Analysis of Whether Small and Medium Businesses are Underserved by Energy Efficiency Programs in California

Prepared for the California Energy Efficiency Coordinating Committee

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 All opinions, errors and omissions remain the responsibility of the authors. All reference URLs were accurate as of the date of publication.

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# Executive Summary

The California Energy Efficiency Coordinating Committee (CAEECC) Small and Medium Business Underserved Working Group (SMB UWG) examined a large set of energy efficiency (EE) participation data for programs that investor-owned utilities (IOUs) identified as targeting SMBs. This data set was for over 270,000 energy efficiency project claims from 2017 through 2019 for 71 programs from four IOUs across California.[[1]](#footnote-1) By combining the EE claims data set with publicly available data on business characteristics, demographics, rurality, and environmental and social justice factors, we were able to examine who was and was not benefiting from these energy efficiency programs. We specifically examined participation rates, savings, and investment flow against variables that the UWG identified as typically being underserved.

We present our findings in three general categories: variables illustrating an underserved characteristic, variables indicating positive correlation with EE participation, savings and investment, and those variables that showed no observable impact on underserved status. Table 1 provides a full breakout of the results for each variable and the results are summarized below.

**Variables Associated with an Underserved Characteristic**

The main finding was that firm size, as measured by the number of employees, had the largest identifiable effect on participation, savings, and investment . The business size factors combined made up about two-thirds of the explanatory power of the best fit regression. We documented this finding most directly in a few ways “Micro” firms that had less than 10 employees were associated with lower participation rates, saw less investment, and less savings, even after having controlled for multiple other variables. This finding is in line with the many barriers that have been identified with serving the smallest of business customers, including split incentives for landlords and tenants, difficulty paying up-front costs for undertaking energy efficiency investment, and the difficulty and cost associated with educating small businesses on EE opportunities.

We also found some slight gaps in participation by communities with higher percentages of the population below the poverty line and environmental issues, as identified under the CalEnviroScreen 3.0 (CES3.0) Score. While these effects were small, they were statistically significant and show that communities in which environmental issues exist may lead to less participation by SMBs.

We also found some small, but ultimately inconclusive evidence, that SMBs in ZIP Codes with higher portions of Native American populations and foregin born populations are underserved by energy efficiency programs.

**Variables Associated with Higher EE Participation, Savings and Investment**

Most interestingly, we found that a ZIP Code with any larger business presence increased program uptake rates across all micro, small, and medium businesses. This seems to imply a spillover effect from larger businesses as it relates to SMB EE program participation. It also shows how communities of more exclusively small and micro business may be more insular and difficult to reach.

We also found higher rates of participation, investment and savings for a few variables that we had original hypothesized to be associated with lower participation and benefits. This includes Asian and Hispanic communities, as well as higher program uptake in ZIP Codes with fewer businesses per square kilometer. This probably indicates that the efforts of SMB program administrators to reach some underserved groups were successful. However, without the greater context of full non-residential investment and savings potential, it is difficult to say whether these groups are still underserved or not. Ultimately, it may be that these specific programs have been somewhat successful at reaching some underserved communities, but not that these communities are receiving the full benefits that are technically or economically possible.

**Variables without any Observable Impact on Undereserved Status**

For some of the variables we examined we were unable to find any statistically significant results, either positive or negative. The main variable we found this for was the percentage of the population that was African American. We also found no effect for a more comprehensive measure of rurality at the county level called the Index of Relative Rurality.

**Data Challenges**

While performing the analysis, we also encountered various challenges around data collection and classification that could be improved upon to better understand EE data and the issues facing underserved communities in the future. In particular we found two areas that we believe could be improved upon.

1. Claim data was not tied to rate class in any usable way. While a rate class field exists in the California Energy Data and Reporting System (CEDARS), it was not used by most IOUs, and if it was used, was not based on any specific rules that we were able to determine. While other fields exist to identify residential customers, there was no way to separate out different types of non-residential participation data, and so the analysis we performed was based on a data set of programs associated with SMB customers, and not specifically associated with participation of existing SMB rate classes in all EE programs.
2. We were unable to obtain complete documentation for many of the fields in CEDARS. A publicly available spreadsheet provided a one or two sentence description, and another document provided the list of possible values, but there was no documentation of the meaning behind possible values, and so often times we relied on educated guesses in order to interpret some of the CEDARS data.

**Additional Future Analysis that Merits Completion**

Finally, we believe that additional work is probably warranted regarding the comparison of SMB program data to participants in all non-residential energy efficiency programs, as well as the additional contextualization of savings against savings potential and/or energy usage.

Table . Summary of Main Variables Examined and Key Findings

| **Variable Examined** |  **Hypothesis** | **Actual Relationship** | **Potential Explanation of Relationship**  |
| --- | --- | --- | --- |
| **Underserved Characteristics** |
| Firm Size | Program uptake by smaller firms as measured by employee counts would be lower than larger firms | Micro firms had negative correlation with uptake, savings, and investment. ZIP Codes with larger shares of large firms had higher take up rates. This was the finding with the most explanatory power. | Interesting result and may show some spillover effects from large firms to small firms. Also shows some gaps exist between large and small firms and that employee count is a potentially valid metric for determining firm size.  |
| CES3.0 Score | Communities with social and environmental justice issues, as measured by CalEnviroScreen, face higher barriers to participation. | Initially found CES3.0 scores correlated with higher participation rates. After controlling for demographics, a slight negative correlation was found.  | This seems to indicate that the demographic aspect of these communities is being targeted by these programs, while the underlying environmental issues may not be. |
| Percentage of Population – Foreign Born | Group that may be underserved due to communication and awareness gaps  | Confirmed with a modest negative effect that did not persist across all regressions. Explanatory power was low. | There may be some gaps in service due to difficulty communicating with business in non-native communities. |
| Percentage of Population – Native American | Minority group that may be underserved | Confirmed. Very large negative effect, but also smaller population and results were of borderline significance and explanatory power. | Difficult to draw any real conclusion from the existing data.  |

| **Variable Examined** |  **Hypothesis** | **Actual Relationship** | **Potential Explanation of Relationship**  |
| --- | --- | --- | --- |
| **Characteristics with Associated with Higher EE Participation, Savings, and Investment** |
| Population and Business Density | More rural customers are underserved | ZIP codes with *less* people and business per square foot had greater program uptake. This was the finding with the second most explanatory power. | Density is not conducive to knowledge spillovers of programs. Small numbers in less dense areas are conducive to high uptake rates. |
| Percentage of Population – Asian and Hispanic | Minority groups that may be underserved | Positive correlation found between higher population percentages and uptake rates, when already controlled for foreign born, which had decent explanatory power. | Potential impact from PA outreach. May have some network effect from established communities with shared ethnic background.  |
| Percentage of Population – Broadband Access | No initial hypothesis | Found significant and persistent negative effect indicating that lower participation in areas with less broadband penetration, which had decent explanatory power. | May be related to program uptake being higher in more rural areas.  |
| Median Household Income | Participation rates by small businesses in more wealthy neighborhoods would be higher | Found a negative effect equating to small drop in participation as median income rises that explained a small portion of the variance. | This may be due to program delivery for direct install programs being targeted at customers who are in less wealthy neighborhoods.  |
| Percentage of Population – Greater than 65 years of age | No initial hypothesis | Found significant positive effect, that explained a small portion of the variance. | A surprisingly large effect without a ready explanation. May be related to outreach to senior citizens by program administrators. |

| **Variable Examined** |  **Hypothesis** | **Actual Relationship** | **Potential Explanation of Relationship**  |
| --- | --- | --- | --- |
| **Characteristics with No Observable Impact on Underserved Status** |
| Percentage of Population – Black | Minority group that may be underserved | No persistent effect found. | Almost no effect found in multiple regression approaches.  |
| County Level Rurality  | Less served | No effect found | No effect found in rollup of ZIP Code data to county and comparison against Index of Relative Rurality. |

# Background

The California Public Utility Commissions (CPUC) has authorized energy efficiency programs to serve the general population as well as specific, vulnerable groups. These programs include: (1) EE main-general population; (2) hard-to-reach (HTR) and Regional Energy (REN) programs; and (3) Energy Savings Assistance (ESA) programs. The CAEECC undertook an investigation into which groups of customers are currently underserved by energy efficiency programs, to help devise the appropriate strategies and forums to address these problems. Specifically, the goal of investigating underserved customers further seeks to:

* identify who is not benefiting from energy efficiency programs,
* increase the accessibility and availability of energy-saving programs designed specifically to serve these customers, especially those experiencing high energy burdenbut are not eligible for the Energy Savings Assistance Program,and
* scale up energy savings to help meet the state's aggressive energy-saving goals.

CAEECC directed the SMB UWG to better understand gaps in how small and medium non-residential utility customers are served by California’s energy efficiency programs. The outcomes from this analysis will be used to help with the goal of increasing the availability and accessibility of energy efficiency programs for SMBs. These concerns have been translated into the following research questions, which have guided the analysis detailed in this report:

* Are there gaps in SMB participation in energy efficiency programs in California by geographic areas?
* Are there gaps in SMB participation in energy efficiency programs in California by business characteristics?
* Are there gaps in SMB participation in energy efficiency programs in California by socio-demographic groups?

The program data used to examine these questions from 71 EE programs[[2]](#footnote-2) identified as serving SMBs by four investor-owned utilities (IOUs): Pacific Gas & Electric (PGE), Southern California Edison (SCE), Southern California Gas (SoCalGas), San Diego Gas & Electric (SDGE).

# Methodology

## Analysis Approach

This study used a statistical approach to understanding correlations between energy efficiency program activity related to SMBs and various geographical, socioeconomic, and environmental factors. As shown in the following figure, this was an iterative process that required a large amount of data exploration and successive steps of refinement.

Figure . Overview of Analysis Approach

The first step was to establish a working definition for SMBs and then explore available program participation data to see what participation rates, investment amounts, and energy savings looked like. Next, energy efficiency participation data was aggregated to a ZIP Code-level since it was the most granular geographical area available in program data. With ZIP Code-level information, the analysis was able incorporate additional sources of information and conduct a series of statistical regressions to understand the relationship between SMB energy efficiency activity and socio-economic, geographic, and other environmental factors. Additional analysis was done at the county level. We analyze this data using a regression approach, where some outcome of interest, *yi*~~,~~ is hypothesized to be a linear function of a set of variables, *Xi*, where *i* is an index for zip codes. That is, we suppose:

$$y\_{i}=β\_{0}+\sum\_{j}^{}β\_{j}X\_{ij}+e\_{i}$$

with $β\_{j}$ as the coefficient, or weight, given to the *jth* covariate, $X\_{ij}, $in the determination of the outcome for the ith zip code. The term $β\_{0}$ is an intercept term to center the data. Our analysis will center on the sign, magnitude, and the precision (i.e. statistical significance) of these coefficients. The analysis looked at three indicators of SMB energy efficiency activity as shown in the following table, with participation being the metric with the most meaningful results.

Table . Main Energy Efficiency Factors Examined

|  |  |
| --- | --- |
| **Factor** | **Variables Used** |
| Participation | Unique site counts |
| Investment | Gross measure costs and gross incentive amounts |
| Energy Savings | Gross first year and gross lifecycle energy savings[[3]](#footnote-3) |

## Defining SMB

The first challenge was to establish a working definition for an SMB. The utilities each have a strict definition of customer class based on usage, as shown in Table 3. However, it is clear that the definition of SMB does not align across all investor owned utilities (IOUs).

Table . IOU Definition of Commercial Customer Classes

|  |  |  |  |
| --- | --- | --- | --- |
| **Utility** | **Small** | **Medium** | **Large** |
| SCE | <50 kW | ≥50 kW, < 250 kW | ≥250 kW |
| PG&E | <40,000 kWh;<10,000 therms | 40,000-500,000 kWh; 10,000-250,000 therms | ≥500,000 kWh; ≥250,000 therms |
| SDG&E[[4]](#footnote-4) | <20 kW;<10,000 therms | 20-199 kW | >200 kW;>10,000 therms |
| SCG | <10,000 therms | 10,000 - 50,000 therms | >50,000 therms |

California has additional definitions relevant to SMBs and energy efficiency. The official adopted definition of a “small business” adopted in Resolution E-4939 is as follows:

“A small business customer is defined as a non-residential customer with an annual electric usage of 40,000 kilowatt hours (kWh) or less, or an energy demand of 20 kilowatt (kW) or less, or annual consumption of 10,000 therms of gas or less. Alternatively, a small business customer is a customer who meets the definition of “micro-business” in California Government Code Section 14837.”

This definition brings up additional considerations beyond usage by referencing “micro-business”, which is defined by the California Government Code Section 14837 “as a business, together with affiliates, that has average annual gross receipts of $3,500,000 or less over the previous three years, or is a manufacturer, as defined in Section 14837 subdivision (c), with 25 or fewer employees.” The California Department of General Services (DGS) is authorized to amend the gross receipt amount, and in January 2010 DGS increased the gross receipt amount from $2,750,000 to the current amount of $3,500,000. (see, California Office of Administrative Law, Regulatory Action Number 2000-1110-01S.) It is important to mention that this definition does not include fixed usage or unmetered rate schedule customers.

By looking at all these definitions, we can come up with at least a general idea of what current policy considerations are used for existing customer segmentation of utility customers as related to the “small” portion of SMBs. This includes:

1. An annual usage threshold,
2. Annual gross receipts, and
3. Industry classification and employee count, to a lesser extent

The main concern expressed by the CAEECC, which led to the analysis in this report, is that the currently used definitions, and especially the purely usage-based definitions, do not address the true nature of SMBs and could lead to gaps in energy efficiency service.

While these definitions all are useful context for the analysis, it was impossible to fully utilize any of them as there was no rate class, usage, annual receipts, or employee counts available in the energy efficiency data set.[[5]](#footnote-5) Instead, the approach taken was to utilize the data that the IOUs self-selected as targeting SMB customers, and to determine what gaps and trends were identified within this data. \

## Data Sources

The main source of data was the CPUC’s California Energy Data and Reporting System (CEDARS), which manages data associated with California’s demand-side management (DSM) programs. As shown in Figure 2, this was combined with three other data sources at the ZIP Code-level: American Community Survey (ACS), County Business Patterns, and CalEnviroScreen 3.0 (CES3.0). ZIP Code-level data was then aggregated to the county-level and combined with an Index of Relative Rurality (IRR) Score for additional analysis.

Figure . Overview of Data Sources



Due to privacy concerns, public CEDARS data does not include site-specific details such as city, ZIP Code or North American Industry Classification System Code (NAICS Code). Through a data request to the CPUC, we were able obtain site-specific details for 2017 through 2019, including a unique site identifier which we were able to match up against DSM claim data and aggregate claim information, such as participation, incentives and savings, to the ZIP Code-level.

Once aggregate ZIP Code-level data was available for DSM activity, additional data sources were added to the data set to help identify any gaps in service-based factors identified by the UWG. Firstly, demographic and establishments (business entities) data were collected from the U.S. Census Bureau data tables. Respectively, the datasets originate from the 2019 American Community Survey (ACS) 5-Year Estimates Data Profiles and the 2018 County Business Pattern’s (CBP) ZIP Codes Business Patterns (ZBP) data.

The ACS data was filtered under Zip Code Tabulation Areas (ZCTAs), which are generalized geographical representations of USPS ZIP Code service areas and are created by the U.S. Census Bureau. In most cases, ZCTAs codes are the same as the ZIP Codes for an area. In the instances where ZIP Codes represent only a few addresses (sometimes only one), they will not appear in the ZCTA codes list, and therefore were excluded in the study when merging ACS and ZBP datasets, as the latter are based on USPS ZIP Codes.

The third ZIP Code-level data source was the CES3.0 data set, which looks at social and environmental justice factors. Since the CES3.0 dataset is at the census tract level, we used a population weighted averaging method to get both CES3.0 Scores and an indicator of whether a community is disadvantaged under SB535[[6]](#footnote-6) at the ZIP Code-level.

The DSM claims, demographic, business, and social/environmental justice databases were merged into one file and organized by ZIP Code. Although working strictly with ZIP Codes has some disadvantages, such as having diverse communities making up one ZIP area, it was the most granular level at which data was available and does provide a meaningful basis to compare data from multiple different sources and perspectives.

Based on feedback with UWG members, we also performed some analysis on factors related to rurality. At the ZIP Code-level, we looked at both count of business entities and population per square footage of land area. We also aggregated DSM claims data to the county level and combined this data with the 2010 Index of Relative Rurality (IRR), a continuous and threshold-free measure of rurality (Waldorf and Kim, 2018).

## SMB Data Processing

The UWG SMB Team received DSM claim data for programs targeting SMBs from 2017 through 2019 from Pacific Gas and Electric (PGE), Southern California Edison (SCE), Southern California Gas (SCG), San Diego Gas and Electric (SDGE), totaling 505,500 unique claims. Table 4 shows the additional fields that were then calculated to provide savings variables that looked combined electric and gas savings claims data and look at incentive amounts relative to measure costs.

Table . Additional Claims-Level Fields

|  |  |
| --- | --- |
| **Field** | **Equation** |
| First Year Gross Energy Gross Energy Savings | First Year Gross kWh + (First Year Gross Therms x 29.3) |
| Lifecycle Gross Energy Savings | Lifecycle Gross kWh + (Lifecycle Gross Therms x 29.3) |
| Incentive as a Percentage of Cost | Gross Measure Incentive / Gross Measure Cost |

The following steps were then taken in consultation with the full UWG to make sure that claims data was specifically tied to SMBs:

1. Claims that were flagged as “Upstream” or were missing a site ID were removed to make sure that site attribution was maintained.
2. Claims that were flagged as “Public K through 12” schools were removed, since these claims were to be examined by the Public Service Entity (PSE) team.
3. Claims that were still flagged as “Residential” were removed since they were not deemed an SMB.

After this process there were 272,301 unique claims remaining.

## ZIP Code-Level Aggregation

All the filtered SMB claim data contained a unique site identifier along with a five-digit ZIP Code, so we were able to aggregate claims data at a ZIP Code level. This was done in few different ways. For the participation factor, the count of unique site IDs was calculated for each ZIP Code. For the savings factors and investment factors values were aggregated to the ZIP Code level using the following functions:

* Sum
* Mean
* First Quartile (25% of values below)
* Median (50% of values below, and 50% of values above)
* Top Quartile (25% of values above)

These aggregate claims values were then combined with the three ZIP Code-level data sources.

From the CBP data, we extracted total establishment counts and then establishment counts by number of employees. These were then grouped into smaller buckets, as shown in Table 5, and normalized against the total establishment counts in a given ZIP Code.

Table . Firm Size Groupings

|  |  |
| --- | --- |
| **Description** | **Range** |
| Micro | Less than 10 Employees |
| Small | 10 to 49 Employees |
| Medium | 50 to 249 Employees |
| Large | 250 or More Employees |

From the ACS data we incorporated variables that covered economic measures, ethnic composition, and general population statistics. Finally, we added in population weighted CES3.0 score and an indicator for whether a majority of a given ZIP Codes population was in a community deemed disadvantaged under SB 535. A full list of variables used in the analysis can be found in the appendix.

Any ZIP Code that had less than 10 unique site IDs was dropped from the data set to reduce the impact of small ZIP Codes with noisy or missing data. This left 998 ZIP Codes. An additional 95 ZIP Codes were dropped since they had missing CES3.0 or ACS data. Four additional ZIP codes were dropped since they had more unique site IDs than establishment counts, leading to a final ZIP Code-level count of 899.

# SMB Data Overview

The following table provides totals for the filtered SMB data set compared to the full set of 505,500 claims.

Table . Comparison of SMB Claim Data Totals

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable[[7]](#footnote-7)** | **Total Data** | **Filtered Data** | **% of Total** |
| Unique Claims |  505,500  |  272,301  | 54% |
| Measure Cost |  $3,674,806,000  |  $743,412,000  | 20% |
| Incentive |  $409,866,200  |  $259,129,800  | 63% |
| First Year kWh |  3,596,812,000  |  1,005,519,000  | 28% |
| First Year Therm |  74,453,320  |  39,356,640  | 53% |
| First Year Energy (kWh - Electric & Gas) |  5,778,294,000  |  2,158,669,000  | 37% |
| Lifecycle kWh |  43,843,810,000  |  9,210,218,000  | 21% |
| Lifecycle Therm |  957,500,100  |  424,367,200  | 44% |
| Lifecycle Energy (kWh - Electric & Gas) |  71,898,560,000  |  21,644,180,000  | 30% |

The filtering removed a large portion of the SMB claim data. While a little more than half of the claims are left, only around 37% of first year energy savings and 30% of lifecycle savings remain. However, this still represents a substantial data set that is worth exploring.

Interestingly, measure costs are down the most, at 20% of the total value before filtering, but 63% of the incentive value total remain in the data set. This indicates that the remaining measures had a larger portion of their costs covered by incentives. This makes sense, given that upstream programs were removed, since these programs tend to only cover a portion of the incremental cost to make efficient equipment prices more competitive with baseline equipment. This would also indicate that there are probably more direct install program claims in the filtered data set, since direct install programs tend to cover the full portion of the cost and have been traditionally targeted at SMBs.

The 275,320 SMB claims were associated with 87,116 unique sites in 1,415 zip codes, 56% of the 2,586 ZIP Codes in California. The following table provides some summary statistics for the savings and investment factors identified as a priority by the UWG.

Table . Summary SMB Claim Savings and Investment Factors

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statistic** | **Measure Cost** | **Incentive** | **Incentive % Meas Cost** | **First Year Energy (kWh - Elec & Gas)** | **Lifetime Energy (kWh - Elec & Gas)** |
| **Mean** | $2,730 | $952 | NaN |  7,928  |  79,486  |
| **Std Dev** | $50,901 | $8,047 | NaN |  143,442  |  1,790,491  |
| **Min** | -$2,586 | -$32,676 | -inf |  (137,387) |  (686,934) |
| **1st Quartile** | $35 | $55 | 57% |  35  |  117  |
| **Median** | $208 | $180 | 100% |  457  |  2,652  |
| **2nd Quartile**  | $1,017 | $750 | 100% |  1,978  |  15,925  |
| **Max** | $18,583,750 | $1,654,976 | inf |  39,930,930  |  559,033,000  |

The summary statistics confirm that there are mostly program claims covering the full cost of measures, as indicated by the median incentive as a percent of measure costs being 100%, and some claims that were missing measure cost data, which made it impossible to calculate the mean and standard deviation.

Incentive amounts were generally small and under $1,000, as were measure costs, but the maximum claim is an outlier for $1.7 million, a significant amount. An examination of the top ten largest incentives shows that almost all of them are for boiler installations, generally in laundry facilities or small industrial facilities. In fact, larger projects make up a very small portion of the claims data but skew the standard deviation significantly. If we remove the 39 claims for incentives larger than $250,000, the standard deviations are all cut in half, while the quartiles stay the same and mean values drop slightly, as seen in Table 8. This indicates that most claims in the data set have a much tighter range in costs and savings factors, which may provide less explanatory power for future data exploration.

Table . Summary SMB Claim Savings and Investment Factors – Incentive < $250k

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statistic** | **Measure Cost** | **Incentive** | **Incentive % of Meas Cost** | **First Year Energy (kWh - Elec & Gas)** | **Lifetime Energy (kWh - Elec & Gas)** |
| **Mean** | $2,493 | $884 | NaN |  6,894  |  67,404  |
| **Std Dev** | $31,923 | $4,132 | NaN |  77,969  |  924,214  |
| **Min** | -$2,586 | -$32,676 | -inf |  (137,387) |  (686,934) |
| **1st Quartile** | $35 | $55 | 57% |  35  |  117  |
| **Median** | $208 | $180 | 100% |  456  |  2,651  |
| **2nd Quartile**  | $1,017 | $750 | 100% |  1,978  |  15,912  |
| **Max** | $6,049,370 | $244,518 | inf |  12,186,330  |  178,689,400  |

# Site Penetration

The main participation factor variable that we analyzed was called “site penetration” and was calculated for a given ZIP Code using the following formula:

$$Site Penetration\_{ZIP}=\frac{Count of Unique Sites\_{ZIP}}{Total Establishments\_{ZIP}}$$

Using unique site counts helped control for large projects that would have outsize savings and investment impact. It also provided a more equitable distribution of resources by eliminating the effect of multiple claims going to a single customer. Normalizing the results by total establishments gives us a way to better compare different ZIP Codes to each other as well as an absolute measure of the reach of DSM activity within a community. The following figure shows the distribution of site penetration by ZIP Code.

Figure . Histogram of Site Penetration by ZIP Code



## Firm Size

We begin by designating site penetration, as discussed above, as our initial outcome of interest. Given the brief given to this group, the initial covariates to be included in the model of site penetration are those that describe the distribution of firm sizes in the zip code. These are represented by the normalized variables for the percentage of firms in a ZIP Code that fall into a range of employee counts, as defined in Table 5. The outcome against each feature is shown in Table 9, where “Coeff” labels the column for estimate of the $β$. The R-squared statistic is interpreted as a percentage variation in site penetration due to these variables. The p-value represents the confidence interval.[[8]](#footnote-8)

Table . Individual Regression Results for Site Penetration vs. Firm Size Features

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Coeff** | **R-squared** | **p-value** |
| PER\_MICRO | -0.3503 |  0.0366  | 0.0000 |
| PER\_SMALL | 0.3203 |  0.0169  | 0.0001 |
| PER\_MED | -0.4625 |  0.0066  | 0.0146 |
| PER\_LARGE | -1.1388 |  0.0033  | 0.0834 |
| EXTRA\_LARGE\_FLAG | -3.8862 |  0.0117  | 0.0011 |

All features were found to be statistically significant, with the best explanatory power coming from PER\_MICRO, at around 3.7%. All of the features except for PER\_SMALLhad negative coefficients, meaning that an increase in percentage of firms with a given size would be associated with a decrease in uptake rates. Only PER\_SMALL was associated with an increase in uptake rates. This can be seen more clearly in in the following figure, which shows a scatter plot of the results for the first three firm size variables along with the associated best-fit linear regression.

Figure . Site Penetration Compared to Firm Size at the ZIP Code Level



The previous figure shows a clear separation of the micro, small, and medium firms within each ZIP Code, with the “micro” firms making up around 60 to 90 percent, “small” firms making up 10 to 30 percent, and “medium” firms making up 0 to 10 percent of a given ZIP Codes firms. The change from micro to small in terms of uptake rates indicates that the SMB programs may be more successful at targeting firms in the “small” category, 10 to 49 employees, but have more difficulty reaching the “micro” category, less than 10 employees.

To further examine the relationship between site penetration and firm size, we examined various combinations of the different firm variables in a multi-variate linear regression. Table 10 provides the best regression we found for multiple firm size variables in one regression. The “Std. Err” is the standard error of that coefficient estimate and “t” is the t-statistic for the hypothesis that the coefficient is equal to zero. The usual rule of thumb is that a t-statistic greater than 2 in absolute value indicates “statistical significance”, that is, that there is a high probability that the hypothesized impact of the variable on the outcome is not zero.

Table . Site Penetration vs. Multiple Firm Size Features

|  |  |
| --- | --- |
| **R-squared:** | 0.252 |
| **Adjusted R-squared:** | 0.250 |
| **Feature** | **Coeff** | **Std Err** | **t** | **P>|t|** |
| Intercept | 304.9683 |  19.6200  | 15.54 | 0.0000 |
| PER\_MICRO | -3.0333 |  0.1970  | -15.37 | 0.0000 |
| PER\_SMALL | -2.3858 |  0.2170  | -10.97 | 0.0000 |
| PER\_MED | -4.2776 |  0.2770  | -15.42 | 0.0000 |

The results of this estimation are quite interesting. First the R-squared value of 0.25 is not a trivial amount and was a large jump in explanatory power from just the individual features on their own. The jump in explanatory power specifically came only in specifications with all three size measures included.The next thing to note is that the coefficients of the three size distribution variables are all negative and statistically significant.

A regression coefficient is interpreted as the marginal impact of a one unit increase in the variable, holding the other included variables constant. To interpret, for example, the percent micro coefficient, consider that if small and medium shares are held constant, *the decrease in the micro share of one percentage point implies a one percentage point increase in the large share and an increase of 3 percentage points in site penetration*.The similarity of the three coefficients , implies that **any increase in large business presence results in an increase in participations rates**. Note also that the magnitudes of the effects are large. As noted, a one-percentage point decrease in the percentage of micro-sized businesses yield a 3.0 percentage point increase in site penetration. Similar effects for small and medium shares (2.4 and 4.3 percentage point) can be seen as well[[9]](#footnote-9). Thus, large firms are seen by the local smaller sized businesses to be taking up the DSM activity, and following suit. This follow-the-leader behavior has seemingly dramatic effects.

There are two potential objections to these results. The first is that we are engaging in the “ecological fallacy”. Simply because we observe a correlation between site penetration and small firm sizes does not necessarily mean it’s the small firms that are not taking up the programs. This is not a worrisome objection because the joint share of micro, small and medium business is well over 99% of the establishments in the average ZIP Code, so there is little room for the ecological fallacy to take hold.

A stronger objection is that the low take-up rates in neighborhoods with larger shares of smaller firms are also ZIP Codes with other characteristics that might lead to low site penetration. We take up this problem in subsequent analysis.

## Environmental and Social justice Factors

Next, we looked at environmental and social justice factors as found in the CES3.0 data set. We found that the population weighted CES3.0 score had the best explanatory power, and the best bivariate regression is shown in the following figure.

Figure , Site Penetration Compared to CES3.0 Score at the ZIP Code Level



This graph shows a clear positive correlation between CES3.0 and SMB site penetration, indicating that for every 1-point climb in the CES3.0 score, penetration went up 0.23%. This indicates that SMB programs are getting slightly higher uptake in communities with increased social and environmental justice factors. Table 11 shows the results of previous firm size regression with CES3.0 score included.

Table . Site Penetration vs. Firm Size, Density and CES3.0

|  |  |
| --- | --- |
| **R-squared:** | 0.28 |
| **Adjusted R-squared:** | 0.277 |
| **Feature** | **Coeff** | **Std Err** | **t** | **P>|t|** |
| Intercept | 291.1572 |  19.4020  | 15.01 | 0.0000 |
| PER\_MICRO | -2.8994 |  0.1950  | -14.86 | 0.0000 |
| PER\_SMALL | -2.4411 |  0.2140  | -11.43 | 0.0000 |
| PER\_MED | -4.1303 |  0.2730  | -15.10 | 0.0000 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.1640 |  0.0280  | 5.89 | 0.0000 |

The explanatory power, as measured by R-squared, has gone up and all the variables are still statistically significant at above the 99% confidence level. Coefficients have changed only slightly, with the CES3.0\_SCORE seeing a drop from 0.23 to 0.16, and very little change in the firm size coefficients.

## Density

Next, we examined population and business density. Our prior expectation is that density is good for the adoption of these programs. The spillover effects from large to small business hinted at in the previous section would seem to be more prevalent in dense rather than rural locations. Furthermore, the most rural locations would be least prone to receive outreach efforts from the IOUs.

We looked at two measures of density: number of business entities per square kilometer and population per square kilometer. The following figures show a histogram of these variables by ZIP Code after being normalized against the density ZIP Code in the data set. The distributions are very skewed to smaller values, with business density more skewed than population density.

Figure . Histograms of Normalized Population and Business Density



To account for this skew, we used log10 transformation to make a more normal distribution, as seen by the following figure.

Figure . Histograms of Log Transforms for Population and Business Density



Next it was important to determine how these two features related to each other to avoid multicollinearity issues with the regression analysis.

The following figure shows that they are very closely correlated, an R-squared of 0.87, which means that we should utilize only one or the other of the two features.

Figure . Log of Business Density vs. Log of Population Density



The following table shows the regression test results for the density variables.

Table . Individual Regression Results for Site Penetration vs. Density Variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Coeff** | **R2** | **p-value** |
| POP\_DENSITY | -0.0010 |  0.0411  | 0.0000 |
| POP\_DENSITY\_NORM | -22.7359 |  0.0411  | 0.0000 |
| BIZ\_DENSITY | -0.0102 |  0.0257  | 0.0000 |
| BIZ\_DENSITY\_NORM | -30.8777 |  0.0257  | 0.0000 |
| log\_BIZ\_DENSITY\_NORM | -6.7620 |  0.1970  | 0.0000 |
| log\_POP\_DENSITY\_NORM | -6.3546 |  0.1346  | 0.0000 |

These results show that, as expected, log-transform results are much more correlated with site penetrations, and it also shows that the business density explains significantly more variance than population. Since the participation data is for businesses, it would follow that business density has a higher explanatory power. The following graph shows what the scatter plot of site penetrations and the log of business density looks like.

Figure . Site Penetration vs. Log of Business Density



Interpreting logs can be slightly difficult. We can observe that a 10% increase in the normalized business density leads to a drop of 0.28 percentage points in uptake.[[10]](#footnote-10) Essentially this means that we see participation rates increase dramatically for the least dense ZIP Codes, which is contrary to our hypothesis. This deserves some additional comment. An alternative hypothesis is that only those zip codes that are most distant from urban areas are detached from outreach efforts. However additional analysis that looked at slices of the most rural zip codes, those with normalized population density less than 5% or less than 1%, found the same negative general relationship held. Specifically, that the most rural ZIP Codes had significantly higher average site penetrations. Table 11 takes the regression from the previous section and adds the log of business density feature.

Table . Site Penetration vs. Firm Size, CES3.0, and Density

|  |  |
| --- | --- |
| **R-squared** | 0.363 |
| **Adjusted R-Squared:** | 0.359 |
| **Feature** | **Coeff** | **Std Err** | **t** | **P>|t|** |
| Intercept | 218.6979 |  19.4740  | 11.23 | 0.0000 |
| PER\_MICRO | -2.2622 |  0.1930  | -11.72 | 0.0000 |
| PER\_SMALL | -2.0286 |  0.2050  | -9.91 | 0.0000 |
| PER\_MED | -2.7959 |  0.2860  | -9.78 | 0.0000 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.1806 |  0.0260  | 6.88 | 0.0000 |
| log\_BIZ\_DENSITY\_NORM | -4.8586 |  0.4520  | -10.74 | 0.0000 |

This updated regression provides a significant jump in R-squared values to 36%, while all variables stay extremely statistically significant. The coefficients all retain their signs, but the effects for firm size decrease a bit, while CES3.0 score goes up slightly and the effect of 10% increase in normalized business density becomes a 0.19 percentage point drop. In combination with the results from the previous section, the picture that emerges is one where rural areas can achieve great site penetration through the leadership of the (perhaps single) large firm in the region.

## Demographic Factors

Our last task is to include measures of zip code demographics in the set of covariates. We do this for two reasons. First, the demographic variables themselves are of independent interest. Second, as noted in the previous section, we wish to ensure that demographics are not confounding the relationship between firm size and site penetration uncovered in the previous section. We include percentage of the census tract that is: White, Black, African-American, Hispanic, Asian-American, American Indian, population over the age of 65, and foreign born. We also include percentage of residences that are broadband-enabled, median zip code income, percentage unemployed and then percent below the poverty line as other measures of household resources. With the exception of income, broadband penetration, and percentage White, our prior expectation suggested that each of these zip code characteristics would have a negative impact on site penetration. Each of these variables sometimes equated with populations that are less attuned to energy conservation for a variety of reasons, including lack of resources of lack of information access. In that context, to the extent the local populations are connected to the small businesses in these areas, the lower the site penetration. We would conversely expect a positive coefficient on income. The following table looks at each of the demographic variables on its own as a determinant of site penetration and sorted by the R-squared from greatest to least explanatory power.

Table . Individual Regression Results for Site Penetration vs. Demographic Features

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Coeff** | **R-squared** | **p-value** |
| PER\_HISPANIC\_AND | 0.2242 |  0.1687  | 0.0000 |
| PER\_POP\_BROADBAND | -0.5979 |  0.1521  | 0.0000 |
| PER\_FOREIGN\_NONUS\_CIT | 0.2849 |  0.0978  | 0.0000 |
| MEDIAN\_HOUSEHOLD\_INCOME | -0.0001 |  0.0891  | 0.0000 |
| CIV\_UNEMPLOYMENT\_RATE | 1.3134 |  0.0883  | 0.0000 |
| PER\_POP\_BELOW\_POVERTY | 0.3975 |  0.0625  | 0.0000 |
| PER\_ASIAN | -0.1798 |  0.0413  | 0.0000 |
| PER\_AMERIND | 1.4422 |  0.0274  | 0.0000 |
| PER\_POP\_65+ | -0.2769 |  0.0169  | 0.0001 |
| PER\_POP\_FOREIGNBORN | 0.0398 |  0.0014  | 0.2579 |
| PER\_WHITE | 0.0235 |  0.0012  | 0.2974 |
| PER\_BLACK | -0.0564 |  0.0012  | 0.3068 |

On their own, PER\_WHITE and PER\_BLACK have no explanatory power. A positive coefficient means that a percentage point increase in that variable is correlated with the amount of that coefficient increase in percentage points of site penetration (i.e. for every 1 percentage point increase *PER\_HISPANIC\_AND*, there is a corresponding increase of 0.2242 percentage points of site penetration). PER\_AMERIND has a positive correlation and PER\_ASIAN has a slight negative correlation with participation rates. PER\_HISPANIC\_AND has the most statistically significant effect, with a small positive correlation. PER\_POP\_BROADBAND has nearly as high an R-squared as PER\_HISPANIC\_AND, but is a difficult variable to interpret. Whereas income, poverty, and unemployment all have correlations that are counter to our hypothesis that these would indicate lower participation rates.

Next, we used took the previous regression we developed that looked at firm size, CES3.0 score, and business density and controlled for the different demographic and socioeconomic variables identified in Table 14. This led to many of the variables no longer being statistically significant, and through a feature trimming process we were able to arrive at the following regression that brings together all the features that we looked at for against site penetration.

Table . Site Penetration vs. Firm Size, CES3.0, Density, and Demographics

|  |  |
| --- | --- |
| **R-squared** | 0.419 |
| **Adjusted R-Squared:** | 0.412 |
| **Feature** | **Coeff** | **Std Err** | **t** | **P>|t|** |
| Intercept | 243.5789 |  19.8620  | 12.26 | 0.0000 |
| PER\_MICRO | -2.2334 |  0.1920  | -11.64 | 0.0000 |
| PER\_SMALL | -2.1387 |  0.2050  | -10.44 | 0.0000 |
| PER\_MED | -2.5225 |  0.2820  | -8.94 | 0.0000 |
| POP\_WEIGHTED\_CES3\_SCORE | -0.0903 |  0.0430  | -2.12 | 0.0340 |
| log\_BIZ\_DENSITY\_NORM | -3.9255 |  0.4800  | -8.18 | 0.0000 |
| PER\_AMERIND | -0.2815 |  0.2400  | -1.17 | 0.2410 |
| PER\_ASIAN | 0.0517 |  0.0260  | 1.96 | 0.0510 |
| PER\_HISPANIC\_AND | 0.1850 |  0.0230  | 7.98 | 0.0000 |
| PER\_POP\_BROADBAND | -0.2616 |  0.0730  | -3.58 | 0.0000 |
| PER\_POP\_BELOW\_POVERTY | -0.0945 |  0.0690  | -1.37 | 0.1720 |

The first thing to note from this regression is that the R-squared is now around 41.2%, meaning that approximately 41.2% of the variance in the data set is explained by the regression. This is large for such noisy data. We also see that the coefficients for firm size and business density have barely changed, and are still statistically significant, which shows how robust these features are. Next, we see that the coefficient for CES3.0 score has flipped slightly negative after controlling for ethnic and socioeconomic factors. This indicates that the underlying positive correlation we initially observed was probably due to the factors we now control for, and that the environmental justice aspect of the CES3.0 score is correlated with slightly lower program participation.

One noticeable change from the bivariate results is that with the full set of determinants included in the model, PER\_AMERIND seems to be showing a negative effect. . This probably means that the positive effect seen in the stand-alone feature regression may be due more to positive rurality effects. However, the precision the of the coefficient for PER\_AMERIND. does not lend itself to accurate inference about the role of American Indian population.

Similarly, we observe the effect higher poverty rates now leading to a slightly negative correlation with participation rates, more in line with what we would expect to see. The switch from a positive effect as a standalone variable may also be due in part to the density factor, but again the precision of the result does not lend complete confidence to the observed outcome.

We also observe a small positive correlation between Asian population and a site uptake, but the effect is much smaller than the positive correlation between Hispanic population and program participation. As before, the Black population percentage had no statistically significant correlation with program participation. This may indicate that program administrators are seeing success in reaching businesses in both Asian and Hispanic communities.

Finally, we found a consistent, statistically significant effect from PER\_BROADBAND across all the regression analysis we performed. The effect was always negative, and, in the final regression showed a 0.26 percentage point drop in site penetration for every 1 percentage point increase in broadband penetration. PER\_BROADBAND may represent a combination of factors that relate to infrastructure, such as urbanity, age and status of telecom infrastructure, and affluence of the neighborhood. Ultimately, it appears that this may indicate that these programs got higher participation in programs with lower levels of infrastructure and wealth as measured by broadband penetration rates.

## Conclusions on Site Penetration

The result of our investigation into the determination of site penetration has yielded several findings of interest.

* First, it is almost certain that the presence of large firms increases take up rates, even by neighboring small firms. Higher shares, as such, of smaller sized firms lower site penetration.
* Second, this is not a result of density, per se; it is the lower density areas that have higher site penetrations.
* CES3.0 Scores show low correlation with uptake rates, with some slightly negative effects observed from the environmental justice factors.
* The role of ethnicity is unexpected. Areas with higher Asian and Hispanic populations have more take-up, while no meaningful conclusions can be drawn from Black or Native American populations.
* Communities with higher broadband rates (which, note, are normally urban, affluent and dense in character) do not have as high take up rates.

# Extension to Other Outcomes

While program participation as measured through site penetration was the primary metric used to analyze gaps in EE Services to SMBs, our initial work scope identified a few other EE metrics to explore. In particular, we looked to see if there were gaps in savings and investment. We also received feedback from CAEECC members that it might make sense to examine rurality from at a county level, which we also did.

## Savings

The primary goal for EE programs is usually achieving energy savings, so we believed that it was important to see if there are any identifiable gaps in energy savings for SMBs. The data we had covered both electric and natural gas programs, so natural gas savings were converted to kWh and added to electric savings in order to count all savings together.

Unfortunately, we had no relative measure of savings for this analysis, such as savings potential by customer type, or customer usage, so we had to use other ways to compare savings results. To this end, we looked at the total amount of savings, mean, and median savings for a given ZIP Code. Appendix 8.2 has a full table of the individual regression results for the same set of features used to analyze the site penetration variable, but instead regressed against the first year and lifecycle energy savings. These tables also have the results for site penetration as a comparison.

In general, the savings measures did not have nearly as much explanatory power as site penetration

### Firm Size

For firm size, the main variable that was correlated were the totals, which were all significant at the 99% confidence level. The following table shows the coefficients and R-squared values for the first year and lifecycle savings totals.

Table . Regression Results for Savings Totals vs. Firm Size

|  |  |  |
| --- | --- | --- |
| **Feature** | **Coefficient** | **R-squared** |
| **First Year** | **Lifecycle** | **First Year** | **Lifecycle** |
| PER\_MICRO | -112,157 | -1,143,994 | 0.074 | 0.068 |
| PER\_SMALL | 133,866 | 1,340,541 | 0.058 | 0.051 |
| PER\_MED | 376,180 | 3,852,545 | 0.086 | 0.080 |
| PER\_LARGE | 938,341 | 10,339,960 | 0.045 | 0.048 |

We can see that they all have a respectable R-square of around 5% to 9%. The coefficient for PER\_MICRO is negative, while the coefficients for the other measures are all positive and get increasingly larger. This shows a further gap between micro businesses and the small medium and large business. This gap is one that makes sense, since the measures installed by the larger business will probably have much larger savings than those installed by the smaller businesses. While it is not possible to determine, without context, whether the micro businesses are suffering from seeing lower total and mean savings investment, it does show that a gap exists in how much total savings are flowing to this group of customers.

This trend of a negative coefficient for PER\_MICRO and increasingly large positive coefficients for ever larger business sizes continues for the mean savings measures but has little to no statistical significance. Interestingly, the opposite holds for the median savings, with a positive coefficient for micro and negative coefficients for small and medium businesses. This probably means that large individual projects are skewing results upwards for the non-micro firm sizes.

### CES3.0

The CES3.0 score has a consistent positive correlation across savings measures, but with very little explanatory power. This would continue to imply that the main issue with participation is environmental factors, and that the socioeconomic factors used in the CES3.0 are confounding any correlations.

### Density

Business density has much less correlation with savings than it does with site penetration. The R-squared for site penetration is 19%, but for the maximum effect seen for savings measures is 0.8%. This seems to indicate that density has no major effect on the size of savings being achieved by the SMB programs.

### Demographics

Compared to site penetration, very little demographic data is correlated with the investment measures. PER\_HISPANIC continues to have a positive effect on total and mean savings, with a slightly negative effect on median savings, suggesting some sort of skew from a few larger projects, with Hispanic ZIP Codes seeing generally smaller measure savings. Again, without context it is hard to say if this is actually a gap in service or, more likely that Hispanic communities see higher participation rates, as shown by site penetration, which drives medians down due to many smaller measures.

## Investment

When examining EE programs it is important to understand, not just participation and savings, but how investment flows to communities. Often investment levels in energy efficiency have a multiplier effects and making sure that there are no gaps in investment was a key metric identified in the development of this analysis.

We examined two measures of investment: investment from the perspective of the program administrators through incentives, and investment from the participant through the gross measure cost. Since costs and savings are closely related, there were some similarities in results but also some important differences.

### Firm Size

The results for investment and firm size were very similar to the findings for savings as shown in Table 17 and Table 18. For investment totals and investment mean, all firm size features were very statistically significant and had decent explanatory power, especially for investment totals. We also observed the same negative coefficient for PER\_MICRO, switching to positive for PER\_SMALL and getting progressively larger as the firm size increased. This continues to confirm the gap for micro businesses.

Table . Regression Results for Investment Totals vs. Firm Size

|  |  |  |
| --- | --- | --- |
| **Feature** | **Coefficient** | **R-squared** |
| **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** |
| PER\_MICRO | -14,249 | -43,960 | 0.123 | 0.069 |
| PER\_SMALL | 17,155 | 50,079 | 0.099 | 0.049 |
| PER\_MED | 47,278 | 142,191 | 0.141 | 0.075 |
| PER\_LARGE | 129,957 | 464,418 | 0.089 | 0.067 |

Table . Regression Results for Investment Mean vs. Firm Size

|  |  |  |
| --- | --- | --- |
| **Feature** | **Coefficient** | **R-squared** |
| **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** |
| PER\_MICRO | -27 | -116 | 0.015 | 0.012 |
| PER\_SMALL | 27 | 97 | 0.008 | 0.005 |
| PER\_MED | 59 | 128 | 0.007 | 0.002 |
| PER\_LARGE | 335 | 1,485 | 0.020 | 0.017 |

Some positive correlations with large firms showed up in median incentives and measure costs, which makes sense given that they would tend to have larger projects.

### CES3.0

The CES3.0 score had even less of a correlation with investment than it did with savings. Only showing statistically significant results for total and median incentives, and to a lesser extent for total measure costs, even then there was very little explanatory power.

### Density

In contrast with savings, business density had a more consistent negative correlation with investment, implying that less dense ZIP Codes may see some lower average incentives, but without context it is difficult to say whether this represents any specific gap in service.

### Demographics

The main result of interest is that PER\_FOREIGN\_NON\_US\_CIT had significant positive correlation across all measures of investment, while PER\_POP\_NONUS\_CIT had no discernable statistically significant effect, except for with median incentive and measure costs.

In a departure from both site penetration and savings, PER\_HISPANIC\_AND only had statistically significant correlation with incentive totals and median incentives, and this effect was small but positive.

## County Level Rurality

We examined the site penetration at the county level against the 2010 Index of Relative Rurality as shown in the following figure. The very small correlation shown had no statistical significance, which means we are unable to provide any conclusions regarding a more comprehensive index of rurality at the county level.

Figure . County-level Site Penetration vs. Index of Relative Rurality 2010



# Conclusions

The purpose of this study was to ascertain what charactertristics of small and medium businesses were associated with being underserved energy efficiency programs offered by publicly owned utilities in California. In order to study this question, we defined a variable, zip-code site penetration, to measure the take up of programs at the zip code level. We found that the size distribution of firms had a significant effect on penetration; in particular, the presence of large firms had a positive impact on the overall take up rate in an area, but that greater numbers of smaller firms had a negative impact.

This finding survives several challenges to its identification, in particular, that the finding is due to other confounding neighborhood variables. In that regard, we find that areas that are more Hispanic or Asian have higher business penetration rates, though foreign born neighborhoods are less prone to take up. African-American population shares have no impact. Interestingly we note that rurality, contrary to our prior expectations, has a positive impact on penetration rates. All of these results may be reflective of utility outreach efforts.

More can be done. With more complete data on non-participants we could look at the individual firm-level determinants of program uptake, in addition to superior analysis of savings and investment. With finer (addressed-based) location data we could more carefully examine spillover effects. This could potentially lead to more nuanced and fine-grained analysis of more aspects of energy efficiency take up.

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## Complete Regressions Results for Individual Features

|  |
| --- |
| **Key** |
| 99% Confidence Level |
| 95% Confidence Level |
| 90% Confidence Level |
| Not Significant |

Gross Energy Saved in kWh (Electric and Gas) Compared to Site Penetration - Coefficients

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Site Penetration** | **Total** | **Mean** | **Median** |
| **First Year** | **Lifecycle** | **First Year** | **Lifecycle** | **First Year** | **Lifecycle** |
| PER\_MICRO | -0.35 | -112,157 | -1,143,994 | -253.10 | -3,756.95 | 62.71 | 501.56 |
| PER\_SMALL | 0.32 | 133,866 | 1,340,541 | 257.46 | 3,590.01 | -100.15 | -862.25 |
| PER\_MED | -0.46 | 376,180 | 3,852,545 | 721.15 | 11,170.31 | -113.70 | -235.48 |
| PER\_LARGE | -1.14 | 938,341 | 10,339,960 | 1,051.01 | 23,272.19 | 185.46 | 5,589.28 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.23 | 16,245 | 182,519 | 2.21 | 518.48 | 18.08 | 85.82 |
| log\_BIZ\_DENSITY\_NORM | -6.76 | 61,177 | 222,950 | -3,490.67 | -41,611.11 | 441.07 | 8,277.84 |
| PER\_POP\_65+ | -0.28 | -47,950 | -507,349 | -208.19 | -2,282.63 | 16.20 | 272.32 |
| PER\_WHITE | 0.02 | 1,335.46 | 3,166.32 | 151.02 | 1,413.67 | 8.19 | 50.98 |
| PER\_BLACK | -0.06 | -17,002 | -183,805 | -194.08 | -1,967.24 | 20.27 | 152.49 |
| PER\_AMERIND | 1.44 | -66,025 | -742,092 | -82.19 | -4,062.80 | -65.85 | -1,277.33 |
| PER\_ASIAN | -0.18 | 1,672 | 42,531 | -110.52 | -935.88 | -11.26 | 34.83 |
| PER\_HISPANIC\_AND | 0.22 | 11,065 | 108,963 | 105.03 | 974.40 | -12.60 | -261.98 |
| TOTAL\_HOUSING\_UNITS | 0.00 | 104.30 | 1,011.20 | -0.26 | -3.74 | -0.02 | -0.02 |
| PER\_POP\_FOREIGNBORN | 0.04 | 11,607 | 139,359 | 193.20 | 2,431.37 | 42.71 | 437.98 |
| PER\_FOREIGN\_NONUS\_CIT | 0.28 | 25,545 | 250,698 | 362.70 | 4,050.19 | 0.89 | -100.23 |
| PER\_POP\_BROADBAND | -0.60 | 5.74 | -75,340.48 | -230.37 | -4,584.06 | -26.43 | 26.53 |
| MEDIAN\_HOUSEHOLD\_INCOME | 0.00 | -3.60 | -33.02 | -0.02 | -0.17 | -0.01 | -0.01 |
| CIV\_UNEMPLOYMENT\_RATE | 1.31 | 3,138.15 | -13,569.81 | -158.58 | -2,552.74 | 1.89 | -400.28 |
| PER\_POP\_BELOW\_POVERTY | 0.40 | 15,632.54 | 198,973.60 | 151.08 | 2,333.60 | 36.17 | 167.24 |

Gross Energy Saved in kWh (Electric and Gas) Compared to Site Penetration – R-squared

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Site Penetration** | **Total** | **Mean** | **Median** |
| **First Year** | **Lifecycle** | **First Year** | **Lifecycle** | **First Year** | **Lifecycle** |
| PER\_MICRO | 0.037 | 0.074 | 0.068 | 0.002 | 0.005 | 0.009 | 0.068 |
| PER\_SMALL | 0.017 | 0.058 | 0.051 | 0.001 | 0.002 | 0.013 | 0.051 |
| PER\_MED | 0.007 | 0.086 | 0.080 | 0.002 | 0.004 | 0.003 | 0.080 |
| PER\_LARGE | 0.003 | 0.045 | 0.048 | 0.000 | 0.002 | 0.001 | 0.048 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.065 | 0.007 | 0.007 | 0.000 | 0.000 | 0.003 | 0.007 |
| log\_BIZ\_DENSITY\_NORM | 0.197 | 0.000 | 0.000 | 0.005 | 0.008 | 0.007 | 0.000 |
| PER\_POP\_65+ | 0.017 | 0.010 | 0.010 | 0.001 | 0.001 | 0.000 | 0.010 |
| PER\_WHITE | 0.001 | 0.000 | 0.000 | 0.005 | 0.005 | 0.001 | 0.000 |
| PER\_BLACK | 0.001 | 0.002 | 0.002 | 0.001 | 0.002 | 0.001 | 0.002 |
| PER\_AMERIND | 0.027 | 0.001 | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 |
| PER\_ASIAN | 0.041 | 0.000 | 0.000 | 0.002 | 0.001 | 0.001 | 0.000 |
| PER\_HISPANIC\_AND | 0.169 | 0.008 | 0.007 | 0.004 | 0.004 | 0.004 | 0.007 |
| TOTAL\_HOUSING\_UNITS | 0.049 | 0.051 | 0.042 | 0.002 | 0.004 | 0.001 | 0.042 |
| PER\_POP\_FOREIGNBORN | 0.001 | 0.002 | 0.003 | 0.003 | 0.006 | 0.013 | 0.003 |
| PER\_FOREIGN\_NONUS\_CIT | 0.098 | 0.015 | 0.013 | 0.016 | 0.022 | 0.000 | 0.013 |
| PER\_POP\_BROADBAND | 0.152 | 0.000 | 0.000 | 0.002 | 0.010 | 0.002 | 0.000 |
| MEDIAN\_HOUSEHOLD\_INCOME | 0.089 | 0.002 | 0.001 | 0.000 | 0.000 | 0.002 | 0.001 |
| CIV\_UNEMPLOYMENT\_RATE | 0.088 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PER\_POP\_BELOW\_POVERTY | 0.062 | 0.002 | 0.003 | 0.001 | 0.002 | 0.004 | 0.003 |

Gross Measure Incentives and Costs Compared to Site Penetration – Coefficients

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Site Penetration** | **Total** | **Mean** | **Median** |
| **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** |
| PER\_MICRO | -0.35 | -14,249 | -43,960 | -26.58 | -115.96 | 0.35 | -0.89 |
| PER\_SMALL | 0.32 | 17,155 | 50,079 | 26.70 | 97.37 | -1.30 | -5.20 |
| PER\_MED | -0.46 | 47,278 | 142,191 | 58.57 | 127.61 | -11.28 | -37.45 |
| PER\_LARGE | -1.14 | 129,957 | 464,418 | 334.58 | 1,485.15 | 34.14 | 127.47 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.23 | 1,770 | 4,962 | -0.11 | -1.61 | 2.76 | 4.67 |
| log\_BIZ\_DENSITY\_NORM | -6.76 | 27,722 | -4,375 | -241.07 | -1,584.15 | -21.35 | -255.73 |
| PER\_POP\_65+ | -0.28 | -6,540 | -20,894 | -5.47 | -46.98 | -1.34 | -8.67 |
| PER\_WHITE | 0.02 | -440.80 | -887.01 | 3.34 | 22.93 | 0.89 | 2.95 |
| PER\_BLACK | -0.06 | -1,566 | -7,897 | -2.28 | -53.13 | -0.55 | -6.02 |
| PER\_AMERIND | 1.44 | -5,892 | -17,522 | 41.02 | 74.11 | 15.79 | 63.26 |
| PER\_ASIAN | -0.18 | 800 | 4,114 | -2.91 | -12.22 | -2.01 | -5.04 |
| PER\_HISPANIC\_AND | 0.22 | 1,460 | 2,566 | 1.50 | 6.47 | 1.09 | 3.08 |
| TOTAL\_HOUSING\_UNITS | 0.00 | 14.07 | 34.09 | -0.02 | -0.15 | -0.01 | -0.04 |
| PER\_POP\_FOREIGNBORN | 0.04 | 1,080 | 3,474 | 3.35 | 16.88 | 3.44 | 8.86 |
| PER\_FOREIGN\_NONUS\_CIT | 0.28 | 1,735 | 8,016 | 17.32 | 85.96 | 3.41 | 14.21 |
| PER\_POP\_BROADBAND | -0.60 | 1,009.95 | 2,569.47 | -10.68 | -61.10 | -6.80 | -21.88 |
| MEDIAN\_HOUSEHOLD\_INCOME | 0.00 | -0.43 | 0.45 | 0.00 | 0.01 | 0.00 | 0.00 |
| CIV\_UNEMPLOYMENT\_RATE | 1.31 | -1,571.51 | -3,536.84 | -0.25 | 28.93 | 3.38 | 18.16 |
| PER\_POP\_BELOW\_POVERTY | 0.40 | 760.99 | 2,988.10 | 9.01 | 48.06 | 5.30 | 17.85 |

Gross Measure Incentives and Costs Compared to Site Penetration – R-squared

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Site Penetration** | **Total** | **Mean** | **Median** |
| **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** | **Incentive** | **Meas Cost** |
| PER\_MICRO | 0.037 | 0.123 | 0.069 | 0.015 | 0.012 | 0.000 | 0.069 |
| PER\_SMALL | 0.017 | 0.099 | 0.049 | 0.008 | 0.005 | 0.000 | 0.049 |
| PER\_MED | 0.007 | 0.141 | 0.075 | 0.007 | 0.002 | 0.005 | 0.075 |
| PER\_LARGE | 0.003 | 0.089 | 0.067 | 0.020 | 0.017 | 0.004 | 0.067 |
| POP\_WEIGHTED\_CES3\_SCORE | 0.065 | 0.008 | 0.004 | 0.000 | 0.000 | 0.012 | 0.004 |
| log\_BIZ\_DENSITY\_NORM | 0.197 | 0.007 | 0.000 | 0.018 | 0.033 | 0.002 | 0.000 |
| PER\_POP\_65+ | 0.017 | 0.019 | 0.012 | 0.000 | 0.001 | 0.000 | 0.012 |
| PER\_WHITE | 0.001 | 0.001 | 0.000 | 0.002 | 0.003 | 0.002 | 0.000 |
| PER\_BLACK | 0.001 | 0.002 | 0.003 | 0.000 | 0.003 | 0.000 | 0.003 |
| PER\_AMERIND | 0.027 | 0.001 | 0.000 | 0.002 | 0.000 | 0.004 | 0.000 |
| PER\_ASIAN | 0.041 | 0.002 | 0.003 | 0.001 | 0.001 | 0.006 | 0.003 |
| PER\_HISPANIC\_AND | 0.169 | 0.015 | 0.003 | 0.001 | 0.000 | 0.005 | 0.003 |
| TOTAL\_HOUSING\_UNITS | 0.049 | 0.096 | 0.033 | 0.009 | 0.016 | 0.009 | 0.033 |
| PER\_POP\_FOREIGNBORN | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.013 | 0.001 |
| PER\_FOREIGN\_NONUS\_CIT | 0.098 | 0.007 | 0.009 | 0.025 | 0.027 | 0.017 | 0.009 |
| PER\_POP\_BROADBAND | 0.152 | 0.001 | 0.000 | 0.003 | 0.005 | 0.024 | 0.000 |
| MEDIAN\_HOUSEHOLD\_INCOME | 0.089 | 0.003 | 0.000 | 0.000 | 0.001 | 0.008 | 0.000 |
| CIV\_UNEMPLOYMENT\_RATE | 0.088 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.000 |
| PER\_POP\_BELOW\_POVERTY | 0.062 | 0.000 | 0.000 | 0.002 | 0.003 | 0.013 | 0.000 |

## List of Programs in SMB Data

| **PA** | **PrgID** | **ProgramName** | **PrimarySector** | **ProgramCategory** | **StartYear** | **EndYear** | **DirectInstall** | **Financing** | **ParentProgram** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| PGE | PGE21011 | Commercial Calculated Incentives | Commercial | Other | 2016 |   | No | None | Commercial Energy Efficiency Programs |
| PGE | PGE210118 | Retail Energy Efficiency | Commercial | Other | 2016 | 2018 | Yes | None | Commercial Third Party Programs |
| PGE | PGE210119 | LED Accelerator | Commercial | Other | 2016 |   | No | None | Commercial Third Party Programs |
| PGE | PGE21012 | Commercial Deemed Incentives | Commercial | Other | 2016 |   | No | None | Commercial Energy Efficiency Programs |
| PGE | PGE210143 | Hospitality Program | Commercial | Other | 2016 |   | No | Other Financing | Commercial Third Party Programs |
| PGE | PGE21015 | Commercial HVAC | Commercial | Market Transformation | 2016 |   | No | None | Commercial Energy Efficiency Programs |
| PGE | PGE21018 | EnergySmart Grocer | Commercial | Other | 2016 |   | No | None | Commercial Third Party Programs |
| PGE | PGE21021 | Industrial Calculated Incentives | Industrial | Other | 2016 |   | No | None | Industrial Energy Efficiency Programs |
| PGE | PGE210211 | Light Industrial Energy Efficiency | Industrial | Other | 2017 |   | No | None | Industrial Third Party Programs |
| PGE | PGE21031 | Agricultural Calculated Incentives | Agricultural | Other | 2016 |   | No | None | Agricultural Energy Efficiency Programs |
| PGE | PGE210312 | Dairy and Winery Industry Efficiency Solutions | Agricultural | Other | 2016 |   | No | None | Agricultural Third Party Programs |
| PGE | PGE21032 | Agricultural Deemed Incentives | Agricultural | Other | 2016 |   | No | None | Agricultural Energy Efficiency Programs |
| PGE | PGE21034 | Agricultural Energy Advisor | Agricultural | Market Education Outreach | 2016 |   | No | None | Agricultural Energy Efficiency Programs |
| PGE | PGE21042 | Lighting Innovation | Cross-Cutting | Other | 2016 | 2020 | No | None | Lighting Energy Efficiency Programs |
| SCE | SCE-13-SW-002B | Commercial Calculated Program | Commercial | Other | 2016 |   | No | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-002C | Commercial Deemed Incentives Program | Commercial | Other | 2016 |   | No | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-002D | Commercial Direct Install Program | Commercial | Other | 2016 |   | Yes | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-002F | Nonresidential HVAC Program | Commercial | Market Transformation | 2016 |   | No | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-002G | Savings By Design | Commercial | New Construction | 2016 |   | No | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-002H | Midstream Point of Purchase Program | Commercial | Other | 2017 |   | No | OBF | Statewide Commercial Energy Efficiency Program |
| SCE | SCE-13-SW-003B | Industrial Calculated Energy Efficiency Program | Industrial | Other | 2016 |   | No | OBF | Statewide Industrial Energy Efficiency Program |
| SCE | SCE-13-SW-004B | Agriculture Calculated Energy Efficiency Program | Agricultural | Other | 2016 |   | No | OBF | Statewide Agriculture Energy Efficiency Program |
| SCE | SCE-13-TP-003 | Healthcare EE Program | Commercial | Other | 2016 |   | No | OBF | Commercial 3P Programs |
| SCE | SCE-13-TP-004 | Data Center Energy Efficiency | Commercial | Other | 2016 |   | No | OBF | Commercial 3P Programs |
| SCE | SCE-13-TP-005 | Lodging EE Program | Commercial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-006 | Food & Kindred Products | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-007 | Primary and Fabricated Metals | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-008 | Nonmetallic Minerals and Products | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-009 | Comprehensive Chemical Products | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-010 | Comprehensive Petroleum Refining | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-011 | Oil Production | Industrial | Other | 2016 |   | No | OBF | Industrial 3P Programs |
| SCE | SCE-13-TP-014 | Commercial Utility Building Efficiency | Commercial | Other | 2016 |   | No | OBF | Commercial 3P Programs |
| SCE | SCE-13-TP-020 | IDEEA365 Program | Industrial | Other | 2016 |   | No | OBF | Commercial/Industrial/Agricultural 3P Programs |
| SCE | SCE-13-TP-021 | Enhanced Retrocommissioning | Commercial | Other | 2016 |   | No | OBF | Commercial 3P Programs |
| SCE | SCE-13-TP-023 | Midsize Industrial Customer Program | Industrial | Other | 2017 |   | No | OBF | Industrial 3P Programs |
| SCG | SCG3708 | COM-Energy Advisor | Commercial | Market Education Outreach | 2016 |   | No | None | Local Programs |
| SCG | SCG3710 | COM-Calculated Incentives | Commercial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3711 | COM-Deemed Incentives | Commercial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3713 | IND-Energy Advisor | Industrial | Market Education Outreach | 2016 |   | No | None | Local Programs |
| SCG | SCG3715 | IND-Calculated Incentives | Industrial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3716 | IND-Deemed Incentives | Industrial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3717 | AG-Energy Advisor | Agricultural | Market Education Outreach | 2016 |   | No | None | Local Programs |
| SCG | SCG3719 | AG-Calculated Incentives | Agricultural | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3720 | AG-Deemed Incentives | Agricultural | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3735 | FIN-On-Bill Financing | Cross-Cutting | Financing | 2016 |   | No | OBF | Local Programs |
| SCG | SCG3737 | FIN-SW-New Financing Offerings | Cross-Cutting | Financing | 2016 |   | No | Other Financing | Statewide Programs |
| SCG | SCG3757 | IND-Small Industrial Facility Upgrades | Industrial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3762 | RES-CLEO | Residential | Market Education Outreach | 2016 |   | Yes | None | Local Programs |
| SCG | SCG3793 | COM-Instant Rebates! Foodservice POS | Commercial | Other | 2016 |   | No | None | Third Party Programs |
| SCG | SCG3797 | 3P-IDEEA365-Energy Advantage Program for Small Business | Commercial | Financing | 2016 |   | No | Other Financing | Local Programs |
| SCG | SCG3798 | 3P-IDEEA365-Connect | Commercial | Market Education Outreach | 2016 |   | No | None | Local Programs |
| SCG | SCG3804 | COM-On-Premise Ozone Laundry | Commercial | Other | 2016 |   | No | None | Third Party Programs |
| SCG | SCG3805 | COM-Direct Install Program | Commercial | Other | 2016 |   | Yes | OBF | Third Party Programs |
| SCG | SCG3807 | COM-HOPPS-CRR Program | Commercial | Other | 2016 |   | No | None | Local Programs |
| SCG | SCG3816 | PUB-Deemed Incentives | Public | Other | 2019 |   | No | None | Local Programs |
| SCG | SCG3817 | PUB-Direct Install Program | Public | Other | 2019 |   | Yes | None | Third Party Programs |
| SCG | SCG3834 | COM-LADWP Direct Install | Commercial | Other | 2019 |   | Yes | None | Third Party Programs |
| SCG | SCG3835 | COM-Pasadena Direct Install | Commercial | Other | 2019 |   | Yes | None | Third Party Programs |
| SDGE | SDGE3215 | SW-COM-Strategic Energy Management | Commercial | Market Education Outreach | 2016 | 2019 | No | None | SW COMMERCIAL |
| SDGE | SDGE3216 | SW-COM-Customer Services-Benchmarking | Commercial | Market Education Outreach | 2016 | 2020 | No | None | SW COMMERCIAL |
| SDGE | SDGE3217 | SW-COM-Customer Services- Audits NonRes | Commercial | Audit | 2016 |   | No | None | SW COMMERCIAL |
| SDGE | SDGE3220 | SW-COM-Calculated Incentives-Calculated | Commercial | Other | 2016 |   | No | None | SW COMMERCIAL |
| SDGE | SDGE3222 | SW-COM-Calculated Incentives-Savings by Design | Commercial | New Construction | 2016 |   | No | Other Financing | SW COMMERCIAL |
| SDGE | SDGE3223 | SW-COM-Deemed Incentives-Commercial Rebates | Commercial | Other | 2016 |   | No | None | SW COMMERCIAL |
| SDGE | SDGE3224 | SW-COM-Deemed Incentives-HVAC Commercial | Commercial | Other | 2016 | 2021 | No | None | Third Party Programs |
| SDGE | SDGE3225 | SW-COM-Deemed Incentives-HVAC Core | Commercial | Other | 2016 | 2019 | No | None | SW COMMERCIAL |
| SDGE | SDGE3226 | SW-COM Direct Install | Commercial | Other | 2016 |   | Yes | None | Third Party Programs |
| SDGE | SDGE3254 | Local WE&T-Integrated Energy Education & Training (IEET) | Cross-Cutting | Workforce Education and Training | 2016 |   | No | None | Workforce Education & Training Programs |
| SDGE | SDGE3255 | SW-WE&T-Connections | Cross-Cutting | Workforce Education and Training | 2016 |   | No | None | Workforce Education & Training Programs |
| SDGE | SDGE3257 | SW-WE&T-Strategic Planning | Cross-Cutting | Workforce Education and Training | 2016 | 2019 | No | None | Workforce Education & Training Programs |

1. Pacific Gas & Electric, Southern California Edison, San Diego Gas & Electric, and Southern California Gas Company. [↑](#footnote-ref-1)
2. See the full list of programs in Appendix 8.3 [↑](#footnote-ref-2)
3. Energy savings were the sum of electric savings in kWh and natural gas savings converted to kWh, in order to include as much energy efficiency program activity as possible. [↑](#footnote-ref-3)
4. SDG&E eligibility for commercial programs is based on electrical consumption only, per contracts [↑](#footnote-ref-4)
5. In CEDARS, there are fields for both Electric and Gas Rate classes, however these are optional field that are inconsistently utilized by IOUs and were not found to be helpful in the analysis. [↑](#footnote-ref-5)
6. https://oehha.ca.gov/calenviroscreen/sb535 [↑](#footnote-ref-6)
7. All incentives, costs, and savings are gross values. [↑](#footnote-ref-7)
8. For a statistically significant results at the 90% confidence interval, the p-value would be less than or equal to 0.1, 95% requires a p-value of 0.05, 99% a p-value of 0.01, and so on. The general rule of thumb for social sciences is to maintain a confidence interval of 90% (p-value of 0.1) [↑](#footnote-ref-8)
9. It is worth mentioning that a 1 percentage point share from businesses larger than medium is very raree, with most ZIP Codes having less than 1% share for these types of firms. [↑](#footnote-ref-9)
10. -6.762 X log10(1.1) ≈ -0.28 [↑](#footnote-ref-10)