

2014 Load Impact Evaluation for San Diego Gas and Electric’s Non-Residential SPP Rates

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# Executive Summary

## Introduction

SDG&E’s Smart Pricing Project (SPP), originally proposed in 2010, was adopted in decision D-12-12-004 and provides a dynamic pricing option to virtually all of its estimated 1.2 million residential, 116,000 small commercial (i.e., customers with maximum demand less than 20 kW), and 3,400 agricultural customers. Implementation of time varying rates is a significant shift for SDG&E’s smaller customers and provides an incentive for reducing consumption during peak periods as well as an opportunity for customers to save on monthly bills by adjusting their behavior. This report estimates the load impacts of SPP rates that were made available to small commercial customers during the summer of 2014 (ex post) and predicts load impacts for the SPP rates that are scheduled to go into effect in 2015 for all small commercial and agricultural customers over the period 2015–2025 (ex ante).

The SPP pricing plans include both time of use (TOU) and critical peak pricing (CPP) rate components with different enrollment strategies (mandatory, default, and opt-in) for small commercial and agricultural customers. Table 1-1 summarizes these enrollment policies and the dates of availability for each customer class. Small commercial customers will be defaulted onto the TOU-CPP rate (with opt-out to TOU) starting in November 2015. Agricultural customers will be defaulted onto TOU starting in November 2015 and will be able to opt-out to the TOU-CPP rate. The defaulting of small commercial and agricultural customers will gradually occur over a six-month period (November 2015 through April 2016). After November 2015, flat rates will no longer be available for either group of customers.

Table 1-1: SPP Rates and Availability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Customer Segment | Rate | Enrollment Policy | Start Date | Current Enrollment |
| Small Commercial\* | TOU | Opt-in from non-time varying rate | February 1, 2015 | 1,028 |
| TOU-CPP | Opt-in from non-time varying rate | February 1, 2015 | 1,132 |
| TOU-CPP | Default | November 2015 | n/a |
| TOU | Customers may opt out of TOU-CPP onto TOU | November 2015 | n/a |
| Agricultural\* | TOU | Opt-in from non-time varying rate | February 1, 2015 | 3 |
| TOU-CPP | Opt-in from non-time varying rate | February 1, 2015 | 0 |
| TOU | Default | November 2015 | n/a |
| TOU-CPP | Opt-in from default TOU | November 2015 | n/a |

\*Note: Starting in November 2015, flat rates will no longer be available for small commercial and agricultural customers.

## Small Commercial Opt-in SPP Ex Post Load Impact Summary

As a prelude to the full-scale implementation of time-varying rates to all non-residential customers, SDG&E offered versions of the SPP rates to a subset of small commercial customers beginning in the summer of 2014. Marketing of SPP rates to small commercial customers was not random, but rather targeted customers who were most likely to benefit from being on one of the two SPP rates and customers with account representatives. Given this marketing strategy, the subset of customers who enrolled on the rates consisted of structural winners who self-selected and are not representative of the entire SDG&E small commercial customer population. Indeed, the vast majority of current participants had either quite flat or even inverted load shapes (e.g., U-shaped load patterns) prior to going on the rate rather than the more typical load pattern showing much higher demands during peak hours. Grouping individual accounts into parent accounts that have the same account name shows that there are approximately 80 unique parent accounts associated with the 454 individual customers who enrolled in TOU and approximately 60 parent accounts associated with the 293 individual customers who enrolled in TOU-CPP. This lack of customer diversity further limits the representativeness of the sample to the broader SDG&E population.

Estimates of the peak period load impacts on average summer weekdays for the TOU rate are shown in Table 1-2 for each industry. Relatively small sample sizes resulted in estimated impacts that were not statistically significant and some negative point estimates (i.e., load increases). The table also shows standard errors for each point estimate, which must be approximately doubled to obtain the margin of error for the estimates.

Table 1-2: Peak Period Load Impacts for TOU Customers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Month | Reference Load (kW) | Impact (kW) | Std. Error of Impact | %  Reduction | Aggregate Impact (kW) |
| Information (Treatment N=173) | July | 1.41 | 0.13 | 0.52 | 9% | 22 |
| August | 1.39 | 0.17 | 0.46 | 12% | 30 |
| September | 1.45 | 0.14 | 0.58 | 10% | 25 |
| October | 1.39 | 0.11 | 0.53 | 8% | 19 |
| **Avg. Summer** | **1.41** | **0.14** | **0.52** | **10%** | **24** |
| Public  Administration (Treatment N=191) | July | 0.86 | 0.06 | 0.26 | 7% | 11 |
| August | 0.86 | 0.06 | 0.29 | 7% | 12 |
| September | 0.90 | 0.02 | 0.35 | 2% | 3 |
| October | 0.77 | 0.04 | 0.34 | 5% | 7 |
| **Avg. Summer** | **0.85** | **0.05** | **0.31** | **5%** | **8** |
| Other (Treatment N=89) | July | 3.84 | -0.12 | 0.84 | -3% | -11 |
| August | 3.84 | -0.01 | 0.91 | 0% | -1 |
| September | 3.80 | -0.09 | 1.05 | -3% | -8 |
| October | 3.47 | -0.28 | 0.97 | -8% | -25 |
| **Avg. Summer** | **3.74** | **-0.13** | **0.95** | **-4%** | **-11** |
| All Customers (Treatment N=453) | July | 1.66 | 0.05 | 0.28 | 3% | 23 |
| August | 1.65 | 0.09 | 0.28 | 6% | 41 |
| September | 1.68 | 0.04 | 0.34 | 3% | 19 |
| October | 1.54 | 0.00 | 0.31 | 0% | 2 |
| **Avg. Summer** | **1.63** | **0.05** | **0.30** | **3%** | **21** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

Results for customers who enrolled in the TOU-CPP rate are very similar to those for TOU customers, with impacts generally being small in absolute terms and statistically indistinguishable from zero. These results are presented in Table 1-3. Although percent impacts appear large, this is entirely due to relatively small loads during the peak period. Estimated standard errors are substantially larger than the absolute impacts, indicating small samples and noisy estimates that should not be interpreted with a high degree of confidence.

Table 1-3: Peak Period Load Impacts for TOU-CPP Customers   
on Non-event Summer Weekdays

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Month | Reference Load (kW) | Avg. Impact (kW) | Std. Error of Impact | % Reduction | Aggregate Impact (kW) |
| Public Administration (Treatment N=190) | August | 0.52 | -0.07 | 0.21 | -14% | -14 |
| September | 0.53 | -0.05 | 0.43 | -10% | -10 |
| October | 0.50 | -0.07 | 0.25 | -14% | -13 |
| **Avg. Summer** | **0.52** | **-0.06** | **0.30** | **-13%** | **-12** |
| Other (Treatment N=102) | August | 1.71 | 0.31 | 0.97 | 18% | 31 |
| September | 1.73 | 0.35 | 0.94 | 20% | 35 |
| October | 1.60 | 0.31 | 1.04 | 19% | 31 |
| **Avg. Summer** | **1.68** | **0.32** | **0.98** | **19%** | **32** |
| All Customers (Treatment N=292) | August | 0.94 | 0.06 | 0.37 | 6% | 17 |
| September | 0.95 | 0.09 | 0.43 | 9% | 26 |
| October | 0.88 | 0.06 | 0.40 | 7% | 17 |
| **Avg. Summer** | **0.92** | **0.07** | **0.40** | **7%** | **20** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

Peak period impacts for the two CPP event days are presented in Table 1-4. Estimates are again very noisy and do not show any statistically significant impacts for individual industries for all customers taken as a whole. Based on these results combined with those in Table 1-3, there is no evidence of any load reductions that can be attributed to the SPP rates. Given the strategic targeting of structural winners and the unique subset of customers who chose to enroll, these results should not be interpreted as what might happen if these rates were offered to the broader population as either opt-in or default tariffs.

Table 1-4: Peak Period Load Impacts for TOU-CPP Customers on Event Days

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Event | Reference Load | Impact (kW) | Std. Error of Impact | % Reduction | Aggregate Impact (kW) |
| Public Administration (Treatment N=190) | 15-Sept | 0.57 | 0.05 | 0.54 | 8% | 9 |
| 16-Sept | 0.61 | -0.02 | 0.50 | -4% | -4 |
| **Average** | **0.59** | **0.01** | **0.38** | **2%** | **2** |
| Other  (Treatment N=102) | 15-Sept | 1.97 | -0.35 | 1.35 | -18% | -36 |
| 16-Sept | 2.06 | -0.36 | 1.34 | -17% | -36 |
| **Average** | **2.02** | **-0.35** | **1.28** | **-17%** | **-36** |
|  | 15-Sept | 1.06 | -0.10 | 0.59 | -9% | -28 |
| All Industries (Treatment N = 292) | 16-Sept | 1.12 | -0.14 | 0.57 | -12% | -40 |
|  | **Average** | **1.09** | **-0.12** | **0.51** | **-11%** | **-34** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

## Small Commercial Ex Ante Load Impact Summary for Approved SPP Rate

SDG&E’s small commercial customers are scheduled to be defaulted onto the TOU-CPP rate in November 2015, with the option of selecting the TOU rate instead. Since there was no ex post data from SDG&E upon which to base the ex ante forecast, it was necessary to rely on results from elsewhere and adjusting them as appropriate to reflect as closely as possible the industry mix in SDG&E’s service territory. The starting point for forecasting the load impacts associated with transitioning all of SDG&E’s small commercial customers to SPP rates is the analysis of PG&E’s transition to mandatory TOU rates for all of its non-residential customers. PG&E’s TOU rate is very similar (both in prices and rate periods) to the SPP TOU rate and because of this similarity, ex ante estimates were obtained by applying the percent impacts from the PG&E evaluation to reference loads for SDG&E small commercial customers under predetermined sets of weather conditions.

Peak period load impact estimates attributable to the TOU component of the SPP rates on a July system peak day (SDG&E weather conditions) are presented in Table 1-5 for each industry. Percent impacts range from -6% for Manufacturing (load increase) to 9% for Agriculture, Mining, and Construction. The forecasted aggregate impact for all small commercial customers is about 11 MW under 1-in-2 conditions and approximately 9% higher (11 MW) under 1-in-10 conditions.

Table 1-5: Ex Ante TOU Load Impacts for Small Commercial Customers   
on September Monthly System Peak Day (SDG&E Weather Conditions)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Industry | SDG&E 1-in-2 | | | SDG&E 1-in-10 | | | % Impact |
| Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) | Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) |
| Agriculture, Mining & Construction | 2.14 | 0.19 | 1.49 | 2.36 | 0.21 | 1.64 | 8.8% |
| Manufacturing | 2.48 | -0.15 | -1.39 | 2.66 | -0.16 | -1.50 | -6.0% |
| Wholesale, Transport & Other Utilities | 2.61 | 0.15 | 1.06 | 2.83 | 0.16 | 1.14 | 5.7% |
| Retail Stores | 3.63 | 0.04 | 0.50 | 3.91 | 0.04 | 0.54 | 1.1% |
| Offices, Hotels, Finance, Services | 2.87 | 0.09 | 5.09 | 3.11 | 0.10 | 5.51 | 3.2% |
| Schools | 3.24 | 0.11 | 0.27 | 3.54 | 0.12 | 0.30 | 3.4% |
| Institutional/ Government | 2.03 | 0.15 | 3.93 | 2.18 | 0.16 | 4.23 | 7.5% |
| **All Small Commercial** | **2.68** | **0.09** | **10.95** | **2.90** | **0.10** | **11.87** | **3.4%** |

The empirical evidence for defaulting small commercial customers onto a CPP rate is essentially non-existent. Impact estimates from California’s Statewide Pricing Pilot from more than a decade ago found that even opt-in, small commercial customers did not produce statistically significant demand reductions. Because of the absence of reliable empirical data on how small commercial customers would respond to a default CPP price, the analysis in this report makes the conservative assumption that the incremental impact of the CPP component of the SPP rates is equal to zero.

## Agricultural Ex Ante Load Impact Summary for Approved SPP Rate

PG&E’s rollout of TOU rates to non-residential customers also included agricultural customers and to our knowledge, the analysis of PG&E’s mandatory TOU rate is the only relevant set of empirical results for agricultural customers that can be used to estimate ex ante impacts for the agricultural SPP rates. Unlike small commercial customers, SDG&E’s agricultural customers will be defaulted onto the TOU rate and given the choice to opt-in to the TOU-CPP rate.

Peak period load impact estimates attributable to the TOU component of the SPP rates on a July system peak day for agricultural customers are presented in Table 1-6 by industry. The agricultural customer segment was separated into two distinct industries—agricultural pumping and water districts. The majority of customers fall into the agricultural pumping category and this industry is responsible for nearly the entire forecasted load reductions associated with the TOU rate. Overall, SDG&E’s agricultural customers are expected to reduce their peak period usage by about 1.10 MW in response to the TOU portion of the SPP rates.

Table 1-6: Ex Ante TOU Load Impacts for Agricultural Customers on July Monthly System Peak Day (SDG&E Weather Conditions)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Industry | SDG&E 1-in-2 | | | SDG&E 1-in-10 | | | % Load Reduction |
| Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) | Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) |
| Agriculture Pumping | 2.46 | 0.47 | 1.05 | 2.49 | 0.47 | 1.06 | 19.1% |
| Water Districts | 2.55 | 0.14 | 0.05 | 2.71 | 0.15 | 0.06 | 5.7% |
| All Agriculture | 2.47 | 0.42 | 1.10 | 2.52 | 0.43 | 1.12 | 17.0% |

As with small commercial customers, there is very limited experience with the impacts of CPP rates on agricultural customers. The results that do exist have been estimated for large agricultural customers who may not behave the same way as SDG&E’s agricultural customer population. Thus, getting a sense for the magnitude of the load impacts on CPP event days is difficult and comes with a large amount of uncertainty. Similar to the approach for small commercial customers, the incremental impacts of the CPP rate for agricultural customers are conservatively assumed to be zero.

## Conclusions and Recommendations

An ex post analysis of the load impacts associated with the voluntary SPP rates in the summer of 2014 showed no statistically significant reductions in peak period usage and the majority of evidence suggests that customers viewed the SPP rates as a way to reduce their electricity costs without needing to change their consumption behavior. Due to the unique set of customers who enrolled on the rates, however, these results cannot be used as the basis for ex ante estimation for the SDG&E small commercial population as a whole.

In the absence of usable ex post results for SDG&E’s territory, the ex ante load impact estimates are necessarily based on borrowed data. The estimates for TOU are based on default TOU impacts for PG&E’s customer population for a mandatory rate where customers could not opt-out to an alternative rate option. SDG&E is planning to default customers onto TOU, but give them the option of changing to a TOU-CPP rate. As such, there is a good deal of uncertainty in the estimates presented here. Given the lack of empirical data on the impacts of default CPP rates for small commercial customers, the incremental impacts of CPP over and above the impacts of the underlying TOU rate impacts are assumed to be zero.

Even after SDG&E deploys default TOU rates for the small commercial population in its own service territory, it will be difficult if not impossible to estimate ex post load impacts unless SDG&E implements the roll-out in stages so there is a period of time when some customers are on the new rates and others are not. Alternatively, SDG&E could hold back a small control group of customers who stay on the standard rate for a period of time for the sole purpose of measuring impacts. In either case, it is critical that customers who remain on the non-time varying rate for some period of time be randomly chosen. Put another way, if SDG&E does a phased roll out of the default rate, it’s important that customers who are assigned the new rate and those that are delayed are identical except that one is on the rate and the other isn’t. If the phased roll out is done on some other basis (e.g., geographically, by size stratum, etc.), it will be much more difficult and, perhaps, impossible to estimate impacts with any degree of accuracy.

# Overview of SPP Program and Evaluation Methodology

SDG&E’s Smart Pricing Program (SPP) was originally proposed in 2010 and provides a dynamic pricing option to virtually all of its estimated 1.2 million residential, 116,000 small commercial (i.e., customers with maximum demand less than 20 kW), and 3,400 agricultural customers.[[1]](#footnote-1) Implementation of time varying rates is a significant shift for SDG&E’s customers and provides an incentive for reducing consumption during peak periods as well as an opportunity for customers to save on monthly bills by adjusting their behavior. This report estimates the load impacts of SPP rates that were made available to small commercial customers during the summer of 2014 (ex post) and predicts load impacts for the SPP rates that are scheduled to go into effect in 2015 for all small commercial and agricultural customers over the period 2015–2025 (ex ante).[[2]](#footnote-2)

The SPP pricing plans include both time of use (TOU) and critical peak pricing (CPP) rate components with different enrollment strategies (mandatory, default, and opt-in) for small commercial and agricultural customers. Table 2-1 summarizes these enrollment policies and the dates of availability for each customer class. For the purpose of consistent terminology, any rate that has both TOU and CPP components will be referred to as a “TOU-CPP” rate. Since customers have a choice about which rate to enroll in, all rates are technically voluntary, however TOU is mandatory in the sense that all rate options have a TOU component. Small commercial customers will be defaulted onto the TOU-CPP rate (with opt-out to TOU) starting in November 2015. Agricultural customers will be defaulted onto TOU starting in November 2015 and will be able to opt-out to the TOU-CPP rate. The defaulting of small commercial and agricultural customers will gradually occur from November 2015 through April 2016.

Table 2-1: SPP Rates and Availability

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Customer Segment | Rate | Enrollment Policy | Start Date | Current Enrollment |
| Small Commercial\* | TOU | Opt-in from non-time varying rate | February 1, 2015 | 1,028 |
| TOU-CPP | Opt-in from non-time varying rate | February 1, 2015 | 1,132 |
| TOU-CPP | Default | November 2015 | n/a |
| TOU | Customers may opt out of TOU-CPP onto TOU | November 2015 | n/a |
| Agricultural\* | TOU | Opt-in from non-time varying rate | February 1, 2015 | 3 |
| TOU-CPP | Opt-in from non-time varying rate | February 1, 2015 | 0 |
| TOU | Default | November 2015 | n/a |
| TOU-CPP | Opt-in from default TOU | November 2015 | n/a |

Note: Starting in November 2015, flat rates will no longer be available for small commercial and agricultural customers.

As a prelude to transitioning all customers to SPP rates in 2015, SDG&E made the rates available to a selected group of small commercial customers on an opt-in basis prior to the summer of 2014. Customer eligibility for the opt-in rates was determined based on billing analysis and marketing focused on a group of customers who had account representatives and/or were expected to save money on an SPP rate compared to their current flat rate.[[3]](#footnote-3) Of the customers who were marketed to, approximately 2,000 enrolled in either the TOU or TOU-CPP rate by the end of summer 2014, with a roughly even split between the two rates. This report contains an impact analysis of the new rates on these customers (ex post), including impact estimates for summer weekdays when the TOU rate was in effect as well as the two CPP events that were called during the summer (September 15 and 16).

For most demand response and pricing programs, it is possible to base ex ante estimates on ex post results. However, in this instance, there are no relevant ex post results yet available for SDG&E’s small commercial and agricultural customers since customers have not yet been defaulted onto these rates and average demand reductions under opt-in and default enrollment are expected to differ significantly. Furthermore, as seen below, the group of volunteers for whom ex post results currently exist are quite different from the average customer and do not represent the broader population that will ultimately be defaulted onto these rates. Given the absence of ex post results in SDG&E’s service territory, it was necessary to rely on estimates from other jurisdictions after adjusting, where feasible, for differences in customer characteristics, rate characteristics, enrollment methods (e.g., opt-in versus default), and marketing strategies between these other jurisdictions and how the tariffs will be deployed at SDG&E. Because of the limited number of relevant studies, the ex ante estimates presented in this report reflect a greater degree of uncertainty than an estimation strategy that made use of historical ex post impacts.

SDG&E has applied to change the rate periods and prices charged for each SPP tariff. A summary of the approved and proposed rates in the summer period is provided in Table 2-2. The proposed rate is different in two important ways. First, although the TOU peak period is the same length as the approved rate, it runs from 2 to 9 PM rather than from 11 AM to 6 PM. Second, the CPP period for the proposed TOU-CPP rate only runs from 2 to 6 PM and no longer perfectly aligns with the TOU peak period. As a result, on CPP days, the proposed tariff actually has four rate periods rather than three. A decision from the CPUC regarding the proposed rates is not expected until April 2015 and as a consequence, this report contains estimates only for the approved prices and rate windows. An analysis of the proposed rates will be completed as an addendum to this report.

Table 2-2: Structure of Approved and Proposed SPP Rate Options   
for the Summer Period

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Rate Option | Day Type | Midnight to  6 AM | 6 to  11 AM | 11 AM to  2 PM | 2 to 6 PM | 6 to 9 PM | 9 PM to Midnight |
| Approved | Weekday | SOP | SP | P/CP | P/CP | SP | SOP |
| Weekend | SOP | SOP | SOP | SOP | SOP | SOP |
| Proposed | Weekday | SOP | SP | SP | P/CP | P | SOP |
| Weekend | SOP | SP | SP | SP | SP | SP |

## Analytical Overview for Estimating Ex Post Impacts

At the end of summer 2014, approximately 972 small commercial customers had enrolled on the TOU rate and 1,130 had enrolled on the TOU-CPP rate. The ex post evaluation strategy was based on the development of matched control groups combined with difference-in-differences regressions. This approach uses statistical matching techniques to identify a group of non-participants that have usage patterns similar to customers who enrolled in the SPP rates. Identifying a matched control group and making use of pre-enrollment consumption data allows for any pre-existing differences observed between the treatment and control groups to be netted out, which reduces selection bias and improves accuracy and precision.

An alternative approach to impact estimation is referred to as “within-subjects analysis” and compares usage by rate period for enrolled customers before and after they go on the rate. This approach uses Individual customer regressions to control for changes in usage over time that are unrelated to the influence of the change in rates, such as variation in weather. This approach was not used to estimate TOU impacts for two important reasons. First, while individual regressions can work for event based programs where events occur on some days and not on others, TOU rates are fundamentally different because they are not event based. Once a customer is enrolled on a TOU rate, it is not possible to observe their behavior absent the influence of TOU prices since the rate affects customers on a daily basis. As a result, factors that coincide with the pre-enrollment or post-enrollment period and affect electricity use can be incorrectly attributed to TOU rates. Second, it is clear from years of experience and out-of-sample testing that using an individual customer regression approach is unreliable for detecting small percent reductions. In particular, this approach will produce false precision for weather sensitive customer segments. The key assumption in the aggregation is that errors for individual customers are independent, but in reality errors are often related because the same or similar models are used for all customers.

With any control group strategy (especially for groups created using statistical matching), the accuracy of the demand reduction estimate depends on the lack of systematic differences between control and treatment customers (e.g., those on an SPP rate).[[4]](#footnote-4) A good control group has customers who, on average, look like and behave identically to participants except for exposure to the price signal. Propensity score matching was used to select the control group. This method is a standard approach for identifying statistical look-alikes from a pool of control group candidates and also explicitly addresses self-selection onto SPP tariffs based on observable differences between SPP participants and non-participants. Once a matched control group was selected, impacts were estimated using a difference-in-differences framework. Both a simple difference-in-differences calculation based on means and a fixed-effects regression specification were used to estimate impacts and the more precise regression-based estimates are presented in Section 4.

The difference-in-differences approach relies on having pre-enrollment data to observe both treatment and control groups. For the TOU rate, this is straightforward because all non-holiday weekdays are subject to the TOU rate and we observe the electricity usage of all customers for a period of time before the rate was made available. For the TOU-CPP rate, the idea of pre-treatment data is slightly different. In this case, the rate is in effect only on particularly hot days with high system loads and so it is important that the pre-treatment period be comprised of similarly hot days.

Using control groups with a difference-in-differences calculation has several advantages. This approach simplifies the estimation process and increases transparency. The estimates can be calculated using simple math and, as a result, are easy to implement and explain. A specific benefit of control groups for the purpose of evaluating CPP rates is that they tend to work even when all of the hottest days are event days. They do not require extrapolating from hot days to extremely hot days because we can observe the control group during actual event conditions. The results also do not depend on the functional form of a regression specification but rather on the similarity of the control and TOU-CPP groups, which can be explicitly assessed using pre-enrollment data. The primary disadvantages of methods that rely on control groups are that they do not work as well with large customers or with programs that lack a large number of nonparticipants in the control pool. They also provide fewer opportunities to disaggregate results.

## Strategy for Ex Ante Impact Estimation

Ex ante load impact estimation requires three basic steps:

1. Estimation of reference loads using pre-treatment data for appropriate customers;
2. Estimation of per customer load impacts under ex ante weather conditions; and
3. Forecasting program enrollment.

Step 1 is relatively straightforward using SDG&E data for all customer segments. Reference loads were estimated using the same methodology for each customer class, namely multivariate regression analysis with hourly interval data that models electricity consumption as a function of day of week, time of day, and temperature.

Steps 2 and 3 are much more challenging given the lack of relevant SDG&E experience and data. The remainder of this section summarizes the general approach and data sources for steps 2 and 3 for each customer class.

### Small Commercial Customers

There are several potential strategies for forecasting ex ante impacts for small commercial customers, but unfortunately none are without shortcomings. A summary of each of the considered approaches along with the primary areas of concern is presented in Table 2-3. After careful consideration of each option, a hybrid approach based on PG&E’s non-residential TOU results and Statewide CPP impact estimates for large and medium commercial customers was judged to be the most promising.

Table 2-3: Options for Producing Ex Ante Impacts for Small Commercial Customers

|  |  |  |
| --- | --- | --- |
| Data Source | Possible Approach | Issues |
| PG&E mandatory Non-residential TOU evaluation | Apply percentage impacts by industry group to estimated reference loads by industry group at SDG&E to estimate impacts for non-CPP days for default TOU-CPP. | Impacts suggest a “price transition effect” more than a price elasticity effect  PG&E implemented mandatory TOU and default CPP separately with a two year time gap in between. During that gap, PG&E customers could not opt-out from TOU while SDG&E customers can opt-out from TOU-CPP to TOU. |
| PG&E opt-in CPP for SMB customers | Apply percent reductions for treatment customers to SDG&E small commercial population. | PG&E customers were not defaulted onto CPP pricing like SDG&E customers will be. Would need to somehow adjust for selection onto the rate. |
| SDG&E opt-in TOU & TOU-CPP ex post evaluation | Estimate CPP day impacts for default TOU-CPP by using the ratio of opt-in TOU-CPP impacts on event days to opt-in TOU impacts on event days and applying it to the non-CPP impacts based on the PG&E evaluation summarized above. | Only structural winners were targeted, resulting in a population that is not representative of the broader SDG&E small commercial population.  Results showed statistically insignificant impacts. |
| SMUD Smart Pricing Options pilot evaluation | Only empirical evidence available for residential customers showing average impacts for default and opt-in rates based on same population.  Predict impacts for customers who opt into TOU from TOU-CPP using the ratio between default and opt-in applied to the default estimates based on the PG&E evaluation summarized above. | The SPO was done for residential customers, not small commercial customers – application would assume that the relationship between impacts for default and opt-in groups is the same for residential and small commercial.  Major climate differences between SMUD and SDG&E territories. |
| Statewide CPP Evaluation for Medium and Large Commercial Customers | Derive elasticities of substitution from SDG&E impacts and apply to small commercial customers to predict CPP impacts. | Large/Medium customers likely to be more price responsive than smaller customers.  Relatively small sample sizes.  Participants limited to SCE territory.  Only allows for producing estimates on CPP event days. |
| Results from pilot studies and other research | Assume a price elasticity of elasticity of substitution from the average of other studies or from one or more selected studies and apply it to SDG&E tariffs. | Some other studies are quite old, most apply to opt-in, not default enrollment, many apply to larger size customer segments (e.g., >20kW) and many pilots have questionable designs. |

PG&E’s experience transitioning all non-residential customers to TOU pricing from 2012–2014 is the most similar situation to SDG&E’s implementation of SPP rates. PG&E’s transition occurred in three distinct phases, which allowed load impacts to be estimated by comparing a cohort that was placed on a TOU rate to a cohort that was not scheduled to be transitioned until the following year. In terms of rate structure and prices, the PG&E and SPP TOU rates for small commercial customers are quite similar, as seen in Table 2-4. The main difference between the strategies employed by each utility is that PG&E defaulted customers onto TOU without any alternative options, whereas SDG&E will be defaulting customers onto TOU-CPP with the option to opt-out to TOU. Therefore, the PG&E data does not provide information about the incremental effect of the CPP rate above and beyond the time of use rate. This difference is not trivial for CPP days since per customer load impacts are known to be affected by enrollment strategy and because impacts are expected to be much higher for a default TOU-CPP rate than for a default TOU rate. SMUD’s Smart Pricing Options pilot clearly demonstrated these differences for residential customers,[[5]](#footnote-5) showing that per customer impacts were larger for opt-in rates compared with default rates and for CPP rates compared with TOU rates (on CPP event days).[[6]](#footnote-6)

Nexant conducted the evaluation of PG&E’s mandatory TOU rate and found statistically significant impacts for most industry groups as seen in Table 2-5. Given the very modest price change during the peak period (as shown in Table 2-4), the impacts are large and the implied own price elasticity is roughly -0.5. This is almost an order of magnitude larger than any elasticity estimated from any of the relatively few pilots and studies that have been conducted in the past. The implication of this is that the estimated impact reflects what could be called a “rate transition effect” more than an effect due solely to price. That is, the impact estimate reflects a combination of outreach, education, awareness, and price that cannot be disentangled into individual impacts. As such, it may be quite appropriate to use these impacts to estimate what might occur at SDG&E with a similar transition, using the industry-specific impacts to adjust the overall impact for differences in the mix of customers across industries between PG&E and SDG&E, but it may be inappropriate to use the implicit price elasticities to predict how the impacts would change due to differences in the price ratios between PG&E’s and SDG&E’s tariffs. It would unequivocally be inappropriate to use these implicit price elasticities to predict what the impacts would be on CPP days for the default TOU-CPP population at SDG&E.

After considering the options summarized above, a decision was made to primarily rely on results from PG&E’s default TOU roll out. Percentage impacts from the PG&E evaluation were applied to SDG&E’s reference loads by industry to estimate load reductions for default TOU-CPP customers on non-CPP weekdays. We do not plan to adjust the percent estimates for the difference in the price ratios between PG&E’s tariff and SDG&E’s tariff, since we believe that a sizeable portion of the effect is not due to price, but due to PG&E’s outreach and education efforts that accompanied the rate transition.

Table 2-4: Comparison of PG&E and Approved SDG&E SPP TOU Rates for   
Small Commercial Customers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Season | Day Type | SDG&E Small Commercial | | | | PG&E Small Commercial | | | |
| Rate block | TOU | Flat Rate | Ratio TOU/Flat | Rate Block | TOU | Flat Rate | Ratio TOU/Flat |
| (₵/kWh) | (₵/kWh) | (%) | (₵/kWh) | (₵/kWh) | (%) |
| Summer | Weekday | 12 to 6 AM  (Off-peak) | 19.1 | 22.2 | 86% | 12 to  8:30 AM  (Off-peak) | 20 | 21.4 | 93% |
| 6 to 11 AM  (Mid-peak) | 21.8 | 22.2 | 98% | 8:30 to  12 PM  (Mid-peak) | 22.4 | 21.4 | 105% |
| 11 AM to  6 PM  (On-peak) | 24.7 | 22.2 | 111% | 12 to 6 PM  (On-peak) | 23.1 | 21.4 | 108% |
| 6 to 10 PM  (Mid-peak) | 21.8 | 22.2 | 98% | 6 to 9:30 PM  (Mid-peak) | 22.4 | 21.4 | 105% |
| 10 PM to  12 AM  (Off-peak) | 19.1 | 22.2 | 86% | 9:30 to  12 AM  (Off-peak) | 20 | 21.4 | 93% |
| Weekends and holidays | 12 AM to  12 PM  (Off-peak) | 19.1 | 22.2 | 86% | 12 AM to  12 PM  (Off-peak) | 20 | 21.4 | 93% |
| Winter | Weekdays | 12 to 6 AM  (Off-peak) | 16.9 | 19.4 | 87% | 12 to  8:30 AM  (Off-peak) | 14.2 | 15 | 95% |
| 6 to 11 AM  (Mid-peak) | 18.3 | 19.4 | 94% | 8:30 to  12 PM  (Mid-peak) | 15.9 | 15 | 106% |
| 11 AM to  6 PM  (On-peak) | 19.3 | 19.4 | 100% | 12 to 6 PM  (On-peak) | 15.9 | 15 | 106% |
| 6 to 10 PM  (Mid-peak) | 18.3 | 19.4 | 94% | 6 to 9:30 PM  (Mid-Peak) | 15.9 | 15 | 106% |
| 10 PM to  12 AM  (Off-peak) | 16.9 | 19.4 | 87% | 9:30 to  12 AM  (Off-peak) | 14.2 | 15 | 95% |
| Weekends and holidays | 12 AM to  12 PM  (Off-peak) | 16.9 | 19.4 | 87% | 12 AM to  12 PM  (Off-peak) | 14.2 | 15 | 95% |
| [1] The rate comparison is only for consumption related charges and includes electricity commodity, utility delivery and DWR bond charges. It does not include fixed monthly charges. | | | | | | | | | |

Table 2-5: Small Business Load Impacts (A1) by Industry for PG&E’s Mandatory TOU Tariff Average Summer Weekday (12–6 PM)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Size category | TOU  Sample Size  (n) | Reference Load  (kW) | % Impact | Impact (kW) | Standard Error | 95% Confidence Interval | |
| Lower Bound | Upper Bound |
| Agriculture, Mining & Construction | 280 | 2.27 | -8.8% | -0.20 | 0.023 | -0.25 | -0.15 |
| Institutional/ Government | 1369 | 2.64 | -7.5% | -0.20 | 0.013 | -0.22 | -0.17 |
| Manufacturing | 224 | 3.93 | 6.0% | 0.24 | 0.046 | 0.15 | 0.33 |
| Offices, Hotels, Finance, Services | 2683 | 3.41 | -3.2% | -0.11 | 0.007 | -0.12 | -0.10 |
| Other or Unknown | 2207 | 2.28 | -2.5% | -0.06 | 0.006 | -0.07 | -0.05 |
| Retail Stores | 680 | 4.33 | -1.1% | -0.05 | 0.014 | -0.08 | -0.02 |
| Schools | 140 | 4.43 | -3.4% | -0.15 | 0.121 | -0.39 | 0.08 |
| Wholesale, Transport & Other Utilities | 738 | 2.02 | -5.7% | -0.11 | 0.010 | -0.13 | -0.09 |
| \*Gray background indicates segments didn't produce statistically significant results with 95% confidence | | | | | | | |

Although the empirical evidence on the impacts of defaulting small commercial customers onto a TOU rate is thin, the evidence for defaulting them onto a CPP rate is essentially non-existent. Using elasticities derived from TOU rate impacts to predict impacts on CPP event days is ill-advised, since a CPP rate is well outside the range of prices used in generating the TOU impacts. Because of the absence of reliable empirical data on how small commercial customers would respond to a default CPP price, the analysis in this report makes the conservative assumption that the impact is equal to zero.

### Agricultural Customers

PG&E’s rollout of TOU rates to non-residential customers also included agricultural customers and to our knowledge, the analysis of PG&E’s mandatory A4 rate is the only set of empirical results for agricultural customers that can be drawn from to estimate ex ante impacts for the agricultural SPP rates. Unlike small commercial customers, SDG&E’s agricultural customers will be defaulted onto the TOU rate and will be given the opportunity to opt onto a TOU-CPP rate. A summary of the SPP TOU rate for agricultural customers is presented in Table 2-6 along with PG&E’s A4 rate for comparison.

Table 2-6: Comparison of PG&E and Approved SDG&E SPP TOU Rates   
for Agricultural Customers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Season | Day Type | SDG&E Agricultural | | | | PG&E Agricultural | | | |
| Rate block | TOU | Flat Rate | Ratio TOU/Flat | Rate block | TOU | Flat Rate | Ratio TOU/Flat |
| (₵/kWh) | (₵/kWh) | (%) | (₵/kWh) | (₵/kWh) | (%) |
| Summer | Weekday | 12 to 6 AM  (Off-peak) | 16.2 | 20.6 | 79% | 12 to 8:30 AM  (Off-peak) | 16.3 | 23.4 | 69% |
| 6 to 11 AM  (Mid-peak) | 19.3 | 20.6 | 94% | 8:30 to 12 PM  (Mid-peak) | 16.3 | 23.4 | 69% |
| 11 AM to 6 PM (On-peak) | 22.2 | 20.6 | 108% | 12 to 6 PM  (On-peak) | 36.7 | 23.4 | 157% |
| 6 to 10 PM  (Mid-peak) | 19.3 | 20.6 | 94% | 6 to 9:30 PM  (Mid-Peak) | 16.3 | 23.4 | 69% |
| 10 PM to  12 AM  (Off-peak) | 16.2 | 20.6 | 79% | 9:30 to 12 AM  (Off-peak) | 16.3 | 23.4 | 69% |
| Weekends and holidays | 12 AM to  12 PM  (Off-peak) | 16.2 | 20.6 | 79% | 12 AM to  12 PM  (Off-peak) | 16.3 | 23.4 | 69% |
| Winter | Weekdays | 12 to 6 AM  (Off-peak) | 13.1 | 16.6 | 79% | 12 to 8:30 AM  (Off-peak) | 13.8 | 18.3 | 75% |
| 6 to 11 AM  (Mid-peak) | 14.5 | 16.6 | 87% | 8:30 to 12 PM  (Mid-peak) | 16.9 | 18.3 | 92% |
| 11 AM to 6 PM (On-peak) | 15.4 | 16.6 | 93% | 12 to 6 PM  (On-peak) | 16.9 | 18.3 | 92% |
| 6 to 10 PM  (Mid-peak) | 14.5 | 16.6 | 87% | 6 to 9:30 PM  (Mid-peak) | 16.9 | 18.3 | 92% |
| 10 PM to  12 AM (Off-peak) | 13.1 | 16.6 | 79% | 9:30 to 12 AM  (Off-peak) | 13.8 | 18.3 | 75% |
| Weekends and holidays | 12 AM to  12 PM  (Off-peak) | 13.1 | 16.6 | 79% | 12 AM to  12 PM  (Off-peak) | 13.8 | 18.3 | 75% |
| [1] The rate comparison is only for consumption related charges and includes electricity commodity, utility delivery and DWR bond charges. It does not include fixed monthly charges. | | | | | | | | | |

The mix of agricultural customers in the PG&E territory differs significantly from the corresponding customer mix in SDG&E. Different customer types (e.g., farms that grow different crops, golf courses, etc.) have very different load shapes and could also differ in their ability/willingness to shift load to other parts of the day. The consequence of this is that applying PG&E’s overall agricultural impacts directly to SDG&E is almost certainly inappropriate. What is needed is to classify agricultural customers into different segments and apply results from PG&E that come from a similar segmentation. This can be accomplished by first segmenting SDG&E’s agricultural customers according to NAICS code and/or business type that align with results that are available from PG&E. Once the segmentation is complete, impacts for SDG&E’s agricultural customers can be predicted directly from PG&E’s load impact estimates.

As with small commercial customers, there is almost no experience with CPP rates for agricultural customers. The results that do exist have been estimated for large agricultural customers who may not behave the same way as SDG&E’s small agricultural customer population. As with the approach for small commercial customers, the incremental impact of the CPP rate for agricultural customers is conservatively assumed to be zero.

## Report Organization

The remainder of this report is organized as follows. Section 3 describes the ex post evaluation design and the methods used to calculate ex post impact estimates for summer weekdays and CPP event days. Section 4 presents the ex post load impact results for the opt-in TOU and TOU-CPP rates that were marketed to select small commercial customers. Section 5 describes the methods used to estimate ex ante load impacts and Section 6 summarizes the ex ante results for both small commercial and agricultural customers. Section 7 concludes with a summary and recommendations.

# Evaluation Design and Ex Post Methods

Marketing and enrollment for the TOU and TOU-CPP SPP rates began early in the summer of 2014. The number of enrolled customers in each rate as a function of time is presented in Figure 3-1. Enrollment in the TOU rate saw an initial jump at the beginning of July, followed by more gradual growth during the rest of the summer. For the TOU-CPP rate, the initial jump in enrolled customers was smaller, but was followed by faster growth during the remainder of the summer. In order to analyze the same group of customers throughout the entire summer, cutoffs were established to determine which customers would be included in the ex post analysis dataset. The TOU analysis group included the 462 customers who were enrolled as of July 1 so that the analysis dataset consisted of July, August, September, and October. For TOU-CPP, the analysis group consisted of the 297 customers who enrolled prior to August 5 and as a result, the analysis dataset covered only August, September, and October.

Figure 3-1: Enrollment in Opt-in SPP Rates During Summer 2014



462 enrolled by July 1, 2014

462 enrolled by July 1, 2014

297 enrolled by Aug 5, 2014

297 enrolled by Aug 5, 2014

Load impacts for the opt-in TOU and TOU-CPP rates offered to selected SDG&E small commercial customers were estimated using cluster analysis, propensity score matching methods, and difference-in-differences estimation. This section provides a detailed description of the implementation of each of these components.

## Cluster Analysis

Marketing of the SPP rates to small commercial customers was not random, but rather targeted customers who were most likely to benefit from being on one of the two SPP rates. Given this marketing strategy, the subset of customers who enrolled in the rates was expected to consist of structural winners who are not representative of the entire SDG&E small commercial customer population. Because of the marketing strategy, it was important to understand the uniqueness of the enrolled TOU and TOU-CPP customers in terms of both demographics and consumption patterns. This initial analysis was conducted using simple descriptive statistics of customer characteristics and k-means cluster analysis of load data.

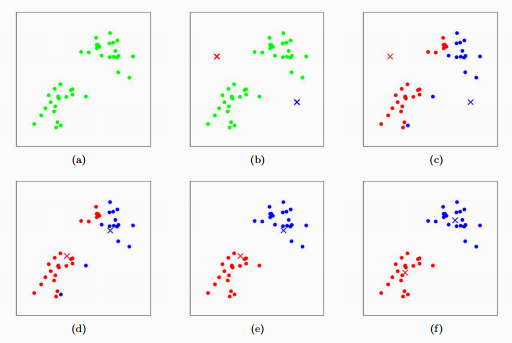
K-means cluster analysis is an algorithm-based approach to identifying a discrete number of similar subgroups within a larger sample of data. The algorithm defines subgroups using centroids in Cartesian space and assigns customers to a cluster based on the proximity to that cluster’s centroid. The best location for the cluster centroids are then determined using an iterative process that consists of the following steps:

* Move the cluster centroids;
* Assign each customer to the nearest cluster; and then

Calculate the sum of the distances between each customer and their assigned centroid.

These steps are repeated as long as the sum of distances can be reduced by moving the centroids. When the sum of distances can no longer be reduced, the optimal cluster assignments have been reached. This process is represented graphically in Figure 3-2, where the original data is shown in panel (a) and cluster centroids are denoted by the red and blue X’s. Final cluster assignments appear in panel (f).

Figure 3-2: Graphical Example of K-Means Clustering with K=2



The clusters of interest in this situation are the load shapes for small commercial customers. Different values of k (i.e., different numbers of clusters) were tested and the data were found to be best described by three distinct load shapes: Constant, U-shaped, and Daytime peak. Normalized load shapes for all customers in each cluster are shown in Figure 3-3, where the y axis represents the percentage of daily load rather than absolute kW. Figure 3-4 shows the raw load shapes of customers on the SPP rates versus a sample of customers on the flat rate for the summers of 2013 and 2014.

Figure 3-3: Normalized Load Shape Clusters for TOU and TOU-CPP Participants



Figure 3-4: Average Load Shapes for TOU-CPP Customers and Non-SPP Customers

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The load shapes clearly show that each cluster represents a fundamentally different pattern of energy consumption and these patterns are closely related to the type of business. Figure 3-5 shows the percentage of customers belonging to each load shape cluster by rate. The figure shows that nearly all of the customers who enrolled in the SPP rates (TOU and TOU-CPP) have either Constant or U-shaped loads, which makes sense in light of the rates being offered only to structural winners. In contrast, 44% of the remainder of the small commercial population has a daytime peaking load shape.

Figure 3-5: Load Shape Clusters by Rate   
(% of the Population)[[7]](#footnote-7)



A more detailed look at the types of treatment customers who fall into each load shape cluster is provided in Table 3-1. The majority of enrolled customers come from one of two industries: Information and Public Administration.[[8]](#footnote-8) This is quite different from the general population, which has a significant number of customers in real estate, professional & technical services, accommodation services, food services, health care, and other industries. Figure 3-5 and Table 3-1 confirm the hypothesis that targeted marketing of the SPP rates led to a treatment sample that is very different from the general small commercial population in terms of both electricity consumption patterns and business type. A priori, these difference prevent any of the insights gained during the ex post analysis from being used as inputs to the ex ante forecasts for the broader population.

Table 3-1: Load Shape Clusters for SPP Treatment Customers   
(TOU and TOU-CPP) by Industry

| NAICS 2-digit Industry Code | Constant | U-shaped | Day-time Peak | Total |
| --- | --- | --- | --- | --- |
| Accommodation and Food Services | 16 | 2 | 0 | 18 |
| Agriculture, Forestry, Fishing and Hunting | 1 | 0 | 0 | 1 |
| Arts, Entertainment, and Recreation | 11 | 10 | 1 | 22 |
| Construction | 25 | 11 | 0 | 36 |
| Educational Services | 16 | 0 | 1 | 17 |
| Finance and Insurance | 3 | 2 | 2 | 7 |
| Health Care and Social Assistance | 6 | 4 | 0 | 10 |
| Information | 175 | 2 | 0 | 177 |
| Manufacturing | 2 | 3 | 3 | 8 |
| Other Services (except Public Administration) | 11 | 1 | 0 | 12 |
| Professional, Scientific, and Technical Services | 6 | 2 | 0 | 8 |
| Public Administration | 268 | 112 | 1 | 381 |
| Real Estate and Rental and Leasing | 9 | 7 | 0 | 16 |
| Retail Trade | 5 | 2 | 2 | 9 |
| Transportation and Warehousing | 3 | 1 | 0 | 4 |
| Utilities | 16 | 2 | 0 | 18 |
| **Total** | **573** | **161** | **10** | **744** |

## Selection of Matched Control Groups

Despite the clear threat to external validity, internally valid impact estimates for the opt-in SPP rates can be attained using a control group identified by propensity score matching techniques that pair SPP customers with non-SPP customers from the same industry and with a similar load shape. Matching was based on pre-enrollment consumption data and six different models were tested for use:



(where t= HE 17 through HE 22)



(where t= HE 17 through HE 22)

In the equations listed above, the dependent variable is a binary variable representing whether or not customer *i* opted in to an SPP rate.[[9]](#footnote-9) Explanatory variables include average daily consumption (*avgdailykwh*), the ratio of peak-to-offpeak consumption for summer months (*avg\_peakratio*), consumption in individual hours (*hourlykwh*), the percentage of electricity consumed during individual hours (*percentofdailykwh*), and the share of total electricity consumed during different rate periods (*avg\_peakshare* and *avg\_shouldershare[[10]](#footnote-10)*). The pool of possible control customers consisted of a random sample of approximately 20,000 SDG&E small commercial customers and each treatment-control pair was restricted to be in the same industry as identified by the first two digits of their NAICS codes.

The 6 matching models were estimated using pre-treatment data from the summer of 2013 (June–October) and were evaluated on the basis of differences in consumption between treatment and each matched control group for a pre-determined holdout period (May 2013). Two statistics were calculated to represent the performance of each model during the holdout period:

* Average Percent Error =

Absolute Sum of Errors =

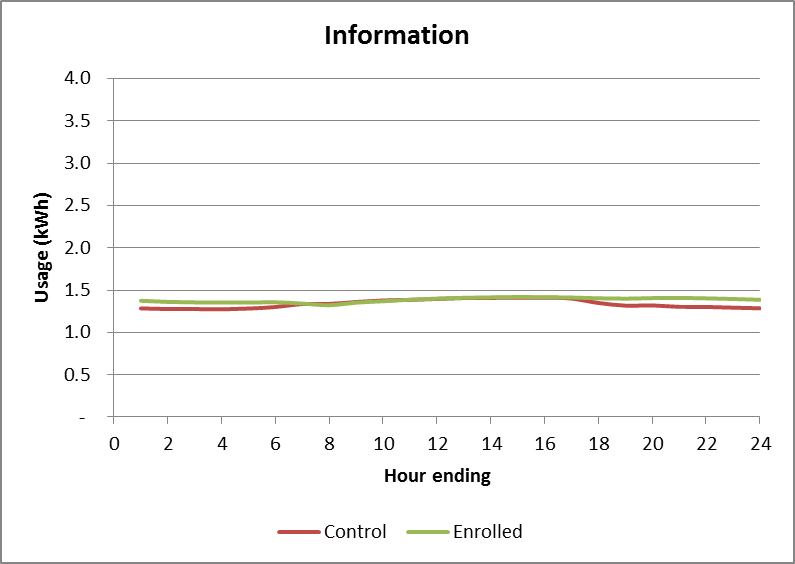
For both APE and ASE, the kWh terms represent the average daily peak usage for a customer (i.e., total kWh between 11 AM and 6 PM). Better performing models have relatively lower values of APE and ASE, indicating that the consumption of the matched control group is similar to the consumption of the enrolled SPP group. These error calculations for the TOU treatment group are presented in Table 3-2.

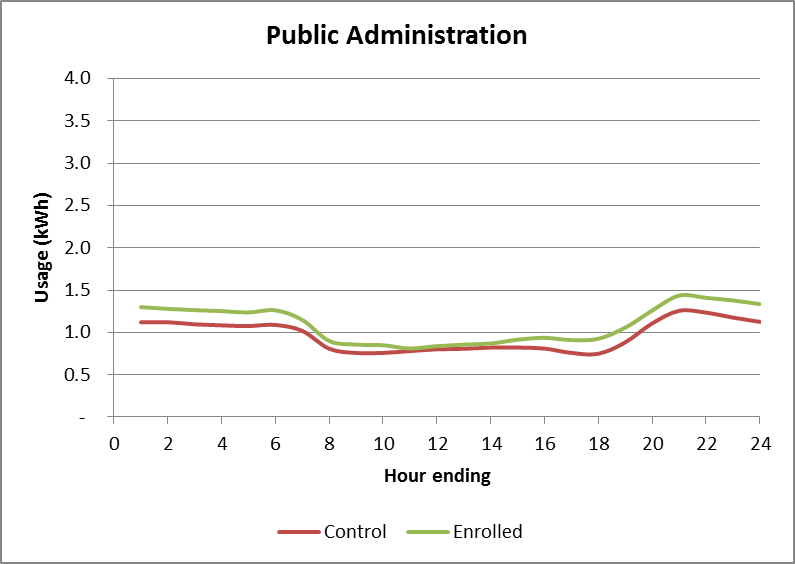
Table 3-2: Propensity Score Matching Model Assessment for TOU Treatment Cohort

| Statistic | Model | Overall | Information | Public Administration | Other |
| --- | --- | --- | --- | --- | --- |
| APE | 1 | 6.7% | -9.9% | 37.2% | 9.9% |
| 2 | -4.1% | -20.7% | 42.3% | -4.8% |
| 3 | -1.2% | 3.5% | 13.3% | -11.0% |
| 4 | -15.4% | -0.9% | -36.3% | -9.9% |
| 5 | -2.6% | -20.1% | 42.7% | -2.0% |
| 6 | -11.5% | -15.9% | 21.2% | -20.0% |
| ASE | 1 | 4,304 | 950 | 875 | 2,479 |
| 2 | 4,777 | 1,331 | 1,107 | 2,339 |
| 3 | 5,091 | 1,016 | 1,625 | 2,450 |
| 4 | 6,001 | 957 | 2,231 | 2,812 |
| 5 | 4,665 | 1,262 | 997 | 2,405 |
| 6 | 4,949 | 1,123 | 1,126 | 2,700 |

The metrics in Table 3-2 show that model performance varies significantly both within and across different industries. For this reason, the best performing models for each industry[[11]](#footnote-11) were used to select the matched control group for each analysis: Model 4 for Information, Model 3 for Public Administration, and Model 2 for Other Industries. A comparison of the treatment and control loads for an average weekday during the summer of 2013 (pre-treatment) is shown for each of the three industries in Figure 3-6.

Figure 3-6: Average Summer Weekday Loads for Treatment and Matched Control Groups during Pre-treatment Period (2013)







The tables and figures in this section include both the TOU and TOU-CPP groups. As Table 3-1 shows, this means there are 573 customers with flat load shapes, 161 with U-shaped load shapes, and only 10 with normal, day time peaking load shapes. These sample sizes help explain the effectiveness of the matches that are observed in Figure 3-6. For the Information and Public Administration customers who have mostly flat and U-shaped loads, matching is effective when looking at the average load. For the customers in other industries, however, the matching is not as good due to the diverse industries being labeled as “Other.” Because the matching equations contain variables that capture only peak usage, treatment customers who are matched with customers from a different industry are likely to have off-peak consumption patterns that are quite different. In this situation, the end result is less effective matching. Limiting the matching pool to the same industry classification would potentially solve this problem for the larger industries, but would likely still result in poor matches for the categories with smaller samples.

### Difference-in-differences Estimation

After identifying matched control groups for each treatment cohort (TOU and TOU-CPP), impact estimates were obtained using difference-in-differences. This approach uses comparisons of the control and treatment groups both before and after implementation of the rate to identify the load impacts. Figure 3-7 conceptually illustrates difference-in-differences with repeated observations. If the new rate leads to reductions in demand, then a change in demand will be observed for participating customers, but not for control group customers that remain on flat pricing. The timing of the change should coincide with the transition of customers onto the rate.

Using difference-in-differences means that the matched control group does not need to perfectly match the treatment group in the pre-treatment period. This is because any differences that may be due to unobservable factors that could not be included in the matching model will be netted out by the differencing. This feature, however, is not a cure-all and therefore it is still desirable for pre-treatment consumption for the treatment and matched control groups to be as similar as possible.

Figure 3-7: Example of Difference-in-differences with Repeated Observations



Difference-in-differences estimation can be implemented using either simple means or a panel regression with fixed effects and time effects. For robustness, both methods were used in this evaluation, but the estimates from the regression model are reported due to their increased precision. The increased precision is achieved by including variables that explain energy use, such as temperature and day-of-week effects, which filter background noise (variation) and allow the signal (the response to TOU rates) to be more easily detected. Separate regression equations were estimated for each hour to produce load impact estimates for all hours of the day. The dependent variable in the regression equation is hourly electricity use and only non-holiday weekdays were included in the analysis. The full panel model specification is presented as Equation 1:

| Variable | Definition |
| --- | --- |
| *i, t* | Indicate observations for each individual (i) and date (t). |
|  | The model constant. |
|  | The change in electricity use due to the treatment. This change is only experienced by the treatment group after TOU is implemented. The parameter represents the difference-in-differences. |
|  | The difference pre and post TOU implementation period unrelated to treatment. |
|  | Change in electricity use due to weather (Avg. temperature during first 17 hours of  the day). |
|  | Change in electricity use due to month. |
|  | Customer fixed effects, which control for unobserved factors that are time invariant and unique to each customer. They do not control for fixed characteristics such as air conditioning that interact with time varying factors like weather. |
|  | The idiosyncratic (white-noise) error for each individual customer and time period. |
|  | A binary indicator of whether or not the customer is part of the treatment or control group. |
|  | A binary indicator of whether the time period occurs before (0) or after (1) implementation of TOU. |
|  | Average temperature during first 17 hours of the day. |
|  | Set of dummy variables for each summer month. |

# Small Commercial Ex Post Load Impact Estimates

This section presents the results of the ex post impact evaluation for each SPP rate along with interpretations of the estimates.

## TOU

Estimates of the peak period load impacts on average summer weekdays for the TOU rate are shown in Table 4-1 for each industry. None of the impacts were found to be statistically significant at even the 90% confidence level and some point estimates were negative (i.e., load increases[[12]](#footnote-12)).

Table 4-1: Peak Period Load Impacts for TOU Customers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Month | Reference Load (kW) | Impact (kW) | Std. Error of Impact | %  Reduction | Aggregate Impact (kW) |
| Information (Treatment N=173) | July | 1.41 | 0.13 | 0.52 | 9% | 22 |
| August | 1.39 | 0.17 | 0.46 | 12% | 30 |
| September | 1.45 | 0.14 | 0.58 | 10% | 25 |
| October | 1.39 | 0.11 | 0.53 | 8% | 19 |
| **Avg. Summer** | **1.41** | **0.14** | **0.52** | **10%** | **24** |
| Public  Administration (Treatment N=191) | July | 0.86 | 0.06 | 0.26 | 7% | 11 |
| August | 0.86 | 0.06 | 0.29 | 7% | 12 |
| September | 0.90 | 0.02 | 0.35 | 2% | 3 |
| October | 0.77 | 0.04 | 0.34 | 5% | 7 |
| **Avg. Summer** | **0.85** | **0.05** | **0.31** | **5%** | **8** |
| Other (Treatment N=89) | July | 3.84 | -0.12 | 0.84 | -3% | -11 |
| August | 3.84 | -0.01 | 0.91 | 0% | -1 |
| September | 3.80 | -0.09 | 1.05 | -3% | -8 |
| October | 3.47 | -0.28 | 0.97 | -8% | -25 |
| **Avg. Summer** | **3.74** | **-0.13** | **0.95** | **-4%** | **-11** |
| All Customers (Treatment N=453) | July | 1.66 | 0.05 | 0.28 | 3% | 23 |
| August | 1.65 | 0.09 | 0.28 | 6% | 41 |
| September | 1.68 | 0.04 | 0.34 | 3% | 19 |
| October | 1.54 | 0.00 | 0.31 | 0% | 2 |
| **Avg. Summer** | **1.63** | **0.05** | **0.30** | **3%** | **21** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

It is important to note that the lack of statistical significance does not mean that small customers in general do not respond to time-varying price signals. The lack of statistical significance may be due to a combination of small sample sizes, unique load shapes that prove difficult to match, and diverse customers within each industry that increase the amount of noise in the average load shape. The robustness of the ex post results was tested by using different models to identify the matched control groups for the analysis. Using different models did not have any material effect on the results—that is, in all cases, impact estimates turned out to be small and statistically insignificant.

## TOU-CPP

Due to the nature of the TOU-CPP rate, there are two separate analyses to be considered: one for non-event weekdays and a second for event days. The non-event day analysis is identical to the TOU analysis since TOU and TOU-CPP rates are equivalent on those days. For event days, several modifications to the analysis must be made. The simplest of these is that the post-treatment days of interest for the TOU-CPP rate are each of the two CPP event days called during the summer of 2014 (September 15 and September 16). Because CPP events are typically called on days that are particularly hot, it is also important to identify “event-like” days in the pre-treatment period and remove all other days in the pre-treatment period from the analysis dataset. The four hottest days in September 2013 were chosen as “event-like” days and a comparison of these days with other hot September days in 2014 (including the CPP days) is shown in Table 4-2. Although the “event-like” days are not quite as hot as the actual events, they will suffice as a pre-treatment period in the difference-in-differences estimation.

Table 4-2: Ten Hottest September Days in 2013 and 2014 by Mean17[[13]](#footnote-13)

|  |  |  |  |
| --- | --- | --- | --- |
| Rank | | Date | Mean17 |
| 1 | | 16-Sep-14 | 83.4 |
| 2 | | 17-Sep-14 | 83.4 |
| 3 | | 15-Sep-14 | 81.7 |
| 4 | | 6-Sep-13 | 80.1 |
| 5 | | 8-Sep-14 | 79.9 |
| 6 | | 4-Sep-13 | 79.7 |
| 7 | | 5-Sep-13 | 79.3 |
| 8 | | 3-Sep-13 | 78.1 |
| 9 | | 9-Sep-14 | 77.9 |
| 10 | | 12-Sep-14 | 77.0 |
|  | CPP event days | | |
|  | Pre-treatment “event-like” days | | |

Load impacts for TOU-CPP customers on non-event days are presented in Table 4-3. The results are very similar to those for TOU customers, with impacts generally being small in absolute terms and statistically indistinguishable from zero. Although percent impacts appear large, this is entirely due to relatively small loads during the peak period. Estimated standard errors are substantially larger than the absolute impacts, indicating that the estimates are very noisy and should not be interpreted with a high degree of confidence.

Table 4-3: Peak Period Load Impacts for TOU-CPP Customers on   
Non-event Summer Weekdays

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Month | Reference Load (kW) | Avg. Impact (kW) | Std. Error of Impact | % Reduction | Aggregate Impact (kW) |
| Public Administration (Treatment N=190) | August | 0.52 | -0.07 | 0.21 | -14% | -14 |
| September | 0.53 | -0.05 | 0.43 | -10% | -10 |
| October | 0.50 | -0.07 | 0.25 | -14% | -13 |
| **Avg. Summer** | **0.52** | **-0.06** | **0.30** | **-13%** | **-12** |
| Other (Treatment N=102) | August | 1.71 | 0.31 | 0.97 | 18% | 31 |
| September | 1.73 | 0.35 | 0.94 | 20% | 35 |
| October | 1.60 | 0.31 | 1.04 | 19% | 31 |
| **Avg. Summer** | **1.68** | **0.32** | **0.98** | **19%** | **32** |
| All Customers (Treatment N=292) | August | 0.94 | 0.06 | 0.37 | 6% | 17 |
| September | 0.95 | 0.09 | 0.43 | 9% | 26 |
| October | 0.88 | 0.06 | 0.40 | 7% | 17 |
| **Avg. Summer** | **0.92** | **0.07** | **0.40** | **7%** | **20** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

Peak period impacts for the two CPP event days are presented in Table 4-4. Estimates are again very noisy and do not show any statistically significant impacts for individual industries or all customers taken as a whole. Based on these results, combined with those in Table 4-3, there is no evidence of any load reductions that can be attributed to the SPP rates. Given the strategic targeting of structural winners and the unique subset of customers who chose to enroll, these results should not be interpreted as what might happen if these rates were offered to the broader population as either opt-in or default tariffs.

Table 4-4: Peak Period Load Impacts for TOU-CPP Customers on Event Days

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Industry | Event | Reference Load | Impact (kW) | Std. Error of Impact | % Reduction | Aggregate Impact (kW) |
| Public Administration (Treatment N=190) | 15-Sept | 0.57 | 0.05 | 0.54 | 8% | 9 |
| 16-Sept | 0.61 | -0.02 | 0.50 | -4% | -4 |
| **Average** | **0.59** | **0.01** | **0.38** | **2%** | **2** |
| Other  (Treatment N=102) | 15-Sept | 1.97 | -0.35 | 1.35 | -18% | -36 |
| 16-Sept | 2.06 | -0.36 | 1.34 | -17% | -36 |
| **Average** | **2.02** | **-0.35** | **1.28** | **-17%** | **-36** |
|  | 15-Sept | 1.06 | -0.10 | 0.59 | -9% | -28 |
| All Industries (Treatment N = 292) | 16-Sept | 1.12 | -0.14 | 0.57 | -12% | -40 |
|  | **Average** | **1.09** | **-0.12** | **0.51** | **-11%** | **-34** |

\* = Significant at 90% confidence, \*\* = Significant at 95% confidence

## Bill Analysis

A working hypothesis throughout the ex post analysis is that because of the specific targeting of the marketing effort, customers who enrolled on one of the SPP rates during the summer of 2014 were unlikely to change their behavior due to the fact that their existing load shapes had very little consumption during the peak period. As a result, these structural winners would save money on their monthly bills compared to the flat rate simply by switching to one of the SPP rates. As a check on this assumption, bill impacts were estimated for all treatment customers. The results from this analysis are presented in Figure 4-1.

Figure 4-1: Distribution of Bill Impacts for SPP Treatment Customers



The bill analysis was segmented by industry and climate zone to allow for a more disaggregated analysis. The red vertical lines in each graph identify the average bill change for each segment. In all cases, this average is below zero, indicating that customers likely saved money on the SPP rates. In addition to the mean being below zero, each distribution also shows that the majority of customers had lower estimated bills after enrolling in the SPP rate.

# Ex Ante Methodology

## Estimating Impacts for Small Commercial Customers

As mentioned earlier in this report, the CPUC Load Impact Protocols[[14]](#footnote-14) require that ex ante load impacts be estimated assuming weather conditions associated with both normal and extreme utility operating conditions. Normal conditions are defined as those that would be expected to occur once every 2 years (1-in-2 conditions) and extreme conditions are those that would be expected to occur once every 10 years (1-in-10 conditions). Since 2008, the IOUs have based the ex ante weather conditions on system operating conditions specific to each individual utility. However, ex ante weather conditions could alternatively reflect 1-in-2 and 1-in-10 year operating conditions for the California Independent System Operator (CAISO) rather than the operating conditions for each IOU. While the protocols are silent on this issue, a letter from the CPUC Energy Division to the IOUs dated October 21, 2014 directed the utilities to provide impact estimates under two sets of operating conditions starting with the April 1, 2015 filings: one reflecting operating conditions for each IOU and one reflecting operating conditions for the CAISO system.

SDG&E’s small commercial customers will be defaulted onto the TOU-CPP rate, with the option of selecting the TOU rate instead. The starting point for forecasting the load impacts associated with transitioning all of SDG&E’s small commercial customers to SPP rates is the analysis of PG&E’s transition to mandatory TOU rates for all of its non-residential customers. As discussed in Section 2, PG&E’s TOU rate is very similar (both in prices and rate periods) to the SPP TOU rate. Because of this similarity, the high level strategy for obtaining ex ante estimates is to apply the estimated percent impacts from the PG&E evaluation to reference loads for SDG&E small commercial customers under predetermined sets of weather conditions. This section describes the steps associated with implementing this strategy as well as the implicit assumptions underlying it.

### Reference Loads

Reference loads provide a baseline level of consumption for customers representing what their electricity usage would be in the future if they did not switch to an SPP rate, but rather remained on their current rate (i.e., they are an estimate of counterfactual consumption). Reference loads can be compared to the predicted loads for customers after they transition to SPP rates to assess the effect of the new rates.

Since nearly all small commercial customers in SDG&E’s service territory are currently on a non-time-varying rate, there is ample data that can be used to model reference loads. The best approach for this modeling (in the absence of holding back a control group) is to develop a regression model that predicts electricity consumption as a function of weather conditions, month, day of week, hour of day, and other variables that influence usage. To develop the best possible model, 10 specifications were tested and the one that most accurately predicted loads during an out-of-sample test was selected as the final model. This model is shown as Equation 2:

|  |  |
| --- | --- |
| Equation 2: |  |
| Variable | Definition | |
| *h, i, d* | Indicate observations for each hour (h), industry (i) and day (d). | |
|  | The model constant. | |
|  | Cooling degree days on day d, defined as max(0, Avg. daily temp – 60). | |
|  | A binary indicator of whether the day of the observation is a weekday (0=weekend, 1=weekday). | |
|  | Set of dummy variables for each month of the year. | |
|  | Error term (assumed to be mean zero and independent of all other regressors). | |

The reference load model was estimated separately for each small commercial industry type for each hour of the day and includes terms for a weekday dummy variable interacted with cooling degree days, the same weekday dummy interacted with cooling degree days squared, the weekday dummy by itself, and a set of dummy variables for the months of the year. This specification captures changes in weather conditions as well as seasonal variation in electricity usage and was used to estimate reference loads for every combination of industry, day type (weekday or weekend), month, and set of weather conditions. Estimated reference loads for the average small commercial customer throughout the year are presented in Table 5-1.

The values in the table represent average load during the peak period for monthly peak days under each set of weather conditions. The highest reference loads during the peak period for this group of customers occur in September for each of the weather scenarios. During the summer months, the CAISO and SDG&E based reference loads (and underlying weather) are quite similar under 1-in-2 year conditions. For 1-in-10 year conditions, the SDG&E based weather conditions are typically a bit higher than the CAISO based conditions.

Table 5-1: Estimated Reference Loads for Small Commercial Customer   
Under Ex Ante Weather Conditions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month | Reference Loads (kW) | | | |
| CAISO | | SDG&E | |
| 1-in-2 | 1-in-10 | 1-in-2 | 1-in-10 |
| January | 1.70 | 1.70 | 1.70 | 1.70 |
| February | 1.71 | 1.71 | 1.71 | 1.71 |
| March | 1.70 | 2.01 | 1.70 | 1.92 |
| April | 1.86 | 2.27 | 1.94 | 2.36 |
| May | 1.93 | 2.37 | 2.10 | 2.47 |
| June | 2.20 | 2.44 | 2.20 | 2.45 |
| July | 2.44 | 2.52 | 2.44 | 2.70 |
| August | 2.66 | 2.69 | 2.61 | 2.80 |
| September | 2.71 | 2.92 | 2.68 | 2.90 |
| October | 2.20 | 2.47 | 2.30 | 2.56 |
| November | 1.81 | 2.09 | 1.85 | 2.21 |
| December | 1.67 | 1.67 | 1.67 | 1.67 |

### Impact Estimates

Estimates from the PG&E mandatory TOU evaluation for small and medium commercial customers are presented in Table 5-2 by industry. There are three features of these results that are particularly interesting and relevant to ex ante impact estimation for SDG&E. The first is that the magnitudes of the impacts for most industries are large given the relatively small price differentials between the peak and off-peak periods. Indeed, the price elasticities corresponding to the PG&E impacts are an order of magnitude larger than the estimates from most other studies in the literature. One possible explanation for this outcome is that the PG&E impacts capture a base behavioral response that is associated with changing to TOU rates. Prior studies have not studied this issue in depth and instead have relied on large TOU price differentials and small sample sizes. If it is indeed the case that some amount of the response to TOU rates is “fixed,” then observed impacts should not be interpreted purely as price impacts because they also reflect behavioral responses triggered by non-price features of the rate transition. Using the PG&E results as the basis for ex ante forecasts for PG&E assumes that a similar “rate transition” effect will occur for SPP rates.

Table 5-2: Industry Level Results from PG&E Non-res Mandatory TOU Evaluation

| Industry Type | Season | Day type | Rate Block | Ref Load (kW) | % Reduction | Impact (kW) | Standard Error |
| --- | --- | --- | --- | --- | --- | --- | --- |
|
|  |
| Agriculture, Mining & Construction | Summer | Weekdays | Peak | 2.27 | 8.8% | 0.20 | 0.024 |
| Part-Peak | 1.86 | 6.2% | 0.11 | 0.026 |
| Off-Peak | 1.25 | -1.2% | -0.01 | 0.025 |
| Weekends & Holidays | Off-Peak | 1.29 | 3.8% | 0.05 | 0.024 |
| Non-Summer | Weekdays | Part-Peak | 1.71 | 14.8% | 0.25 | 0.011 |
| Off-Peak | 1.18 | 11.6% | 0.14 | 0.012 |
| Weekends & Holidays | Off-Peak | 1.07 | 13.7% | 0.15 | 0.014 |
| Institutional/ Government | Summer | Weekdays | Peak | 2.64 | 7.5% | 0.20 | 0.013 |
| Part-Peak | 2.16 | 6.7% | 0.14 | 0.007 |
| Off-Peak | 1.16 | 9.1% | 0.11 | 0.008 |
| Weekends & Holidays | Off-Peak | 1.46 | 4.0% | 0.06 | 0.010 |
| Non-Summer | Weekdays | Part-Peak | 2.20 | 8.5% | 0.19 | 0.006 |
| Off-Peak | 1.16 | 8.5% | 0.10 | 0.009 |
| Weekends & Holidays | Off-Peak | 1.35 | 5.9% | 0.08 | 0.007 |
| Manufacturing | Summer | Weekdays | Peak | 3.93 | -6.0% | -0.24 | 0.046 |
| Part-Peak | 3.02 | -4.8% | -0.14 | 0.030 |
| Off-Peak | 1.66 | -1.3% | -0.02 | 0.012 |
| Weekends & Holidays | Off-Peak | 1.45 | 5.4% | 0.08 | 0.053 |
| Non-Summer | Weekdays | Part-Peak | 3.24 | 3.2% | 0.10 | 0.041 |
| Off-Peak | 1.67 | 3.0% | 0.05 | 0.015 |
| Weekends & Holidays | Off-Peak | 1.43 | 13.3% | 0.19 | 0.046 |
| Offices, Hotels, Finance, Services | Summer | Weekdays | Peak | 3.41 | 3.2% | 0.11 | 0.007 |
| Part-Peak | 2.59 | 3.6% | 0.09 | 0.005 |
| Off-Peak | 1.62 | 2.0% | 0.03 | 0.004 |
| Weekends & Holidays | Off-Peak | 1.82 | 1.7% | 0.03 | 0.005 |
| Non-Summer | Weekdays | Part-Peak | 2.47 | 4.9% | 0.12 | 0.008 |
| Off-Peak | 1.61 | 2.5% | 0.04 | 0.003 |
| Weekends & Holidays | Off-Peak | 1.62 | 2.6% | 0.04 | 0.004 |
| Other or Unknown | Summer | Weekdays | Peak | 2.28 | 2.5% | 0.06 | 0.006 |
| Part-Peak | 1.78 | 1.2% | 0.02 | 0.004 |
| Off-Peak | 1.16 | -1.5% | -0.02 | 0.004 |
| Weekends & Holidays | Off-Peak | 1.29 | 0.6% | 0.01 | 0.006 |
| Non-Summer | Weekdays | Part-Peak | 1.76 | 2.5% | 0.04 | 0.005 |
| Off-Peak | 1.16 | 0.8% | 0.01 | 0.006 |
| Weekends & Holidays | Off-Peak | 1.16 | 1.3% | 0.02 | 0.006 |
| Retail Stores | Summer | Weekdays | Peak | 4.33 | 1.1% | 0.05 | 0.014 |
| Part-Peak | 2.98 | 2.4% | 0.07 | 0.012 |
| Off-Peak | 1.53 | 3.1% | 0.05 | 0.011 |
| Weekends & Holidays | Off-Peak | 2.25 | 0.6% | 0.01 | 0.010 |
| Non-Summer | Weekdays | Part-Peak | 3.09 | 3.3% | 0.10 | 0.015 |
| Off-Peak | 1.48 | 4.7% | 0.07 | 0.014 |
| Weekends & Holidays | Off-Peak | 1.94 | 1.9% | 0.04 | 0.011 |
| Schools | Summer | Weekdays | Peak | 4.43 | 3.4% | 0.15 | 0.121 |
| Part-Peak | 3.08 | 6.5% | 0.20 | 0.070 |
| Off-Peak | 1.42 | 8.0% | 0.11 | 0.021 |
| Weekends & Holidays | Off-Peak | 1.62 | 12.8% | 0.21 | 0.047 |
| Non-Summer | Weekdays | Part-Peak | 2.98 | 13.0% | 0.39 | 0.090 |
| Off-Peak | 1.76 | 9.2% | 0.16 | 0.037 |
| Weekends & Holidays | Off-Peak | 1.48 | 16.7% | 0.25 | 0.027 |
| Wholesale, Transport & Other Utilities | Summer | Weekdays | Peak | 2.02 | 5.7% | 0.11 | 0.010 |
| Part-Peak | 1.57 | 5.1% | 0.08 | 0.008 |
| Off-Peak | 1.14 | -0.3% | 0.00 | 0.009 |
| Weekends & Holidays | Off-Peak | 1.05 | 5.1% | 0.05 | 0.007 |
| Non-Summer | Weekdays | Part-Peak | 1.63 | 6.4% | 0.10 | 0.009 |
| Off-Peak | 1.14 | 1.5% | 0.02 | 0.008 |
| Weekends & Holidays | Off-Peak | 0.99 | 4.4% | 0.04 | 0.010 |

The second noticeable feature of the PG&E results is that customers in nearly every industry experienced statistically significant load reductions for all of the TOU rate blocks, including the off-peak period for which the price per kWh became lower. This result suggests that customers responded to the TOU rate by engaging in more efficient behavior overall as opposed to shifting consumption from the peak and semi-peak periods to the off-peak period. The final characteristic of the PG&E results that deserves attention is that percent impacts in the winter are larger than those in the summer for most industries despite the price differentials being higher in the summer. Though seemingly counterintuitive at first, these results are evidence that prices are most likely not the only stimulus responsible for changing behavior. Pricing theory, while useful, sometimes tells only part of the story.[[15]](#footnote-15)

There are several possible explanations for why transitioning to a TOU rate would result in decreased usage during all rate periods and larger impacts in the winter, including:

* The transition to TOU increased self-awareness about energy consumption habits overall;
* Customers responded to TOU by using rules of thumb, which may lead to reductions in other time periods;
* Actions that reduce consumption by a fixed amount would be larger in percentage terms during the winter, when total usage is lower;
* The higher prices were in effect between 8:30 AM and 9:30 PM. Customers may have been taking actions to reduce demand over the broader high price period. Actions targeting such a broad period could easily spill over into off-peak hours. Alternatively, given the broad period of higher prices, customers may have consciously elected to reduce consumption;
* The TOU rate transition took place in November and customer response may have been based on the loads that were adjustable at the time;
* Some customers may be responding by installing energy efficiency measures because it is what they know; and

The response is due to high levels of education/communication, although the fact that it persists for a year with little change undermines this argument for a temporary education boost.

### Adjustments to PG&E Results

Although the structure of the PG&E and SDG&E TOU rates are similar, they are not identical. Specifically, the SDG&E rate has additional rate periods on certain day types, which are shown in Table 5-3.

Table 5-3: SPP Rate Periods That Are Not Part of PG&E Rates

|  |  |  |
| --- | --- | --- |
| Season | Day Type | Rate Block |
| Summer | Weekends & Holidays | Semi-Peak |
| Non-Summer | Weekdays | Peak |
| Weekends & Holidays | Semi-Peak |

To estimate load impacts for these periods, the relative PG&E impacts between rate periods were used to scale the existing impacts up or down. As an example, consider impacts for the customer segment that includes Offices, Hotels, Finance and Services as shown in Table 5-4.

Table 5-4: PG&E Impacts for Offices, Hotels, Finance and Services Industry

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Season | Day Type | Rate Block | Percent Impact |
| Offices, Hotels, Finance, Services | Summer | Weekdays | Peak | 3.24% |
| Semi‐Peak | 3.61% |
| Off‐Peak | 2.01% |
| Weekends & Holidays | **Semi-Peak** | **3.08%** |
| Off‐Peak | 1.72% |
| Non-Summer | Weekdays | **Peak** | **4.35%** |
| Semi‐Peak | 4.85% |
| Off‐Peak | 2.51% |
| Weekends & Holidays | **Semi-Peak** | **4.99%** |
| Off‐Peak | 2.58% |

The shaded cells in Table 5-4 denote day type and rate block combinations that are unique to the SPP rates and are estimated by combining other estimates from the same season, where possible. For instance, the semi-peak impact on summer weekends and holidays was obtained by scaling up the off-peak impact by the ratio of semi-peak to off-peak impacts on summer weekdays (1.72% \* (3.61%/2.01%) = 3.08%). A similar calculation is done for the semi-peak period on non-summer weekends and holidays. For the non-summer weekday peak period impact, the peak to semi-peak ratio in the summer is used since using estimates from the same season is not possible (in this case 4.85% \* (3.24%/3.61%) = 4.35%).

### Standard Errors and Confidence Intervals

The PG&E evaluation involved tens of thousands of customers and a statistically matched control group that was able to produce very precise estimates.[[16]](#footnote-16) By applying these same estimates to SDG&E, we are introducing several new sources of uncertainty that reflect differences between customers in the two territories. These sources include differences in the mix of customers, differences in climate, differences in weather sensitivity, differences in the education and outreach initiatives, and differences in business types within a particular industry. Though it would clearly be wrong to apply the estimated PG&E standard errors as is, there is no good mechanism for determining how they should be adjusted in light of the additional uncertainty. Absent a good strategy for making defensible quantitative adjustments to the standard errors, the best approach is to simply inflate the estimated errors by a sufficiently large factor (we used ‘15’) to produce confidence intervals that are more likely to reflect the true uncertainty of the estimates than do the very small standard errors from the PG&E evaluation. These errors and confidence bands should not be interpreted as having come from any robust econometric estimation, but are intended to point out the large amount of uncertainty surrounding the point estimates. Due to the lack of empirical data that exists for the relevant population, we see no other feasible approach.

### Incremental Impacts of CPP Prices

PG&E’s impact estimates can be used as the basis for all SPP ex ante load impacts except for one—the peak period impact for CPP event days. Because the PG&E impacts are for a TOU rate, another data source is required to estimate impacts for the high priced peak period on CPP days.[[17]](#footnote-17) To date, there is essentially no empirical evidence on the effect of default CPP rates on small commercial customers in California or elsewhere.

Factoring in differences in climate, customer mix, and enrollment strategy (default vs. opt-in), the closest experience to SDG&E’s transition to a default TOU-CPP rate is the transition of medium and large commercial customers to a default CPP rate in May 2008.[[18]](#footnote-18) Medium and large commercial customers share the same climate as their small commercial counterparts and were also defaulted onto their new rate. The biggest differences between the two groups of customers (large/medium vs. small) are that larger customers may be fundamentally different in their potential to respond to time-varying prices (larger amount of equipment) and are generally believed to be more capable of doing so.[[19]](#footnote-19)

While opt-in CPP rates for small commercial customers have been tested, default CPP rates have not. Even the most relevant opt-in CPP rate study for small customers, California’s Statewide Pricing Pilot that was done in 2003 and 2004, showed no statistically significant impacts for small customers on CPP rates without enabling technology. Due to the lack of robust empirical data on how small commercial customers respond to default CPP pricing, this report makes the conservative assumption that the incremental impact of the CPP portion of the SPP rates is zero.

## Estimating Impacts for Agricultural Customers

PG&E’s rollout of TOU rates to non-residential customers also included agricultural customers and to our knowledge, the analysis of the mandatory A4 rate is the only set of empirical results for agricultural customers that can be drawn from to estimating ex ante impacts for the agricultural SPP rates. Unlike small commercial customers, SDG&E’s agricultural customers will be defaulted onto the TOU rate and given the option of opting on to the TOU-CPP rate.

The mix of agricultural customers in the PG&E territory differs significantly from the corresponding customer mix in SDG&E. Different customer types (e.g., farms that grow different crops, golf courses, etc.) have very different load shapes and could also differ in their ability/willingness to shift load to other parts of the day. The consequence of this is that applying PG&E’s overall agricultural impacts directly to SDG&E is almost certainly inappropriate. Instead, agricultural customers in SDG&E territory were mapped into PG&E subindustries so that the PG&E results for that customer segment could be applied.

As with small commercial customers, there is very limited experience with the impacts of CPP rates on agricultural customers. The results that do exist have been estimated for large agricultural customers who may not behave the same way as SDG&E’s agricultural customer population.[[20]](#footnote-20) Thus, getting a sense for the magnitude of the load impacts on CPP event days is difficult and comes with a large amount of uncertainty. Similar to the approach for small commercial customers, the incremental impacts of the CPP portion of the rate are assumed to be zero in the analysis.

# Ex Ante Load Impact Results

This section presents the results of the ex ante impact evaluation for each class of SDG&E customer that will transition to the SPP rates.

## Small Commercial Customers (Approved Rate Windows)

Peak period load impact estimates attributable to the TOU component of the SPP rates on a July system peak day (SDG&E weather conditions) are presented in Table 6-1 for each industry. Percent impacts range from -6% for Manufacturing (load increase) to 9% for Agriculture, Mining & Construction. The forecasted aggregate impact for all small commercial customers is about 11 MW under 1-in-2 conditions and approximately 9% higher (11 MW) under 1-in-10 conditions.

Table 6-1: Ex Ante TOU Load Impacts for Small Commercial Customers   
on September Monthly System Peak Day (SDG&E Weather Conditions)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Industry | SDG&E 1-in-2 | | | SDG&E 1-in-10 | | | % Impact |
| Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) | Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) |
| Agriculture, Mining & Construction | 2.14 | 0.19 | 1.49 | 2.36 | 0.21 | 1.64 | 8.8% |
| Manufacturing | 2.48 | -0.15 | -1.39 | 2.66 | -0.16 | -1.50 | -6.0% |
| Wholesale, Transport & Other Utilities | 2.61 | 0.15 | 1.06 | 2.83 | 0.16 | 1.14 | 5.7% |
| Retail Stores | 3.63 | 0.04 | 0.50 | 3.91 | 0.04 | 0.54 | 1.1% |
| Offices, Hotels, Finance, Services | 2.87 | 0.09 | 5.09 | 3.11 | 0.10 | 5.51 | 3.2% |
| Schools | 3.24 | 0.11 | 0.27 | 3.54 | 0.12 | 0.30 | 3.4% |
| Institutional/Government | 2.03 | 0.15 | 3.93 | 2.18 | 0.16 | 4.23 | 7.5% |
| **All Small Commercial** | **2.68** | **0.09** | **10.95** | **2.90** | **0.10** | **11.87** | **3.4%** |

Aggregate impacts for each month of the year are presented in Table 6-2. The impacts range from a low of about 8 MW in May to a high of almost 13 MW in November. It should be noted that impacts are approximately 30–40% larger in the winter compared to the summer, which is a direct consequence of basing the ex ante estimates on the results from PG&E.

Table 6-2: Aggregate Ex Ante TOU Load Impacts for Small Commercial Customers on   
Monthly System Peak Days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month | Load Impact (MW) | | | |
| CAISO | | SDG&E | |
| 1-in-2 | 1-in-10 | 1-in-2 | 1-in-10 |
| January | 12.15 | 12.15 | 12.15 | 12.15 |
| February | 12.21 | 12.21 | 12.21 | 12.21 |
| March | 12.12 | 14.26 | 12.11 | 13.67 |
| April | 13.19 | 16.16 | 13.76 | 16.81 |
| May | 7.96 | 9.83 | 8.69 | 10.23 |
| June | 9.09 | 10.12 | 9.09 | 10.15 |
| July | 10.02 | 10.40 | 10.06 | 11.14 |
| August | 10.97 | 11.09 | 10.75 | 11.53 |
| September | 11.10 | 11.96 | 10.95 | 11.87 |
| October | 8.92 | 10.07 | 9.36 | 10.43 |
| November | 12.84 | 14.84 | 13.16 | 15.70 |
| December | 11.91 | 11.92 | 11.92 | 11.92 |

As discussed in Sections 2 and 5, the empirical evidence available for estimating the incremental impact of CPP prices on event days is extremely limited and so these impacts are conservatively assumed to be zero.

## Agricultural Customers (Approved Rate Windows)

Peak period load impact estimates attributable to the TOU component of the SPP rates on a July system peak day for agricultural customers are presented in Table 6-3 by industry. The agricultural customer segment was separated into two distinct industries—agricultural pumping and water districts. The majority of customers fall into the agricultural pumping category and this industry is responsible for nearly the entire forecasted load reductions associated with the TOU rate. Overall, SDG&E’s agricultural customers are expected to reduce their peak period usage by about 1.10 MW in response to the TOU portion of the SPP rates.

Table 6-3: Ex Ante TOU Load Impacts for Agricultural Customers on July Monthly System Peak Day (SDG&E Weather Conditions)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Industry | SDG&E 1-in-2 | | | SDG&E 1-in-10 | | | % Load Reduction |
| Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) | Ref Load (kW) | Avg. Impact per Customer (kW) | Aggregate Impact (MW) |
| Agriculture Pumping | 2.46 | 0.47 | 1.05 | 2.49 | 0.47 | 1.06 | 19.1% |
| Water Districts | 2.55 | 0.14 | 0.05 | 2.71 | 0.15 | 0.06 | 5.7% |
| All Agriculture | 2.47 | 0.42 | 1.10 | 2.52 | 0.43 | 1.12 | 17.0% |

Impacts for agricultural customers by month are shown in Table 6-4. Unlike the results for small commercial customers, impacts for agricultural customers are largest in the summer and smaller in the winter due to the seasonal nature of the growing season and pumping activities. The results are also fairly consistent across each set of ex ante weather conditions, with impacts ranging from a low of around 0.45 MW in December to a high of approximately 1.10 MW in July.

Table 6-4: Aggregate Ex Ante TOU Load Impacts for Agricultural Customers on   
Monthly System Peak Days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Month | Load Impact (MW) | | | |
| CAISO | | SDG&E | |
| 1-in-2 | 1-in-10 | 1-in-2 | 1-in-10 |
| January | 0.53 | 0.53 | 0.53 | 0.53 |
| February | 0.45 | 0.45 | 0.45 | 0.45 |
| March | 0.43 | 0.50 | 0.43 | 0.49 |
| April | 0.57 | 0.63 | 0.58 | 0.64 |
| May | 1.00 | 1.10 | 1.06 | 1.11 |
| June | 1.06 | 1.11 | 1.06 | 1.11 |
| July | 1.10 | 1.11 | 1.10 | 1.12 |
| August | 1.06 | 1.06 | 1.05 | 1.06 |
| September | 1.08 | 1.06 | 1.08 | 1.07 |
| October | 0.97 | 1.01 | 0.99 | 1.02 |
| November | 0.50 | 0.56 | 0.52 | 0.57 |
| December | 0.45 | 0.45 | 0.45 | 0.45 |

As with small commercial customers, the incremental impact of the CPP component of the SPP rates is assumed to be zero for agricultural customers.

# Conclusions and Recommendations

An ex post analysis of the load impacts associated with the voluntary SPP rates in the summer of 2014 showed no statistically significant reductions in peak period usage and the majority of evidence suggests that customers viewed the SPP rates as a way to reduce their electricity costs without needing to change their consumption behavior. Due to the unique set of customers who enrolled on the rates, however, these results cannot be used as the basis for ex ante estimation for the SDG&E small commercial population as a whole.

As discussed throughout the report, the ex ante load impact estimates presented here are necessarily based on borrowed data. The estimates for TOU are based on default TOU impacts for PG&E’s customer population for a mandatory rate where customers could not opt-out to an alternative rate option. SDG&E is planning to default customers onto TOU, but will give them the option of changing to a TOU-CPP rate. As such, there is a good deal of uncertainty in the estimates presented here.

Even after SDG&E deploys default TOU rates for the small commercial population in its own service territory, it will be difficult if not impossible to estimate ex post load impacts unless SDG&E implements the plan in stages so there is a period of time when some customers are on the new rates and others are not. Alternatively, SDG&E could hold back a small control group of customers who stay on the standard rate for a period of time for the sole purpose of measuring impacts. In either case, it is critical that the customers who remain on the non-time varying rate for some period of time be randomly chosen. Put another way, if SDG&E does a phased roll out of the default rate, it’s important that customers who are assigned the new rate and those that are delayed are identical except that one is on the rate and the other isn’t. If the phased roll out is done on some other basis (e.g., geographically, by size stratum, etc.), it will be much more difficult and, perhaps, impossible to estimate impacts with any degree of accuracy.

1. See Application A.10-07-009 for original proposal - http://www.sdge.com/node/476 [↑](#footnote-ref-1)
2. A separate report containing ex ante load impact forecasts for the residential SPP rates will be submitted to the CPUC on June 1, 2015. [↑](#footnote-ref-2)
3. Such customers are sometimes called “structural winners” because the pattern of their existing load shapes would result in monthly bill savings in the absence of any behavioral response to the rate. [↑](#footnote-ref-3)
4. Throughout this report, treatment customers and enrolled customers are used synonymously. [↑](#footnote-ref-4)
5. An argument could be made that small commercial customers are actually more similar to residential customers in terms of energy use behavior than larger commercial or industrial customers. [↑](#footnote-ref-5)
6. Although default rates had lower per customer impacts, they resulted in larger aggregate impacts due to a large difference in enrollment rates that more than made up for the smaller average impacts per customer. [↑](#footnote-ref-6)
7. The number of customers underlying each row in the figure is: Flat = 21,722; TOU = 454; TOU-CPP = 293. [↑](#footnote-ref-7)
8. Because of this, the ex post analysis was conducted for three specific industries – information, public administration, and other – in addition to an analysis containing all customers. [↑](#footnote-ref-8)
9. Matching was performed separately for TOU and TOU-CPP customers. [↑](#footnote-ref-9)
10. In Equation 6, *avg\_pm\_shouldershare* is the average share of daily electricity consumed during the afternoon shoulder period. [↑](#footnote-ref-10)
11. In some cases (such as Information) the best performing model is quite clear. In situations where there is more ambiguity, we chose the model with the lowest APE. Sensitivity analysis of the final results was performed using different models and showed that the matching model used did not lead to any meaningful changes to the results. [↑](#footnote-ref-11)
12. Though negative impacts seem counterintuitive at first sight, load increases in response to the TOU rate may be a rational response since all customers were structural winners. For these customers, the switch to the TOU rate represented a reduction in their average price of electricity based on their historical consumption pattern. [↑](#footnote-ref-12)
13. Mean17 is the average temperature from midnight to 5 PM. [↑](#footnote-ref-13)
14. See CPUC Rulemaking (R.) 07-01-041 Decision (D.) 08-04-050, “Adopting Protocols for Estimating Demand Response Load Impacts” and Attachment A, “Protocols.” [↑](#footnote-ref-14)
15. As examples, see the *2013 Load Impact Evaluation of Pacific Gas and Electric Company's Residential Time-based Pricing Programs* (April 2014), which contains results showing customers reducing loads when given a price discount and evidence of customers who experience the smallest price differentials (Tier 5 customers non-CARE customers) delivering much, much larger reductions than customers with the largest price ratios (CARE customers). [↑](#footnote-ref-15)
16. This is primarily true for the SMB population. Estimates of standard errors for agricultural customers are based on smaller samples and are generally of a more reasonable magnitude when compared directly with the impact estimates. [↑](#footnote-ref-16)
17. It would be possible to calculate elasticities based on the TOU impacts and apply them to the CPP prices, but this represents an extreme out-of-sample prediction and past experience has shown the resulting estimates to be highly inaccurate. [↑](#footnote-ref-17)
18. SDG&E transition customers to default CPP in May 2008. PG&E and SDG&E did so in November and October, respectively, of 2009. [↑](#footnote-ref-18)
19. Large commercial customers commonly have account representatives at a utility that are able to advise customers on their energy using behavior and how to manage their bills. [↑](#footnote-ref-19)
20. There is a large amount of data on how water districts respond to default CPP rates. These larger customers were classified by SDG&E as Agricultural while SCE and PG&E included them in the general medium and large commercial customer population that was shifted to default CPP in 2009. [↑](#footnote-ref-20)