Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

EVALUATION PLAN

FINAL

# 2023 Load Impact Evaluation of San Diego Gas and Electric's Electric Vehicles Time-of-Use (TOU) Rates

Prepared for San Diego Gas & Electric

By Demand Side Analytics, LLC

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# *ACKNOWLEDGEMENTS*

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# 1 INTRODUCTION

This evaluation plan lays out the analysis approach and requirements for evaluating impacts for SDG&E's electric vehicle rates:

- EV-TOU-2 : A three-part TOU rate that provides larger overnight prices and higher peak period prices than default TOU rates. The participant population for this rate has not grown much. Thus, the ability to evaluate the load impacts for the rates will depend on the number of sites in the PY 2023 cohort.
- EV-TOU-5: A three-part TOU rate with the same structure as EV-TOU-2. However, it has substantially lower overnight prices (super-off-peak) and a higher daily fixed fee charge. Nearly all new enrollments on electric vehicle rates have elected this rate.

There are two main objectives for this evaluation plan. The primary objective is to engage in science and avoid after-the-fact analysis and decisions where there is a temptation to modify models to find the desired results. This requires documenting the hypothesis, specifying the intervention, establishing the sample size and the ability to detect a meaningful effect, identifying the data that will be collected and analyzed, identifying the outcomes that will be analyzed and segments of interest, and documenting in advance the statistical techniques and models that will be used to estimate energy savings and demand reductions. The goal is to leave little to no ambiguity regarding what data will be collected or how the data will be analyzed. The secondary objective is to comply with the California Load Impact Evaluation Planning Protocols (Protocol #2). As a result, the evaluation plan is customized the explicitly address the 12 questions in the planning protocol.

Key issues that affect the evaluation approach are:

- Identifying an appropriate control pool. The primary challenge in evaluating electric vehicle programs is in finding appropriate control customers. The evaluation must be able to distinguish the impact of the electric vehicle rate on overall electric consumption from the impact of simply having an electric vehicles, meaning that eligible control customers must also have electric vehicles. That requires identifying customers that have electric vehicles who are not on an EV TOU rate and who have similar load patterns before enrollment in EV TOU rates.
- Electric vehicle adoption often coincides with enrollment in the TOU rate and adoption of solar or battery storage. When multiple changes occur at once, it is more difficult to isolate the effect of the TOU rates. Thus, the analysis requires careful attention to other large changes in energy use that can be confounded with electric vehicle impacts, including the adoption of electric vehicles, solar, and storage.
- TOU is a non-event based option. Once a customer enrolls on TOU, they are always on that rate and do not experience and the ON/OFF pattern common to dispatchable DR programs. Thus a year or pre-enrollment date is critical for the evaluation.

- The pool of sites that can be evaluated is limited. While SDG&E has tens of thousands of customers on TOU rates, the pool of sites that can be evaluated is limited to new enrollees with a year of pre-treatment, who did not enroll on the EV TOU rates around the same time they adopted the EV.

# 2 METHODS

Table 1 summarizes the key research questions pertinent to the evaluation of the EV TOU program.

Table 1: Key Research Questions

| | Research Question |
|---|---|
| 1 | What was the load shift in 2023 for each EV rate? |
| 3 | How does weather and market prices influence the magnitude of demand response, if at all? |
| 4 | How do load impacts vary for different customer sizes, locations, and customer segments? |
| 5 | For customers on an EV rate for multiple years, how do impacts vary year-on-year? |
| 6 | What is the ex-ante load reduction capability under resource adequacy planning conditions? And how well does it align with ex-post results and prior ex-ante forecasts? |
| 7 | What concrete steps or experimental tests can be undertaken to improve program performance? |

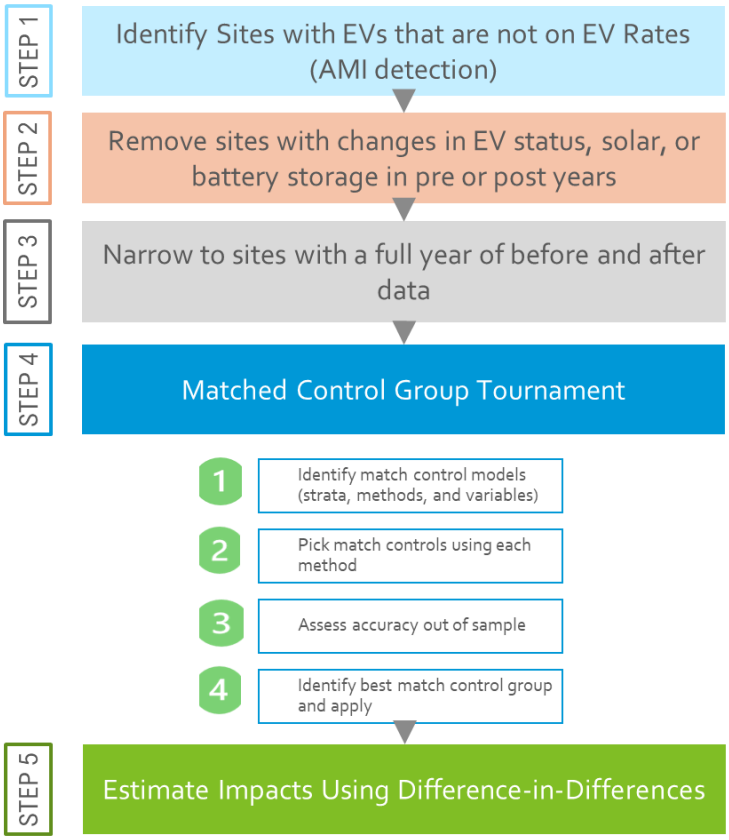
Table 2 summarizes the data sources, segmentation and estimation approaches that will be used. The segmentation is of particular importance because the evaluation will use a bottom up approach to estimate impacts for each segment and ensure that aggregate impacts across segments add up to the sum of the parts. This will be done to address discrepancies between segment and aggregate impacts in past evaluations which took a top down approach for aggregate impacts. Because impacts for each segment will be added together it is important that segmentation be structured to be mutually exclusive and completely exhaustive. In other words, every customer needs to be assigned to exactly one segment.

Table 2: Evaluation Methods Electric Vehicle rates

| Methodology Component | Approach |
|---|---|
| **Data Sources** | Our plan is to analyze the full population of participants and a matched control group. The analysis will include all PY2023 data. For ex-ante, we will need three years of historical data for each customer. PSPS and other outage days will be removed from the analysis for customers affected by these events. |
| **Segmentation of impact results** | The results will be segmented by:<br>▪ Aggregate and Average Customer;<br>▪ Program and Portfolio;<br>▪ Local Capacity Area (LCA);<br>▪ Climate zone;<br>▪ NEM status; |

- Solar vs. non-solar customers
- Presence of battery storage

**Estimation Method: Ex-Post**




The ex-post evaluation will rely on a five steps process summarized in the above figure.

1. **Identify customers who have electric vehicles and but are not on electric vehicle rates using AMI data.**. The goal is to identify the unique load patterns that indicate the presence of electric vehicles in the AMI data, including approximate date the electric vehicle(s) arrived at the household. To do so, we plan to run EV detection algorithms using AMI data from roughly 230,000 sites, with oversampling of zip codes with high EV penetration (based on Department of Motor Vehicle data). If SDG&E is able to provide DMV data by circuit, we can use this data to validate EVs are present at the circuit level.
2. **Continue to remove sites with changes in electric vehicle status, solar, or battery storage over the analysis period.** This is done for both the participants and the control pool candidate. The goal will be to identify site who only had changes in the electric vehicle rate status. We exclude sites that whose enrollment on electric vehicle TOU rates coincides with the introduction of the electric vehicle, and sites where the arrival of solar or battery storage can be confounded with the customer response to electric vehicle rates.
3. **Narrow the data to sites that have a full year of before and after data.** This is done to avoid imbalanced data which can sometimes lead to spurious relationship. The pre-treatment data is helpful for assessing if energy consumption changed and allows the use of more powerful statistical techniques such as difference-in-differences.

4. **Hold a match control group tournament.** The objective is to identify the most accurate matched control group. A good control group looks like and has similar energy use patterns as the participants. The only difference is that the participant group is on the relevant rate and the corresponding controls are not. The matching is done using a combination of stratified matching – i.e., the customer must be of a similar size bin and in the same industry – and scoring of sites in the same strata (group) using either propensity score or Euclidian distance matching. We usually score candidate controls based on location and pre-treatment electricity use metrics such as load factor, weather sensitivity, hourly load shape, on-peak demand, and weather sensitivity. The process involves defining 10-20 match control group models, picking match controls using each method, assessing the accuracy of each match control group out-of-sample, and identifying the best matched control group. Of the model tested, we first narrow down to the three models with the least bias (or absolute bias below 1%) and the select the best mode based on root-mean-squared error (rmse).

5. **Estimate impacts via difference-in-differences with matched controls**. If the rates lead to reductions in peak demand or consumption: 1) the load patterns before participants transitioned onto the  rates should be nearly identical to the control group, 2) we should observe a change for customers enrolling on electric vehicle rates, but no similar change for the control group, and 3) the timing of the change should coincide with the introduction of the rate. The difference-in-differences calculations helps remove any pre-existing differences between customers in the participant and control groups.

Impacts will be estimated for all dates and hours of the evaluation period and for all new sites (cohort) that have a full year of experience with electric vehicle time-of-use rates. In addition, we provide an early preview for sites that most recently enrolled but do not yet have a full year of data under the electric vehicle rates. Ex-post tables will be produced for electric vehicle rates in compliance with the Load Impact Protocols.

**Estimation Method: Ex-Ante**

The key steps for customer-level ex-ante impacts will be:

- Use three years of historical load data for relevant customers: 2021, 2022, and 2023
- Decide on an adequate segmentation to reflect changes in participant characteristics.
- Estimate the relationship between reference loads and weather and estimate whole house and disaggregated cooling loads on a per household basis.
- Use the models to predict reference loads for 1-in-2 and 1-in-10 weather year conditions.
- Develop an enrollment forecast that incorporates new enrollment projections, site retention, and electric vehicle adoption trends over time.
- Incorporate enrollment forecast with forecast loads and impacts per household
- Ex-ante tables will be produced for EV TOU rates in compliance with the Load Impact Protocols

# 3 EVALUATION PLANNING PROTOCOL

Table 3 lists the study design question in the California Load Impact Protocols and details how the evaluation plan addresses each study design issue for each program.

Table 3: Evaluation Planning Questionnaire

| # | Study design issue | EVTOU |
|---|---|---|
| 1 | Will the evaluation rely on a control group? If so, how will it be developed and what comparisons between the treatment and control group will be made? | A matched control group will be developed for each segment from customers who have EVs but are not enrolled in an EV rate plan. |
| 2 | Will the evaluation rely on pre-intervention data to establish a baseline? | Yes. |
| 3 | Will the study rely on a sample or include the full population receiving the intervention? If a sample is used, does it meet 90/10 precision requirements? | The study will include the full population receiving the intervention. |
| 4 | Is the study designed to detect a specific effect size? And, if so, how was statistical power assessed? | N/A |
| 5 | What is the study's threshold for statistical significance? | 90% confidence using a two-tailed test |
| 6 | What is the size of the control and treatment groups, if applicable? | Treatment:<br>▪ EV-TOU-2: all sites that enrolled in PY2021-PY2023<br>▪ EV-TOU-5: all sites that enrolled in PY2021-PY2023<br><br>Control:<br>▪ Control group will be same size as participant population. We will allow matching with replacement |
| 7 | How will the evaluation address outliers? | Customers for whom a matched control group cannot be identified (due to score distance) will not be included. |
| 8 | How will the evaluation address attrition? | Not applicable. Different rates of attribution are not expected. The EV TOU rates are unlikely to cause customers to relocate. |
| 9 | How will standard errors be calculated? | Time and fixed effects diff-in-diff regression using clustered (at customer level), robust standard errors |
| 10 | Will estimates be developed for subcategories? If so, please define them. | Yes, refer to segmentation in Table 2. |
| 11 | Will energy savings be estimated? | No |
| 12 | Will overlap with energy efficiency programs be estimated? | No |

# 4 DATA NEEDED

Demand Side Analytics delivered a data request for the EV-TOU analysis on September 11th, 2023. At a high level, the data request includes five items:

1. A customer characteristic file for all sites on electric vehicles rates at any time in 2022, or 2023 and a random sample of residential non-participant sites, with oversampling of zip codes with high electric vehicle penetration.
2. Hourly interval data for EV TOU participant sites and control pool sites
3. Enrollment Forecasts for EV TOU rates
4. Weather data
5. Interconnection data

# 5 TIMELINE

The evaluation work has been scoped into seven tasks. All but Task 6 (Project Management) have corresponding deliverables, laid out in Table 4.

Table 4: Evaluation Timeline and Deliverables

| Task | Deliverable PY 2022 | Due Date | Completed |
|---|---|---|---|
| **Task 1 Conduct Project Initiation Meeting** | PI Meeting: | September 2023 | 8/29/2023 |
| | PI Meeting Memorandum: | Five business days after the PI Meeting | 8/31/2023 |
| **Task 2 Develop Measurement and Evaluation Plan** | Draft EM&V Plan: | October 2023 | |
| | Final EM&V Plan: | | |
| **Task 3.1 Data Collection and Validation** | Draft Data Request | Within 5 days of kickoff meeting | 8/31/2023 |
| | Final Data Request | Within 10 days of kickoff meeting | 9/11/2023 |
| **Tasks 3 & 4 Impact Analysis & Reports** | Draft Ex-Post LI Estimates (table generators/report) | Due late December, 2023 | |
| | Final Ex-Post LI Estimates (table generators/report) | Due early January, 2024 | |
| | Draft Ex-Ante LI Estimates (table generators/report) | Due February 15th, 2024 | |
| | Final Ex-Ante LI Estimates (table generators/report) | Due March 1st, 2024 | |
| | Final hourly and monthly Ex-Post and Ex-Ante datasets | Due March 1st, 2024 | |
| | Executive Summary write-up for April 1st reports | Due March 15th, 2024 | |
| | Non-technical abstract for CALMAC website | Due April 10th, 2024 | |
| **Task 5 Presentation of Results** | Presentation | Date to be determined | |
| **Task 7 Database documentation** | 2017 Integrated project database | March 1st, 2024 | |
| | 2017 Database specifications and documentation | March 1st, 2024 | |