Efficiency Rebate Programs May Lead to Higher Electricity Consumption

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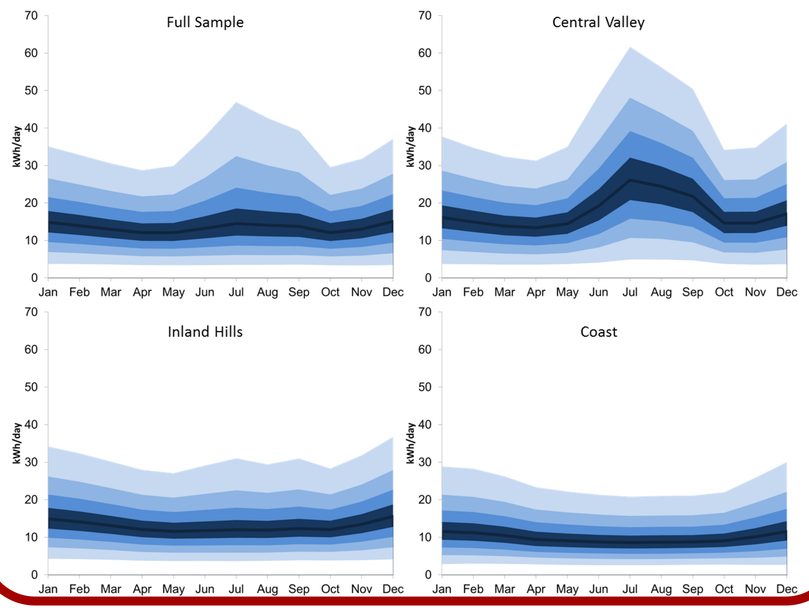
Abstract:

Do rebate programs for residential energy efficiency lead to lower electricity consumption? Using an unbalanced panel of smart-meter data from a sample of approximately 30,000 households in PG&E's service territory from 2008 to 2011, complemented with demand-side management (DSM) program participation and weather information, we assessed the effect of rebates for household electrical efficiency improvements on household electricity consumption. **Surprisingly, we find that participation in the efficiency rebate program leads to an average *increase* in household electricity consumption of about 7%.** We suspect that the reason is simple: the majority of rebate program eligibility is not contingent on equipment scrappage or recycling, and thus the program is likely behaving as an equipment subsidy program leading to additional household energy services for participants. To move towards sustainable, low-carbon, and affordable energy systems in the U.S., energy efficiency is likely needed to play a central role. That will require robust, large-scale programs that deliver the intended savings. With the roll-out of smart meter programs, utilities and policy makers have unprecedented data to evaluate the effects associated with energy efficiency programs.

Data:

Data include the smart-meter's 15-min interval readings from an unbalanced sample of approximately 30,000 customers provided by PG&E, split across three climate zones. Electricity readings are from March, 2008, through December, 2011. We use daily temperature data from National Oceanic and Atmospheric Administration's Global Historical Climatology Network-Daily database for weather stations in California, and hourly temperature data from the Iowa Environmental Mesonet collection of Automated Surface Observing System data from California. The dataset provided by PG&E includes household participation in the efficiency program as well as other PG&E programs.

Deciles of Daily Household Electricity Consumption, by Month



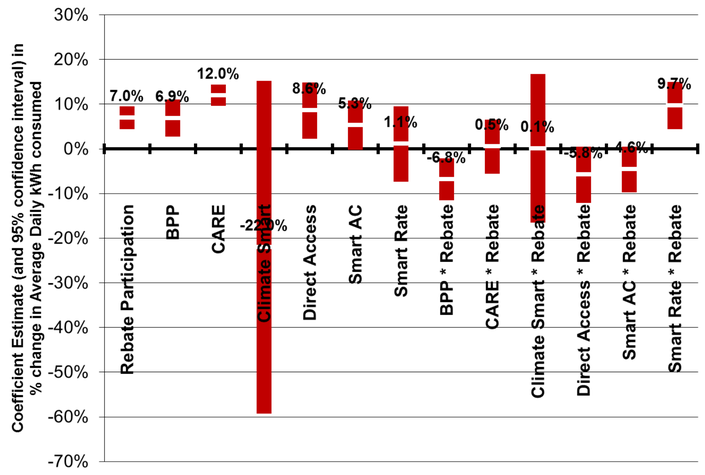
Method:

Rebate program participation impact is estimated using a fixed effects model. This form allows us to control for household characteristics that are time-invariant. To this we add fixed time effects for day of the week and month of the year as well as time and location specific temperature controls. Our preferred model form also includes indicators for household participation in other PG&E demand-side programs, as well as interactions of those programs with the efficiency rebate program.

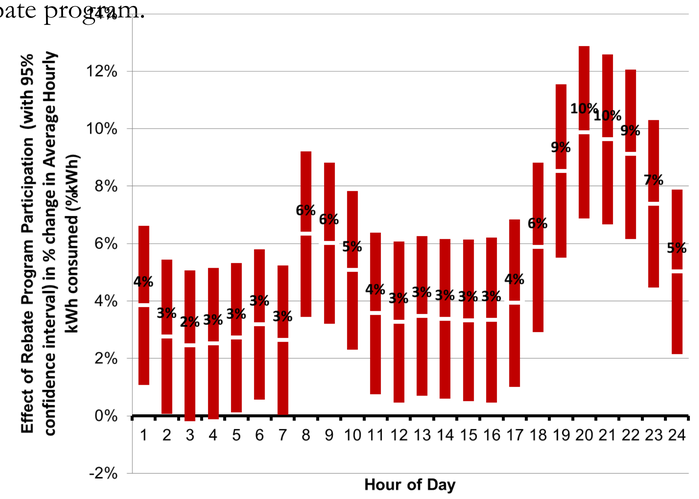
$$\ln(kWhs_{i,t}) = \alpha + \beta_j(Temp_{i,t})_j + \gamma(RebateDummy_{i,t}) + \delta_k(TimeDummies_t)_k + \zeta(TimeTrend_t) + \varphi_q(Program_{i,t})_q + \psi_q(RebateDummy_{i,t} * Program_{i,t})_q + \varepsilon_{i,t}$$

Results:

The chart below shows the estimated average daily electricity consumption effects of each of the included PG&E programs, as well as the interaction of the efficiency rebate program with all the others, along with the 95% confidence interval of each estimate.



This second chart shows the average change in household electricity consumption by hour of day following participation in the efficiency rebate program.



Control Group Concerns:

This analysis suffers from a control group issue. The ideal comparison that we would like to make is between a household's energy consumption following participation in the program and what that household would have consumed in the absence of the program's existence. Would the household have made an equipment purchase if the rebate was not available? If so, did the program encourage a shift towards a more efficient version of the purchase that was made? Obviously, these idealized comparisons are impossible to make in practice. An answer of 'no' to the first of these questions would mean that the program is in fact increasing counterfactual energy consumption while an answer of 'no' to the second would mean that the program is having no net effect. A 'yes' to both would suggest that the program is operating as intended. However, the dataset we use was not collected with these questions in mind. The analysis we have produced highlights that these questions require answers.

A step towards producing the required analysis would be to incorporate household-level demographic information with this dataset. This would enable the formation of more appropriate comparison groups using a propensity score matching method. As the data are, characteristics upon which the propensity for a household to participate in the rebate program are available only at the neighborhood (US Census blockgroup) level, therefore neighborhood location becomes the controlling characteristic for assessing participation likelihood. Household-specific demographics (ideally, including information about the building structure in addition to the occupants) would enable the creation of participation scores based on the observed rates of participation for similarly situated households. That would allow a comparison of the energy consumption patterns of households that participated in the program with households that were scored as similarly likely to participate in the program but which nevertheless did not.

Difference Between Groups:

Households that participate in the efficiency rebate program have different Census neighborhood characteristics than those households that do not. The following table reports some differences between these two groups.

Variable	Difference In Means	t score
Median Home Value*	$82k (20%)	17
Median Income*	$16k (20%)	24
% Renters	-13 points (30%)	25
% Poor	-4 points (30%)	16
% w/ Bachelors (or >)	6 points (15%)	13

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