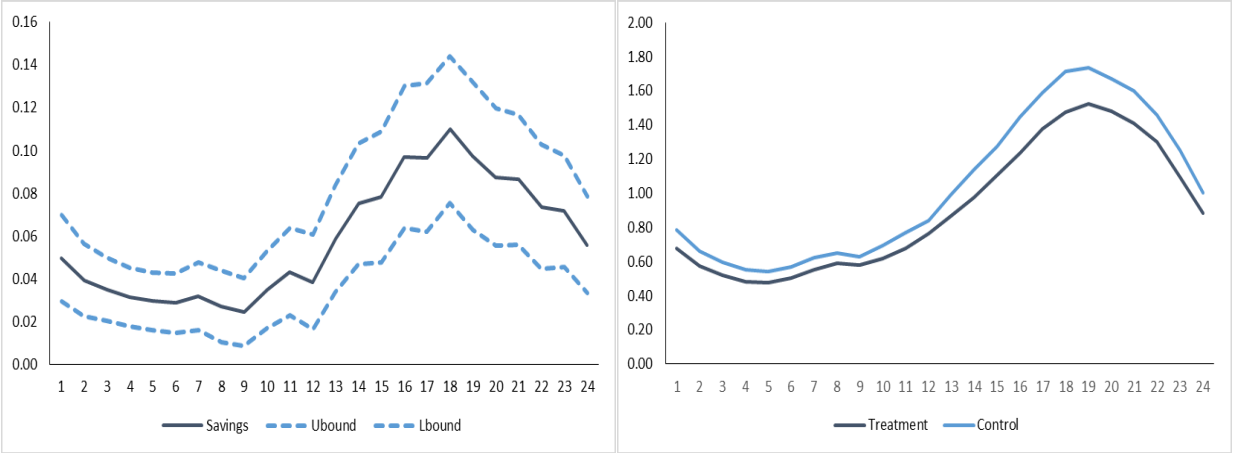
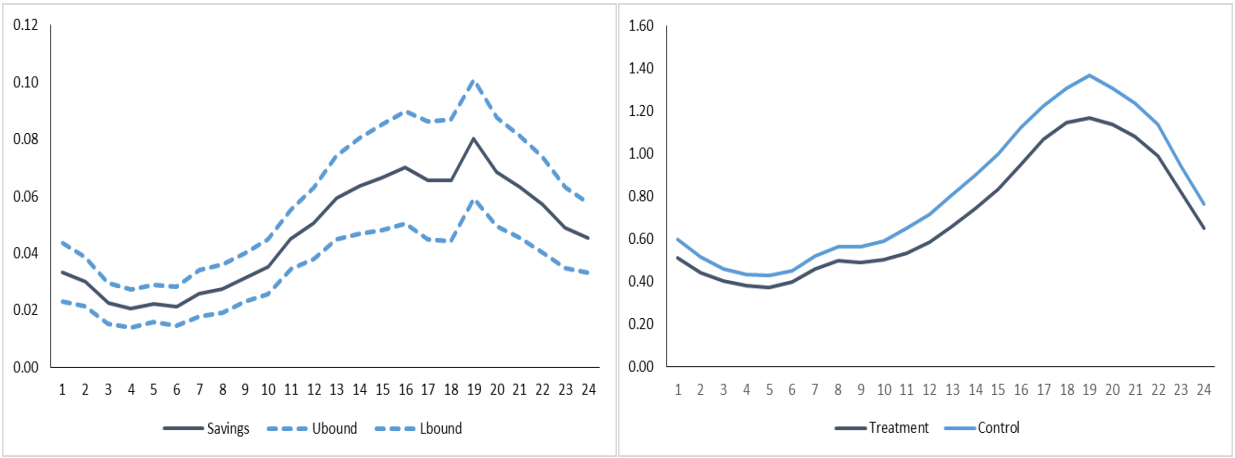


Figure 4-7 Average Per-Participant Savings: Hot Summer Day, Singly-enrolled, Email, 5 or Fewer Alerts



We do not include the load shapes for the dually-enrolled participants; however they are similar to those for singly-enrolled participants presented above.

We were also interested in quantifying the segment level on-peak demand impacts on the most relevant day type—the hot summer days. As with the segment level energy savings, the demand savings estimates are different from the program level estimates. This is because while we cannot always estimate statistically significant savings at the program level because of the variation among customers, we are often able to estimate the savings at the segment level. We estimated these impacts by summing all of the statistically significant segment level estimates for both the dually and singly enrolled participants. We present these estimates to provide insight into which customers are saving more or less across segments only, we use estimates in Table 4-14 above when we claim savings for the Energy Alerts program as a whole.

In Table 4-16 below, we present the estimated on-peak kW impacts for each Energy Alerts segment; we also indicate whether the estimate was significant, and the total recognized impact for that segment. At the bottom of the table, we sum the recognized, or significant, on-peak impacts across segments for singly- and dually-enrolled participants to estimate the impacts for the entire program.[24]

[24] We determined whether to consider an estimate significant based on the percentage of significant hours within each period. An estimate had to have at least three significant intervals and all intervals had to have the same sign, i.e. all positive or all negative in order to be included in the table above as significant. By doing this we are assuming that if we

Table 4-16 2015 Energy Alerts Program Level On-peak Demand Savings: Hot Summer Days

Segment	Number of Participants	Average On-peak Impact (kW)	Total Estimated Impact (kW)
	Singly-enrolled		
Email: Fewer than 5 Alerts	7,767	0.065	506
Email: More than 5 Alerts	1,568	NS	NS
SMS/phone: Fewer than 5 Alerts	5,600	0.086	481
SMS/phone: More than 5 Alerts	9,591	NS	NS
Total	**24,526**	**0.0403**	**988**
	Dually-enrolled		
Email: Fewer than 5 Alerts	10,133	0.200	2,024
Email: More than 5 Alerts	18,353	NS	NS
SMS/phone: Fewer than 5 Alerts	8,601	0.149	1,279
SMS/phone: More than 5 Alerts	14,659	NS	NS
Total	**51,746**	**0.0638**	**3,303**

All the savings values shown are statistically significant. Insignificant values were replaced with "NS."

were to explicitly estimate confidence intervals for the on-peak period in questions, they would maintain overall significance, even though some individual hours may not be significant on their own.

Key Findings and Recommendations

This section presents our key findings and recommendations for future program years.

Key Findings

The following were identified as key findings during the AEG's evaluation of PG&E's CWP and Energy Alerts programs.

Findings

Total annual energy savings from both CWP and Energy Alerts are presented below in Table 5-1. These savings estimates are very consistent with previous evaluation years. In total, the participants across all programs saved just over 7.8 GWh of energy in 2015. Singly-enrolled Energy Alerts participants saved an average of 86 kWh per customer, while dually-enrolled participants saved an average of 87 kWh per customer. We were unable to obtain statistically significant savings estimates for Singly-enrolled CWP participants at the population level.

Table 5-1 Total Annual Energy Savings: All Participants

Subpopulation	Number of Participants	Annual Savings (kWh per customer)	Total Savings (MWh)
Singly-enrolled CWP Participants	667,731	0	0
Singly-energy Alerts Participants	38,526	85.93	3,310
Dually-enrolled Participants	51,746	86.88	4,496
Total Energy Savings	**758,003**	**10.36**	**7,806**

The total annual demand savings from both CWP and Energy Alerts are presented below in Table 5-2. Again, the demand savings are consistent with previous evaluation years. In total, the participants across all programs provided approximately 4.5 MW of demand reduction in 2015. Singly- and dually-enrolled Energy Alerts participants saved an average of 0.05 kW per customer. We were unable to obtain statistically significant savings estimates for singly-enrolled CWP participants at the population level.

Table 5-2 Total Annual Demand Savings: All Participants

Subpopulation	Number of Participants	Annual Savings (kW per customer)	Total Savings (kW)
Singly-enrolled CWP Participants	667,731	0	0
Singly-enrolled Energy Alerts Participants	38,526	0.052	1,999
Dually-enrolled Participants	51,746	0.049	2,582
Total Energy Savings	**758,003**	**0.006**	**4,582**

Customer Web Presentment Findings

- Based on our analysis for 2015, it appears that singly-enrolled CWP participants are not saving any energy. One possibility is that CWP participants are saving energy but we were simply unable to detect those savings due to the variability inherent in the data. In addition, the large gap between the pre and post treatment periods for our continuing customers may have introduced bias into our matching process and prevented us from detecting savings in the CWP population.

- One additional hypothesis that may explain why we were unable to detect savings for the CWP participants is the very large number of participants. This may, at first, sound counterintuitive since having a large number of participants is often an advantage. However, in this case, it may be that many more customers are viewing the website out of curiosity, but fewer customers are actually engaging with and making modifications in behavior based on the information provided. We see some evidence of this when we look at the distribution of participants across engagement levels, with the highly engaged customers making up only about 3% of the total CWP population.
- At the segment level, we have seen consistently across evaluation years that the highly engaged participants save energy, and the less highly engaged participants do not. While some individual months may be statistically significant (either positive or negative) among the less engaged participants, the overall pattern of the savings estimates does not suggest consistent positive or negative savings for those groups. In contrast the savings estimates for the highly engaged participants do show consistent positive and significant savings estimates across most months. This pattern indicates that those customers are actively engaging with the website and saving energy as a result.

Energy Alerts Findings

- Nearly all of the savings for the Energy Alerts program are attributable to participants who receive five or fewer alerts in 2015. In this group, we saw consistent positive savings estimates across nearly all the months of 2015.
- We did not see any positive, statistically significant annual savings for those participants who receive more than five alerts per year. In fact, we saw some small negative significant savings estimates among those participants during one or two months. Based on the pattern of the savings that we saw, we believe these negative estimates to be the result of random variations in usage between the treatment and control group that are not indicative of true positive or negative savings. Another possible explanation is that participants become indifferent after they receive a threshold number of alerts. In many cases, those customers with large homes or high AC use due to location are unable to move out of the higher tiers, yet will continue to receive alerts regardless of any changes made in the home.
- If we compare the savings between participants that receive alerts by email and those that receive alerts by SMS/phone, we find that those receiving alerts by email save more on average.
- Relative to 2014, savings among singly-enrolled customers decreased slightly, while savings among dually-enrolled customers increased slightly. In addition, this year singly- and dually-enrolled customers saved about the same amount at the annual level.
- Singly-enrolled Energy Alerts participants saved a total of 3,310 MWh during 2015, or 86 kWh per participant, for an average annual impact of 1.2%.
- Singly-enrolled Energy Alerts participants have an average demand savings of 0.052 kW (2.95%) on a hot summer day. The singly-enrolled Energy Alerts participants achieved a demand savings of 1.9 MW in 2015.

Dually-enrolled Customer Findings

- Dually-enrolled CWP participants saved a total of 4,496 MWH in 2015, or 87 kWh per participant, for an average annual impact of 1.10%
- Dually-enrolled CWP participants have an average demand savings of 00.049 kW (or 2.6%) on a hot summer day. The dually-enrolled participants achieved a demand savings of 2.5 MW in 2015.
- Dually enrolled CWP participants are saving energy; however, we believe the majority of the savings in the dually enrolled population to be attributable to Energy Alerts vs. CWP.
- The incremental effect of CWP participation for an Energy Alerts participant appears to be negligible at the program level.

Recommendations

The following were identified as recommendations for future program years:

- The high participation rate for CWP suggests that customers are receiving value from the program, even if savings cannot be attributed directly to those customers. Therefore, we recommend that PG&E continue to offer and enhance their customer interface, even if we cannot attribute savings directly to those customers.
- Energy Alerts appears to be a successful program. However, we have not accounted for the possibility of double counting between Energy Alerts and PG&E's other conservation and Energy Efficiency programs. It is very likely that participants that are interested in Energy Alerts would also be interested in other PG&E programs. Therefore some portion of the savings we attribute to Energy Alerts may be attributable to other programs.
- Given the proportion of program savings attributable to participants receiving fewer than five alerts, we would recommend marketing Energy Alerts to customers with a monthly usage that borders Tiers 2 and 3 several months out of the year. These are the participants that seem to be able to most effectively take advantage of the Energy Alerts.

The Energy Alerts population has been fairly consistent and stable over the last three evaluation years. Therefore, we conclude that Energy Alerts participants are not only saving energy but getting value from the program.

Potential Sample Bias

Imposing any type of limitation on a sample can introduce bias. In this case, we limited the sample to participants with adequate historical data. By limiting the treatment group to customers who maintain the same residence, we are more likely to select single family homes or long term renters. These types of customers may be likely to make changes in energy use that require investment in their property and therefore may be more likely to act on information provided to them about their usage. They may also be more likely to use more energy.

It is not possible to estimate the level of bias introduced into the sample due to these restrictions directly, but it is possible to get a sense of how much bias might be present by comparing the characteristics of the participants selected for analysis and those that were excluded.[25]

Singly-enrolled Customer Web Presentment Potential Bias

Table A-1 presents a comparison of the percentage of CWP participants with various demographic characteristics between the overall participant population and the restricted participant population.

Table A-1 Comparison of Population to Restricted Population – Singly-enrolled CWP

Characteristic	CWP Population N=665,847	Restricted Population N=285,998
CARE	19.2%	20.6%
Non-CARE	80.8%	79.4%
Coastal	55.7%	55.2%
Inland	44.3%	44.8%
Single Family	71.8%	82.0%
Multifamily	28.2%	18.0%

Interestingly, both coastal customers and CARE customers have very similar distributions in both the population and restricted population. However, by restricting the participants to those with complete billing data, thereby capturing those that remain in the same residence longer, we see lower percentages of multifamily customers in the restricted population. This means that this group is underrepresented in our sample. However, because the sample is weighted based on the distribution of participants in the population, we will accurately reflect the savings for those multifamily, CARE, and coastal customers we are able to analyze.

It can also be useful to examine the relationship between key population segments and demographic characteristics. In Table A-2 below, we show the percentage of customers with different characteristics by number of My Usage views for the restricted population. When we compare the number of participants by segment with each characteristic, we can see that the number of times a participant views the website is not highly correlated with their CARE status, weather zone, or dwelling type. For example, 53.8% of all single family participants and 54.4% of multifamily participants only viewed the My Usage webpage one time during 2015. This supports the conclusion that CWP energy savings are not highly correlated with the characteristics we could compare here; therefore, excluding multifamily participants is unlikely to introduce a significant bias.

[25] Participants were excluded because of limited or missing data. Unfortunately it is exactly this data that we would need to accurately estimate the bias. Therefore, it is extremely difficult to know how the energy consumption or savings of excluded customers might differ from those included in the analysis.

Table A-2 Correlation Between Views and Demographic Characteristics – Singly-enrolled CWP

Characteristic	One View	2-6 Views	7-15 Views	16+ views
CARE	52.6%	38.2%	6.0%	3.2%
Non-CARE	59.4%	34.0%	4.4%	2.2%
Coastal	55.1%	36.9%	5.4%	2.6%
Inland	52.5%	38.0%	6.0%	3.5%
Single Family	53.8%	37.4%	5.7%	3.2%
Multifamily	54.4%	37.4%	5.6%	2.5%

We were also interested in comparing rates between treatment and control group customers in our analysis sample. Table A-3 shows the percentage of singly-enrolled CWP participants and controls in each rate. We defined TOU as customers on either HE6, HE7, or HEVA and standard as everything else. In our sample, there were no customers on the traditional TOU rate, E-6. The overwhelming majority (97.3%) of singly-enrolled CWP customers are on the standard rate. There were 274 participants and eight control customers on a TOU rate. Even with only eight control group customers participating in TOU, the total number of treatment customers that are on a TOU rate is so small, only 2.7%, that this difference is unlikely to affect the analysis in any appreciable way.

Table A-3 Comparison of Standard and TOU rates – Singly-enrolled CWP N=10,318

Rate	Control Group	Treatment Group
Standard	99.9%	97.3%
TOU	0.1%	2.7% (274 participants)

Singly-enrolled Energy Alerts Potential Bias

Table A-4 presents a comparison of the percentage of Energy Alerts participants with various demographic characteristics between the overall participant population and the restricted participant population.

Table A-4 Comparison of Population to Restricted Population – Singly-enrolled Energy Alerts

Characteristic	Energy Alerts Population N=38,276	Restricted Population N=35,073
CARE	21.6%	17.9%
Non-CARE	78.4%	82.1%
Coastal	49.9%	52.8%
Inland	50.1%	47.3%
Single Family	80.6%	86.8%
Multifamily	19.4%	13.2%

Our restrictions had a more significant effect on the CWP group this year than last year. The distribution that changed the most was for the multifamily and single family categories. The multifamily group is underrepresented by a little more than 6 percent, with the overall number of participants dropping from 19.4% to 13.2%. We used weighting to ensure that we will accurately reflect the savings for the customers we analyzed.

In Table A-5 below, we show the percentage of customers with different characteristics by number of alerts for the restricted population. When we compare the number of participants by segment within each characteristic, we can see because the number of alerts is highly correlated with a customer's energy consumption, substantially more multifamily participants (56.2%) receive five or fewer alerts annually in comparison to single family participants (29.0%). This is also true to a lesser extent for coastal (37.6%) versus inland (31.0%) participants. The results we see below are in line with what we would expect to see based on our stratification. Those customers that receive fewer

alerts are necessarily lower usage customers, and are therefore also more likely to be multi-family and/or coastal (lower cooling load) customers. Therefore, these correlations are unlikely to indicate any sample bias and are in fact a side effect of the stratification that was used which will affect all the customers in the population equally.

Table A-5 Correlation Between Views and Demographic Characteristics – Singly-enrolled Energy Alerts

Characteristic	5 or fewer Alerts	More than 5 alerts
CARE	35.7%	64.3%
Non-CARE	33.9%	66.1%
Coastal	37.6%	62.4%
Inland	31.0%	69.0%
Single Family	29.0%	71.0%
Multifamily	56.2%	43.8%

Table A-6 shows the percentage of singly-enrolled Energy Alert participants and controls in each rate. We defined TOU as customers on either HE6, HE7, or HEVA and standard as everything else. In our sample, there were no customers on the traditional TOU rate, E-6. The overwhelming majority (99%) of singly-enrolled Energy Alerts customers are on the standard rate. There were 73 participants and zero control customers on a TOU rate. Only two control group customers participated in TOU, but the total number of treatment customers that are on a TOU rate is so small (1.0%), that this difference is unlikely to affect the analysis in any appreciable way.

Table A-6 Comparison of Standard and TOU rates – Singly-enrolled Energy Alerts N=7,051

Rate	Control Group	Treatment Group
Standard	100%	99.0%
TOU	0%	1.0% (73 participants)

Dual Participation Potential Bias

Table A-7 presents a comparison of the percentage of dual participants with various demographic characteristics between the overall participant population and the restricted participant population.

For dual participants, we see slightly lower percentages of inland and multifamily customers in the restricted population. Once again, we used weighting to ensure that we will accurately reflect the savings for those coastal and multifamily customers we are able to analyze.

Table A-7 Comparison of Population to Restricted Population – Dually-enrolled

Characteristic	Dual Population N=51,076	Restricted Population N=18,499
CARE	19.6%	17.3%
Non-CARE	80.4%	82.7%
Coastal	46.2%	48.3%
Inland	53.8%	51.8%
Single Family	81.3%	88.5%
Multifamily	18.7%	11.5%

In Table A-8 and Table A-9, we show the percentage of customers with different characteristics by CWP viewing stratum and by Energy Alerts stratum. Similar to the singly-enrolled CWP participants, when we compare the number of participants by segment with each characteristic, we can see that the number of times a participant views the website is not highly correlated with their CARE status, weather zone, or dwelling type. This suggests that under-representing the inland and multifamily participants is unlikely to introduce a significant bias.

Table A-8 Dual Participation Correlation Between Views and Demographic Characteristics – Five or Fewer Alerts

Characteristic	One View	2-6 Views	7-15 Views	16+ views
CARE	33.0%	47.0%	12.2%	7.8%
Non-CARE	30.9%	47.0%	13.6%	8.5%
Coastal	33.8%	46.8%	12.4%	7.0%
Inland	28.5%	47.2%	14.3%	9.9%
Single Family	30.3%	46.8%	13.8%	9.1%
Multifamily	33.5%	47.4%	12.3%	6.8%

Table A-9 Dual Participation Correlation Between Views and Demographic Characteristics – More than Five Alerts

Characteristic	One View	2-6 Views	7-15 Views	16+ views
CARE	31.9%	46.6%	12.9%	8.5%
Non-CARE	30.2%	46.1%	13.5%	10.2%
Coastal	32.9%	46.4%	12.4%	8.4%
Inland	28.8%	46.0%	14.2%	11.0%
Single Family	30.5%	46.1%	13.5%	9.9%
Multifamily	30.5%	46.6%	12.9%	10.0%

Table A-10 shows the percentage of singly-enrolled Energy Alert participants and controls in each rate. We defined TOU as customers on either HE6, HE7, or HEVA and standard as everything else. In our sample, there were no customers on the traditional TOU rate, E-6. The overwhelming majority (98.2%) of dual participants are on the standard rate. There were 119 participants and a single control customer on a TOU rate. Even with only two control group customers participating in TOU, the total number of treatment customers that are on a TOU rate is so small, only 1.8%, that this difference is unlikely to affect the analysis in any appreciable way.

Table A-10 Comparison of Standard and TOU rates – Dually-enrolled

Rate	Control Group	Treatment Group
Standard	100.0%	98.2%
TOU	0.0% (2 participants)	1.8% (119 participants)

Model Selection and Validation

Model selection and validation

Above, we discuss the development of a set of regression models capable of estimating program effects. However, for each model that we develop, we also tested many different specifications during the modeling process. During that process we generally use several different methods to validate the results and select the most precise model. For this evaluation we will use a combination of visual inspection, and MAPE comparisons. We also include a cross check of the model results using statistical DID.

Visual inspection can be a simple, but highly effective tool during the model selection and validation process. During the inspection we will look for specific aspects of the predicted actual daily and monthly load estimates to tell us how well the models perform, for example:

- We closely examine the differences between the actual and predicted load for odd increases or decreases that could indicate an effect that is not properly being captured in the model.
- We also look for bias both visually and mathematically. Bias is the consistent over or under prediction of the actual load. We may see bias that is temperature related, under predicting during hotter months and under predicting during cooler months. We have also seen bias that is time based, over predicting in the beginning of the year, and under predicting at the end of the year. Identification of bias and its source often allows us to adjust the models to capture and isolate the bias-inducing effects within the model specification.

Regression Model MAPEs

It is particularly important to have a concrete method of comparing model accuracy during the model selection process. We compared both model MAPE (mean absolute percent error) and MPE (mean percent error) to determine the most accurate and unbiased model. The model's MAPE can tell us the overall error of the model. Comparing the MAPE of several different models shows which is the most accurate. Looking at the MPE shows us if there is any bias in the model, since consistent negative or positive values indicate a consistent under or over prediction of the load

Table B-1 to Table B-4 present the MAPEs of the regression models by program averaged across the months in 2015. These represent the average modeling error between the actual and predicted values. Lower MAPEs indicate that the model is a good predictor of an average customer's monthly usage. In general, the majority of the MAPEs are lower than 10%, but do range from 1% on the low end to 31% at the extreme. In general the higher MAPEs tend to correlate to segments with smaller sample sizes (where we expect lower precision) and lower MAPEs tend to correlate to segments with larger sample sizes (where we expect higher precision).

Table B-1 Mean Absolute Percent Error– Energy Alerts

Number of alerts	MAPE (E-mail)	MAPE (SMS/phone)
5 or less	10%	31%
More than 5	3%	4%

Table B-2 Mean Absolute Percent Error– CWP

Number of Visits	MAPE (New)	MAPE (Continuing)
1 visit	8%	4%
2 to 6 visits	13%	5%
7 to 15 visits	1%	9%
More than 15 visits	1%	15%

Table B-3 Mean Absolute Percent Error– Dual as Energy Alerts

Number of alerts	MAPE (E-mail)	MAPE (SMS/phone)
5 or less	1%	2%
More than 5	2%	1%

Table B-4 Mean Absolute Percent Error– Dual as CWP

Number of Visits	MAPE (New)	MAPE (Continuing)
1 visit	3%	2%
2 to 6 visits	3%	2%
7 to 15 visits	7%	3%
More than 15 visits	13%	2%

Comparison of DID and Regression Results

We also present a comparison of the DID and Regression savings estimates. We expect the DID estimates and the regression estimates to be close, although we do view the regression estimates as a refinement of the initial DID estimates.

Figure B-1 shows that in all months except for January and December, the difference in savings between the regression and DID are all within 5 kWh from each other for the CWP program. In January, the DID results show positive savings while the regression results are negative. For the month of December, the results are both negative but the regression shows a much higher usage increase for those participating in CWP. Overall, the pattern of savings across the months is very similar, validating the regression results.

Figure B-2 shows the results of the EAL program. Here, the regression results show consistently lower savings than the DID. Over individual months however, the savings of EAL participants follow very similar patterns in all months except for the month of December. In all but the months of June, July, and December where we see a larger gap between the regressions and DID results, the difference in savings is under 5 kWh.

Figure B-3 presents the Dual regression and DID savings comparisons. Here, the comparisons seem to be the closest among all three programs. In all months except for January and December there is less than a 5 kWh discrepancy between results. Additionally, in all but the months of May and December the savings between models show the same positive or negative savings. Both models pick up the high usage in the summer months and follow similar savings patterns across months validating the regression results.

Figure B-1 Average Per-Participant Program Savings Comparison: CWP

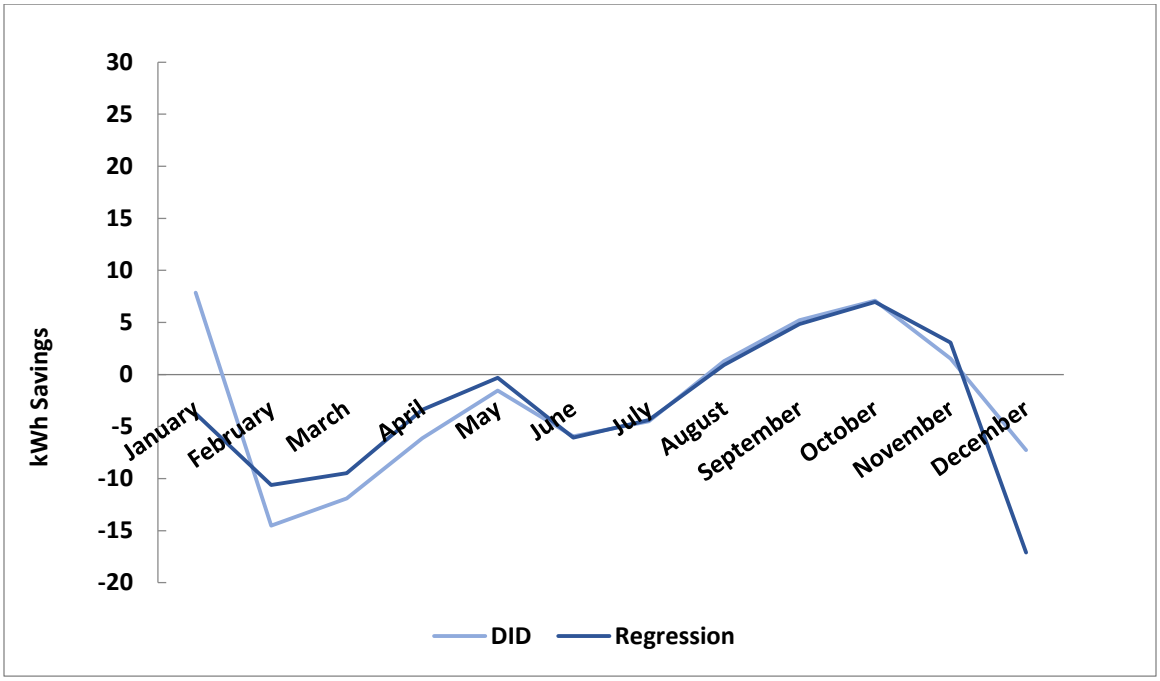


Figure B-2 Average Per-Participant Program Savings Comparison: EAL

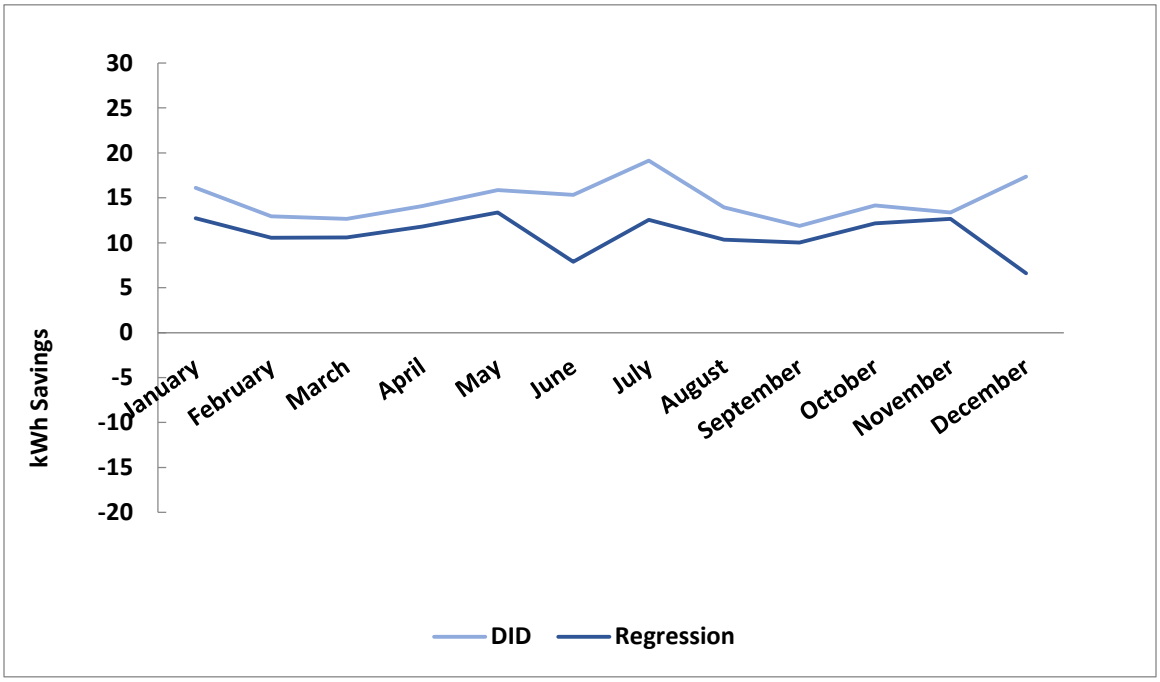
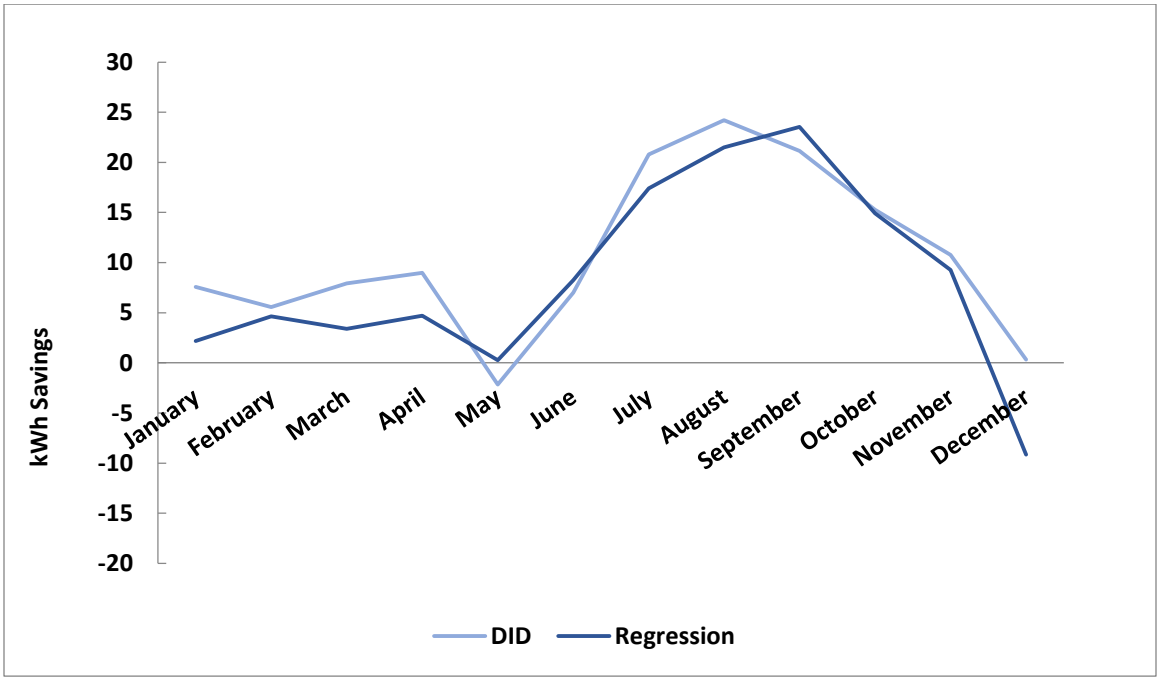


Figure B-3 Average Per-Participant Program Savings Comparison: Dual



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