IOU: San Diego Gas & Electric

Topic: Smart Programmable Thermostats-

Programmable Communicating Thermostat (PCT)

Background

SDGE began offering the PCT in early 2014 in support of the commercial Demand Response program. As of February 2015, over 9,350 PCTs have been rolled out to roughly 1,200 commercial customers. Enrollment has grown substantially since summer 2014. This number is expected to gradually increase to 2,013 customers by the end of 2016 or roughly 15,000 PCT. The SDG&E PCT is limited to one manufacture / model- ECOBEE SI equipped with a Zigee Home Area Network (HAN) module that communicates with the existing utility smart meter. Changes are in motion to change the landscape and offer commercial customers a "Bring your own Smart Thermostat" with a given implementation timeline of 45-60 days.

Customer must undergo a DR load profile analysis prior to qualifying for a PCT and once qualified the customer PCT is installed by an authorized SDGE DI contractor or approved HVAC Trade Professional. At the time of PCT installation HVAC name plate information is collected. Customers who receive a PCT agree to sign up for DR events with the option to opt-out the day of .

Climate Zones

SDG&E's service territory has limited climatic diversity, but the variation in temperature and AC use has a real impact on many customers' loads on summer days when the ocean breeze cools off the coast and leaves customers further inland hot. Participants in the commercial thermostat program as of the 2014 summer come from one of two climate zones – Coastal and Inland.

Participants

The participants in the commercial thermostat program come from a number of different industries. During 2014 events, Offices, Hotels, Finance, and Services accounted for nearly half of all of the participating commercial customers and a slightly higher percentage of the total number of thermostats. Schools made up 12% of the total participating customers, but had 21% of the installed thermostats. Retail stores made up 8.5% of the participating customers, while having under 3% of the thermostats. On average there are nine (9) PCT per commercial customer.

Analytics Evaluation –Ex Post

The fundamental problem for estimating load impacts is developing an estimate of the reference load. The reference load is an estimate of what load would have been in the absence of the thermostat control that is in effect for participants. For this evaluation, the focus is on what load

would have been on days in which thermostat control was dispatched. The methods used in the commercial thermostat program evaluation rely on the selection of a control group using statistical matching and individual customer regressions, as explained in Sections 3.1 and 3.2, respectively.

The matched control group method used for most of this analysis is superior to a within-subjects analysis (individual customer regressions approach) when there is a large population of non-participating customers to use as a pool for matching and because it eliminates the problem of model misspecification.[1] Any reference load model based on loads observed at non-event times requires the modeler to make assumptions about the relationships between load, time, and temperature. If this assumed function does not reflect the true relationships between load, time, and temperature, then the model can produce incorrect results. In contrast, the matched control group automatically deals with this problem by assuming that the customers who behave similarly to participants during non-event periods would also behave similarly during event periods. This eliminates the need to specify load as a function of weather.

The primary source of reference loads, and hence impact estimates, is a number of matched control groups. These control groups are assembled from among the non-participant population. The methods used to assemble the groups are designed to ensure that the control group load on event days is an accurate estimate of what load would have been among participants on event days had they not participated.

The fundamental idea behind the matching process is to find customers who were not subject to events that have similar characteristics to those who were subject to events. The control groups were selected using a propensity score match to find customers who had demand patterns most similar to participants. In this procedure, a probit model is used to estimate a score for each customer based on a set of observable variables that are assumed to affect the decision to participate in the commercial thermostat program. **A probit model is a regression model designed to estimate probabilities**—in this case, the probability that a customer would choose to participate. The score can be interpreted two different ways. First, the propensity score can be thought of as a summary variable that includes all the relevant information in the observable variables about whether a customer would choose to participate. Each participant is matched with a non-participant that has the closest propensity score. The second way to think of the propensity score is as the probability that a customer will participate based on the included independent variables. Thinking of it this way, each customer in the control group is matched to a participant with a similar probability of participating given the observed variables.

The match was performed for commercial customers within each 2-digit NAICS, climate zone, and month. It was based on a set of variables that characterize usage in the middle of the day on two hot non-event days in the same month as the events. The set of usage variables in the propensity score model were the average usage from 10 AM to 6 PM on each of the two hot

[1] For a comparison of results using various research methods, including RCT/RED designs, statistical matching and within-subjects regression analysis, see the interim report on Sacramento Municipal Utility District's Smart Pricing Options pilot:
https://www.smartgrid.gov/sites/default/files/MASTER_SMUD%20CBS%20Interim%20Evaluation_Final_SUBMITTED%20TO%20TAG%2020131023.pdf

non-event days.[2] These days were chosen because they were the only days with temperatures that closely reflected those on event days. Many matching models were tested and the final model was chosen because it resulted in the closet match between participants and control customer average usage during event hours on hot, non-event days (discussed below). A match was found for each participant, but the same control customer could be matched to multiple participants, meaning that a control customer could be represented more than once in the control group.

Analytics Evaluation Ex-Ante

The ex post estimates presented in Section 4 and the ex ante estimates presented above differ for a number of reasons, including differences in weather, enrollment, and estimation methodology. This section discusses the impact of each of these factors on the difference between ex post and ex ante impact estimates.

Table 5-7 summarizes the key factors that lead to differences between ex post and ex ante estimates for the commercial thermostat program and the expected influence that these factors have on the relationship between ex post and ex ante impacts. Given that the load impacts are quite sensitive to variation in weather, even small changes in *mean*17 between ex post actual and ex ante weather conditions can produce relatively large differences in load impacts. Changes in enrollment between the values used for ex post estimation and the 2015 enrollment values are expected to more than double impact estimates as the program has grown substantially since the last event in September.

Benefits

- Cost effective (using existing DR program and customer base)
- Use existing EE programs and trade pros to deploy PCT
- Using existing KW Engineering DR WP to claim (modified) EE savings

Challenges

- Limited to One manufactures/Model
- CPUC CS/ED READI DEER EE value is negative for Residential
- SDGE DR/EE (preliminary) analytics was provided by NEXANT -2Q2015
- Uploaded PCT DR Workpaper to WPA on April 2, 2015- includes limited EE savings based on a GSA multiplier of 25%.

[2] The days were July 24th and July 30th to estimate impacts for the one July event day, and September 8th, and September 9th to estimate impacts for the three consecutive September event days. Several alternative sets of days were tested and