# Comparison of Event-Based Demand Response Programs with and without Enabling Technology

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# ABSTRACT

Many utilities offer residential customers both critical peak pricing (CPP) and direct load control (DLC) programs. At some utilities, customers can enroll in both types of programs, while at others they are barred from doing so to avoid double payment for the same load reduction. Pacific Gas & Electric (PG&E) operates both a CPP program (SmartRate) and a DLC program (SmartAC) for residential customers during the summer. Both programs are opt-in and customers can join one or both programs. The question this paper answers is how do impacts vary between SmartRate, SmartAC and dually-enrolled customers?

Because customers opt-in to SmartRate and SmartAC (or both), the population of each is not necessarily comparable to that of the others. To control for selection bias, propensity score matching was used to select a group of SmartRate customers and a group of SmartAC customers who were similar to dually-enrolled customers based on usage and location. Impacts were calculated at the hourly level using difference-in-differences.

Results of this analysis show that customers with DLC devices provide greater impacts than customers without them. Dually-enrolled customers provided the greatest impacts (0.68 kW) with SmartAC customers close behind (0.58 kW). SmartRate customers showed the lowest impacts (0.33 kW). The two important takeaways are: 1) customers who are dually-enrolled show greater impacts than customers on only the DLC program, so the utility is not necessarily paying customers twice for the same load reduction; and 2) enrolling customers who are already on CPP onto a DLC program results in greater impact gains than enrolling DLC customers on a CPP rate.

### Introduction

PG&E operates both a critical peak pricing (CPP) program, SmartRate, and a direct load control (DLC) program, SmartAC, for residential customers during the summer. SmartAC had over 145,000 residential customers at the end of the summer of 2011 while SmartRate had about 23,000 customers. Customers are not limited to being on one program or the other; there were 4,700 customers who were enrolled in both SmartRate and SmartAC during the summer of 2011. This paper explores how the impacts differ among customers that are (1) only enrolled on SmartRate, (2) only enrolled on SmartAC, and (3) dually-enrolled on SmartAC and SmartRate.

SmartRate is a dynamic rate that overlays other available tariffs. SmartRate has a high price during the peak period up to 15 event days per year (between May and October), referred to as Smart Days, and slightly lower prices at all other times during the summer. The peak price adder is \$0.60 per kWh. SmartAC is a DLC program that involves the installation of programmable communicating thermostats or load control switches at households with central air conditioning (CAC). Events can be called from May to October and can last up to six hours (for no more than 100 hours per season). For customers enrolled in both SmartAC and SmartRate, CAC control devices activate for both SmartRate and SmartAC event days. It is particularly beneficial for customers enrolled on SmartRate only to also enroll in SmartAC as it guarantees an automated response to controlling load during high price periods.

# Methodology

The basic analytical requirement for any impact evaluation is the estimation of a reference load during event periods. Since SmartAC and SmartRate are both opt-in programs, the customers enrolled in each are not necessarily representative of the overall population. Under the same logic, customers who choose to enroll in both programs are probably different not only from the overall population but from the SmartAC only and SmartRate only populations. In order to control for this selection bias, propensity score matching is used. The matching process finds customers within the SmartAC and SmartRate populations that have characteristics similar to the dually-enrolled population. This ensures that the comparison of load impacts isolates the differences in impacts due to the programs rather than due to underlying differences between the three groups.

First, the 4,700 dually-enrolled customers were matched to SmartRate only customers using propensity score matching based on hourly usage on hot non-event days and local capacity area. Next, the same set of dually-enrolled customers was matched to SmartAC-only customers using the same variables. This left the analysis with three sets of customers: dually-enrolled, SmartAC only and SmartRate only.

Figure 1 provides evidence that the matching procedure produced three sets of customers that have quite similar loads on hot non-event days. The figure shows the average usage of each of the three groups on June 15, 2011 and August 24, 2011. These are the only two days that were included in both propensity score matches. All three groups have very similar usage patterns throughout the day. More importantly, they have nearly identical usage from 4 to 6 pm, the hours over which all events overlap. SmartAC only customers used about 2 percent more than dually-enrolled customers from 4 to 6 pm and SmartRate only customers used about 3 percent more than dually-enrolled customers.



Figure 1: Average Usage Among Matched Groups on June 15 & August 24, 2011

As shown above, there are three lines (one for each group) on non-event days. On event days, however, there are four lines because the SmartAC only group is divided into treated and non-treated customers. Non-treated customers from the SmartAC only group act as the control for each of the three other groups: SmartAC only treated, SmartRate only and dually-enrolled.

### Results

Figure 2 shows the results of the load impact analysis. The blue line shows the reference load, based on the usage of SmartAC only customers who were not called for an event. The green line with squares shows the usage for SmartRate only customers, the red line with Xs shows usage for SmartAC only customers. Although the SmartAC only group had slightly different event hours from the other treated groups, the relative size of each groups' impacts is still apparent. Dually-enrolled customers having the largest impacts, followed by SmartAC only customers with SmartRate only customers having the smallest impacts.



Figure 2: Load Impacts for SmartAC, SmartRate and Dually-Enrolled Customers June 21 & 22, 2011

Table 1 goes into more detail and shows impacts for each of the three matched groups on the five overlapping SmartAC/ SmartRate days. Event impacts are shown only for the hours 4 to 6 pm because those are the hours over which the events always overlapped. As mentioned above, dually-enrolled customers showed the greatest load impacts of the three groups. SmartAC only customers showed lower impacts than the dually-enrolled group but only by about 15 percent. SmartRate only customers, however, showed less than half the impacts of dually-enrolled customers. This highlights the importance of the CAC control device for achieving greater load impacts.

| Date                                  | Program<br>Called | Event<br>Hours | Avg. Hourly Impacts  |                        |                              |
|---------------------------------------|-------------------|----------------|----------------------|------------------------|------------------------------|
|                                       |                   |                | SmartAC<br>Customers | SmartRate<br>Customers | Dually-Enrolled<br>Customers |
| 6/21/2011                             | SMR/SMAC          | 4-6 PM         | 0.65                 | 0.54                   | 0.93                         |
| 6/22/2011                             | SMR/SMAC          | 4-6 PM         | 0.71                 | 0.43                   | 0.86                         |
| 9/6/2011                              | SMR/SMAC          | 4-6 PM         | 0.47                 | 0.24                   | 0.53                         |
| 9/7/2011                              | SMR/SMAC          | 4-6 PM         | 0.58                 | 0.22                   | 0.56                         |
| 9/8/2011                              | SMR/SMAC          | 4-6 PM         | 0.47                 | 0.23                   | 0.53                         |
| Average Impact when All Groups Called |                   |                | 0.58                 | 0.33                   | 0.68                         |

Table 1: Load Impacts for SmartAC, SmartRate and Dually-Enrolled Customers

# Conclusion

The most apparent finding of this paper is that customers with enabling technology tend to provide greater impacts than customers without. This, however, is not very surprising. A more interesting finding is that customers with enabling technology who are also enrolled on a CPP program tend to give more impacts than customers simply in the DLC program. Although the added benefit is small compared to total impacts, this suggests that giving customers the incentives or benefits from both programs is not simply double-paying the customer for the same impacts. This analysis also shows that while recruiting DLC customers to join a CPP rate would increase impacts slightly, much larger impact improvements can be gained by recruiting customers on the CPP rate to sign up for a DLC program.