EVALUATION PLAN

FINAL

2025 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

November 2025

ACKNOWLEDGEMENTS

Evaluation Team

- Josh Bode, MPP
- Marshall Blundell, Ph.D.

SG&E Team

- Leslie Willoughby
- Lizzette Garcia-Rodriguez
- Erich Kevari

TABLE OF CONTENTS

Tables

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 2025 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 2025 and ex-ante load impact forecasts through 2036. 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, 2024, and September 30, 2025.

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 TOU RATE METHODS

Key issues that affect the evaluation approach for customers on EV-TOU-2 and EV-TOU-5 rates 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 rates.

Table 1: Key Research Questions

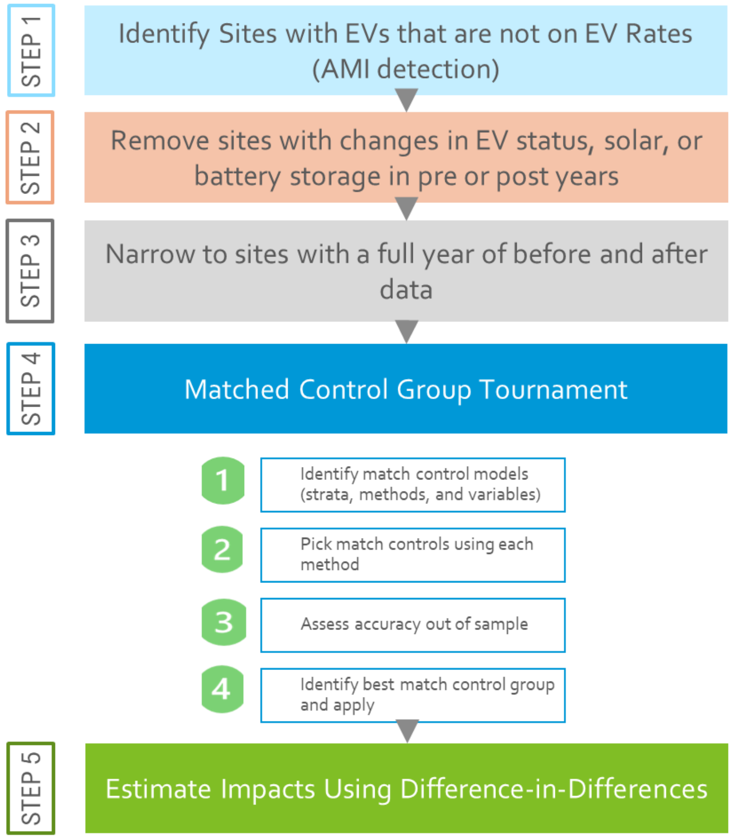
	Research Question
1	What was the load shift in 2025 for each EV rate?
3	How does weather and market prices influence the magnitude of demand response, if at all?
4	How do load impacts vary for different customer sizes, locations, and customer segments?
5	For customers on an EV rate for multiple years, 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 PY2025 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: 2023, 2024, and 2025 ▪ 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 TOU RATE 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 TOU-ELEC RATE METHODS

The TOU-ELEC rate was a new offering for PY 2024. In the PY 2024 evaluation season, the approach was exploratory in nature. In PY 2025 the approach remains exploratory since our ability to estimate precise impacts will largely depend on whether there have been enough new enrollees. As such, TOU-ELEC methods described here do not follow formal evaluation planning protocols.

In PY 2024 we estimated impacts by two methods:

1. The same matched control group, difference-in-differences methodology as EV-TOU-2 and EV-TOU-5 customers;

2. A panel regression with multiple fixed effects that exploits variation in TOU-ELEC enrollment timing to compare late-enrollee with early-enrollee load, pre- and post-enrollment while controlling for different technology types.

The decision to conduct an exploratory analysis was motivated by challenges associated with the first enrollment year on a rate for qualifying technology. These challenges are still relevant in the PY 2025 evaluation and are as follows:

- 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.

Results from the exploratory analysis in PY 2024 suggested that the second evaluation approach was better suited to the above challenges. Estimates were more precise than with matched control groups, and, though the true effect is unknown, estimated load impacts were plausible and similar to those obtained for EV-TOU customers. In the second method, rather than exclude customers with technology adoption dates close to enrollment dates, we control for technology effects using the technology adoption dates that customers provide when they enroll. This allows us to keep more customers in the analysis for more precision. We also do not need to identify a matched control group of customers that never enrolled but also have enabling technology (which is challenging since we do not observe heat pump ownership for non-enrollees), since we use only enrolled customers and let late enrollees serve as the counterfactual for early enrollees, using the fact that many of them adopt new technology before enrollment.

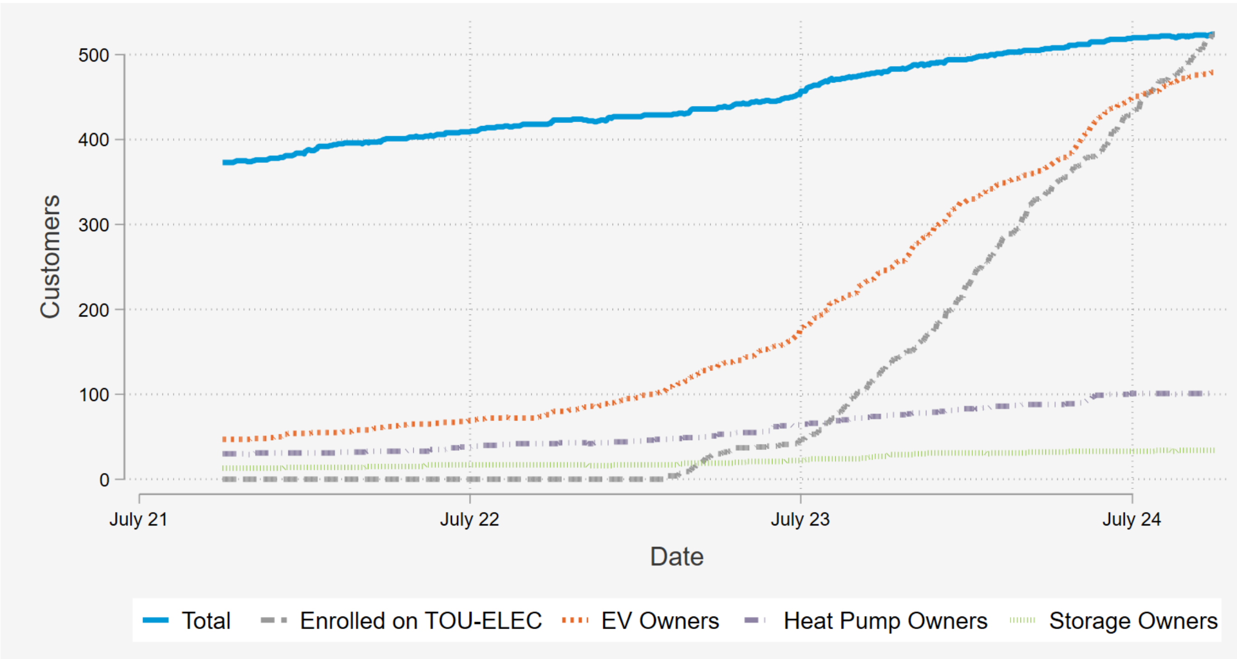
The analysis for PY 2025 remains exploratory because program enrollment is capped and remains small. If monthly ex post load impacts are sufficiently precise, we will estimate ex ante load impacts and perform a full load impact evaluation.

4.1 EXAMINE SAMPLE SIZE AND TECHNOLOGY OWNERSHIP

The first step will be to perform a descriptive analysis qualifying technologies, technology acquisition dates, and enrollment dates for TOU-ELEC customers. The purpose of this analysis is to understand the sample size available for estimation and the variation in technology ownership and enrollment dates.

Figure 1 was produced for the PY 2024 analysis and shows the number of customers observed over time, as well as the number enrolled on TOU-ELEC, and the number adopting each qualifying technology over time. Customers begin enrolling on TOU-ELEC in early 2023. By the end of the analysis period, they have almost all enrolled. Similarly, we observe increasing EV ownership over the analysis period. By the fall of 2024, almost all customers own EVs. We do observe EV ownership changing for some customers before TOU-ELEC enrollment, and some customers own EVs throughout the analysis period. The second-most popular qualifying technology is heat pumps. Over the sample period, ownership increases from fewer than 50 customers to about 100. Battery storage ownership does increase over the sample period, but even by the end of the period, fewer than 50 customers own storage. This information on ownership of qualifying technologies is self-reported when customers enroll. It is possible the information is misreported by some customers, perhaps purposefully, in order to enroll on the rate, or simply by mistake due to a mistake or omission. It is also possible that customers own multiple of a particular qualifying technology, and only report the first.

Figure 1: TOU-ELEC Customers for October 2011 through September 2024



4.2 ESTIMATE EX POST LOAD IMPACTS

To recover the causal effect of the TOU-ELEC rate on demand, DSA will estimate impacts using a panel regression with multiple fixed effects.

Equation 1 specifies the model used to produce average customer-level impacts in kW. The model is estimated by OLS regression on data at the individual customer *i*, date-level *t* level spanning October 1 2021 to September 30 2025.

Equation 1: OLS Model Specification

$$kW_{it} = \beta_1 TOUELEC_{it} + \beta_2 EV_{it} + \beta_3 HP_{it} + \beta_4 Storage_{it} + \beta_5 PV_{it} + \beta_3 PV_{it} \times System\ Size_i + \rho_{i\ x\ temp} + \delta_{i\ x\ month} + \tau_{t\ x\ techmology} + \varepsilon_{it}$$

Table 4 defines each model term in the equations above.

Table 4: Description of Model Terms

Model Term	Description
kW_{it}	Average kW for customer *i* on date *t* (for peak period or super off peak period, as applicable)
$TOUELEC_{it}$	Variable encoding TOU-ELEC enrollment on date *t* for customer *i*
EV_{it}	Variable encoding EV ownership on date *t* for customer *i*
HP_{it}	Variable encoding heat pump ownership on date *t* for customer *i*
$Storage_{it}$	Variable encoding battery storage ownership on date *t* for customer *i*
PV_{it}	Variable encoding solar PV ownership on date *t* for customer *i*
$\rho_{i\ x\ temp}$	Customer-level daily maximum temperature bin fixed effect

$\delta_{i\,x\,month}$	Customer-level month fixed effect
$\tau_{t\,x\,techmology}$	Date-level technology fixed effect
ε_{it}	Error term

We will estimate the model separately with average daily peak load and average daily super off peak load as the dependent variable. Because the TOU-ELEC enrollment date is likely subject to measurement error, we will omit 60 days pre- and post-TOU-ELEC enrollment. Standard errors will be two-way clustered at the customer, date level. We will modify the model to estimate monthly effects by interacting the independent variable of interest, $TOUELEC_{it}$ with calendar month.

The coefficient of interest is β_1, the average effect of TOU-ELEC enrollment on load. Because enrollees report technology ownership and acquisition date of each qualifying technology when they enroll, we will directly control for customer-level adoption of EVs, heat pumps, and battery storage over time. Similarly, since we observe solar ownership and adoption dates, as well as solar system size in kW for each net energy metered (NEM) customer, we will directly control for the presence of solar, and each NEM customer's system size. We will include binned daily maximum temperature fixed effects at the customer-level to control for unobservable features of a customer that are constant over time, but might vary with temperature. [2] We will also include month fixed effects at the customer-level to control for unobservable features of a customer that are constant within month. Date-level fixed effects at the qualifying-technology-level will control for variables that affect demand that are common across customers within a technology.

4.3 ESTIMATE EX ANTE LOAD IMPACTS

Table 2 summarizes the ex ante evaluation approach 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. For TOU-ELEC customers it might be possible that no segmentation is achievable due to sample size and we are limited to estimating impacts for the average enrollee.

Table 5: Evaluation Methods Electric Vehicle rates

Methodology Component	Approach
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: 2023, 2024, and 2025 ▪ 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.

[2] Temperature is split into bins using the following cut points: (25, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 105). High and low temperatures have wider bins to ensure at least 1% of observations fall in each bin.

- 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

5 DATA NEEDED

Demand Side Analytics delivered a data request for the EV-TOU analysis on September 16, 2025. 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 2024, or 2025 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 6.

Table 6: Evaluation Timeline and Deliverables

Task	Deliverable PY 2022	Due Date	Completed
Task 1 Conduct Project Initiation Meeting	PI Meeting:	September 2025	9/10/2025
	PI Meeting Memorandum:	Five business days after the PI Meeting	9/24/2025
Task 2 Develop Measurement and Evaluation Plan	Draft EM&V Plan:	October 2025	10/28/2025
	Final EM&V Plan:		
Task 3.1 Data Collection and Validation	Draft Data Request	Within 5 days of kickoff meeting	9/16/2025, 9/16/2025
	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, 2025	
	Final Ex-Post LI Estimates (table generators/report)	Due early January, 2026	
	Draft Ex-Ante LI Estimates (table generators/report)	Due February 15th, 2026	
	Final Ex-Ante LI Estimates (table generators/report)	Due March 1st, 2026	
	Final hourly and monthly Ex-Post and Ex-Ante datasets	Due March 1st, 2026	
	Executive Summary write-up for April 1st reports	Due March 15th, 2026	
	Non-technical abstract for CALMAC website	Due April 10th, 2026	
Task 5 Presentation of Results	Presentation	Date to be determined	
Task 7 Database documentation	2017 Integrated project database	March 1st, 2026	
	2017 Database specifications and documentation	March 1st, 2026	