Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

EVALUATION PLAN

FINAL

2024 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 as adopted by the CPUC in D-04-08-050. The relevant[1] electric vehicle rates are:

- 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 2024 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.
- TOU-ELEC: A new three-part TOU rate with the same structure as the above rates. However, relative to the other TOU rates for electric vehicles, it has a lower peak price and off-peak price and a slightly higher super off-peak price. Unlike the rates above, which are exclusively for EV owners, customers with qualifying technology can enroll. Enrollees must have a heat pump, battery, or electric vehicle.

There are two main objectives for this evaluation plan. The primary objective is to specify the methodology that will be used to estimate ex-post load impacts for program year 2024 and ex-ante load impact forecasts through 2035. The purpose is to 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 second objective is to comply with the California Load Impact Evaluation Planning Protocols (Protocols 1-3), in creating a comprehensive plan to estimate demand reductions for electric vehicle rate customers between October 1, 2023, and September 30, 2024.

Protocol 1 requires producing and evaluation plan and is met by this evaluation plan. Protocol 2 requires identifying other potential applications for load impact estimates in addition to long-term planning. This load impact evaluation will also be used for resource adequacy and to develop capability profiles. They will not be used for customer settlement or monthly reporting to the CPUC of progress towards

[1] The scope of this evaluation is limited to SDG&E's whole-home TOU rates for EV owners. There does exist a separately metered rate for EV owners called "EV-TOU" that is not included in this evaluation. For the purpose of this evaluation, when we refer to "EV TOU rates" we mean only the EV-TOU-2 and EV-TOU-5 rates.

DR resource goals. Protocol 3 requires that the evaluation plan must address a list of 13 issues. For clarity, Table 3 summarizes each issue identified in the planning protocols and how it will be addressed in the evaluation.

2 EV OWNER METHODS

Key issues that affect the evaluation approach for EV owners 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.

Table 1 summarizes the key research questions pertinent to the evaluation of the EV TOU and TOU-ELEC rates.

Table 1: Key Research Questions

	Research Question
1	What was the load shift in 2024 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?

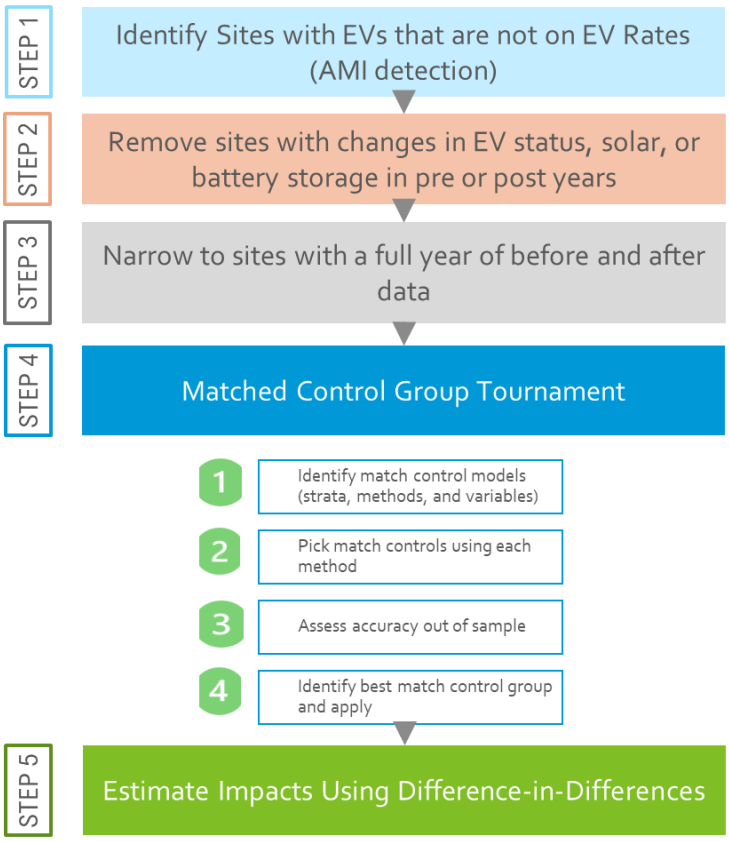
7	What concrete steps or experimental tests can be undertaken to improve program performance?

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 PY2024 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: ▪ Aggregate and Average Customer; ▪ System (CAISO/SDG&E); ▪ CARE status; ▪ Rate; ▪ Rate and NEM status; ▪ NEM status; and ▪ Zip code area.

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 250,000 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, battery storage, or heat pump status over the analysis period.** This is done for both the participants (to the extent possible for heat pumps) 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 robust 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: 2022, 2023, and 2024
- 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 EV OWNER 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	Electric Vehicle Rates Evaluation
1	What is the target level of confidence and precision in the impact estimates?	The full population will be analyzed. The expected precision of load impact estimates is expected to meet 90/10 requirements.
2	Will the evaluation producing ex post and ex ante estimates?	Yes. The evaluation will be used to produce both ex-post and ex-ante impact estimates
3	Are changes in the participant mix of program design anticipated to occur over the forecast horizon?	Yes. The participant population is expected to increase. The mix is expected to remain largely similar.
4	Are persistence estimates needed?	No.
5	Are additional M&V or survey activities needed?	No. The evaluation will be conducted using smart meter data only.
6	Are impacts needed for geographic subregions?	Yes. Load impacts will be developed by local capacity area and climate zone.
7	Will sub-hourly impact estimates be produced?	No.
8	Are impacts needed for customers segments?	Yes, refer to segmentation in Table 2.
9	Are impacts needed for additional day types in addition to minimum required by the protocols?	No.
10	Will the evaluation investigate why the estimates are what they are?	Yes.
11	Will the evaluation estimate the number and/or percent of DR resource participants who are structural benefiters or free riders?	No.
12	Will an external control group be used?	Yes. A matched control group will be developed for each segment from customers who have EVs but are not enrolled in an EV rate plan.
13	Will the evaluation use a common methodology or pool data across utilities?	NA

4 NON-EV OWNER METHODS

The TOU-ELEC rate is a new offering for PY 2024. For this evaluation season, our approach will analyze TOU-ELEC customers with EVs using the same methodology as EV-TOU-2 and EV-TOU-5 customers. The new rate will simply be analyzed as a new offering alongside EV-TOU-2 and EV-TOU-5. For non-EV owners on TOU-ELEC, the analysis approach will be exploratory in nature for this program year. This decision is motivated by challenges associated with the first enrollment year on a rate for qualifying technology:

- Small and uncertain sample sizes. In total, there are a few hundred customers enrolled on TOU-ELEC. To avoid confounding estimates of rate impacts with the effects of technology adoption, customers that acquired their heat pump or battery within a year of enrollment must be dropped from the analysis. This will likely leave very few eligible customers for analysis, resulting in imprecise load impacts. In subsequent program years, we expect there will be more customers eligible for analysis.
- Identification and uncertain availability of an appropriate control pool. As is the case for evaluating load impacts for EV owners, the primary challenge in evaluating TOU-ELEC customers with batteries and heat pumps is finding appropriate control customers. The evaluation must be able to distinguish the impact of the rate on overall electric consumption from the impact of simply having a qualifying technology, meaning that eligible control customers must also have qualifying technology. That requires identifying customers that have heat pumps and batteries who are not on the TOU-ELEC rate and who have similar load patterns before enrollment in the rate. A significant challenge with identifying control customers for heat pumps is the lack of customer-level information on heat pump adoption. Some SDG&E customers are on electric heating baselines, but those customers do not necessarily have heat pumps, and have historically used electric resistance heating. Regarding batteries, SDG&E customers self-report whether they have a battery attached to their PV system when they interconnect. There may be a limited number of customers who installed batteries without a PV system, in which case they do not need to notify SDG&E that they possess a battery.

The main steps in the non-EV owner analysis are outlined below.

1. The first step will be to tabulate the qualifying technologies, technology acquisition dates, and enrollment dates for TOU-ELEC customers.
    a. The goal is to characterize the number of customers by technology, with and without the restriction that the new technology was not acquired within a year of enrollment.
2. Tabulate TOU-ELEC enrollees by their previous rate and technology.

a. Note that if a customer was previously on an EV-TOU rate, the peak-to-off-peak price ratio is lower under TOU-ELEC than under the EV-TOU rates.

3. Characterize customer load shape pre- and post-TOU-ELEC enrollment by technology.

    a. If sample sizes allow, we can do a preliminary analysis that does not use control customers but leverages variation in enrollment timing across customers. This is a difference-in-differences analysis with no "never treated" customers. For example, a customer with a heat pump that enrolled late can serve as a control for a customer with a heat pump that enrolled early. The feasibility and value of such an analysis will depend on the sample sizes we observe in step 1.

        i. Within such an analysis it is possible to examine impacts by technology, if sample sizes allow.

4. Investigate sources for control customer data.

    a. Examine the counts of battery customers not on TOU-ELEC.

    b. Identify any customer-level data on heat pump rebate take-up.

5 DATA NEEDED

Demand Side Analytics delivered a data request for the EV-TOU analysis on August 30, 2024. We updated it to include TOU-ELEC data on October 10, 2024. 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 2023, or 2024 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
6. Customer characteristics and interval data for TOU-ELEC participant sites.

6 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 2024	8/28/2024
	PI Meeting Memorandum:	Five business days after the PI Meeting	8/31/2024
Task 2 Develop Measurement and Evaluation Plan	Draft EM&V Plan:	October 2024	10/10/2024
	Final EM&V Plan:		
Task 3.1 Data Collection and Validation	Draft Data Request	Within 5 days of kickoff meeting	8/25/2024, 8/30/2024
	Final Data Request	Within 10 days of kickoff meeting	
Tasks 3 & 4 Impact Analysis & Reports	Draft Ex-Post LI Estimates (table generators/report)	Due late December, 2024	
	Final Ex-Post LI Estimates (table generators/report)	Due early January, 2025	
	Draft Ex-Ante LI Estimates (table generators/report)	Due February 15th, 2025	
	Final Ex-Ante LI Estimates (table generators/report)	Due March 1st, 2025	
	Final hourly and monthly Ex-Post and Ex-Ante datasets	Due March 1st, 2025	
	Executive Summary write-up for April 1st reports	Due March 15th, 2025	
	Non-technical abstract for CALMAC website	Due April 10th, 2025	
Task 5 Presentation of Results	Presentation	Date to be determined	
Task 7 Database documentation	2017 Integrated project database	March 1st, 2025	
	2017 Database specifications and documentation	March 1st, 2025	