Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

2025 Load Impact Evaluation of San Diego Gas and Electric's Vehicle Grid Integration and Electric Vehicle-High Power Rates

Prepared for San Diego Gas & Electric
By Demand Side Analytics, LLC
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ACKNOWLEDGEMENTS

Evaluation Team

- Josh Bode, MPP

- Marshall Blundell, Ph.D.

SG&E Team

- Leslie Willoughby

- Lizzette Garcia-Rodriguez

- Erich Kevari

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1   INTRODUCTION

This evaluation plan lays out the analysis approach and requirements for evaluating impacts, as adopted by the CPUC in D-04-08-050, for SDG&E's Vehicle Grid Integration (VGI) rates, known as Power Your Drive (PYD), and SDG&E's Electric Vehicle-High Power (EV-HP) rates:

- VGI: A real-time rate with system- and local-demand response (DR) events. It is assessed on charging stations at multi-unit dwellings (MUDs) and workplaces.

- EV-HP: A TOU-CPP rate with a subscription component designed to recover costs previously recovered with demand charges. It is assessed on medium- and heavy-duty electric vehicle fleets.

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 (Protocols 1-3), in creating a comprehensive plan to estimate load impacts for the customers on the VGI and EV-HP rates between October 1, 2024, and September 30, 2025. As a result, the evaluation plan is customized the explicitly address the 12 questions in the planning protocol.

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 DR resource goals. Protocol 3 requires that the evaluation plan must address a list of 13 issues. For clarity, Table 3 and Table 6 summarize each issue identified in the planning protocols and how it will be addressed in the evaluation for each rate.

2 VGI METHODS

Key issues that affect the VGI evaluation approach are:

- **Lack of an appropriate control pool.** An appropriate pool of control customers would be multi-unit dwelling (MUD) and workplace level 2 charging stations that are not enrolled.

- **The Power Your Drive Customers face wholesale market prices and at no time experience the otherwise applicable tariff.** Thus, the analysis relies on estimating the relationship between charging behavior and market prices.

- **Power Your Drive is more complex than event-based programs.** Once a customer enrolls on RTP, they are always on that rate and do not experience and the ON/OFF pattern common to dispatchable DR programs. Customers do experience events: 12 days in PY 2023 were subject to system events, and 298 days in PY 2023 were subject to local events on at least one circuit. However, simply analyzing VGI as an event-based option has several drawbacks. It is not feasible to estimate precise hourly load impacts for hundreds of local event days. System event days are only possible to estimate using within-subjects variation. Finally, restricting to system event days drastically underestimates load reductions on those days, since the day-ahead price is also higher and there are often local events.

Table 1 summarizes the key research questions pertinent to the evaluation of the PYD Program.

Table 1: Key Research Questions

	Research Question
1	How many charging stations are enrolled by customer type and how has this changed over time?
2	What is the utilization of charging stations by customer segment?
3	What was the load shift in 2024 under the VGI rate, including adder events?
4	How do weather and market prices influence the magnitude of customer response, if at all?
5	What is the customer awareness of different price signals?
6	How do load impacts vary for different customer sizes, locations, and customer segments?
7	What is the ex-ante load reduction capability under resource adequacy planning conditions?

| 8 | What concrete steps or experimental tests can be undertaken to improve program performance? |

Table 2 summarizes the data sources, segmentation and estimation methods 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.

<div align="center">Table 2: Evaluation Methods PYD</div>

Methodology Component	Approach
Data Sources/Samples	Our plan is to analyze the facility-based AMI meter data. The analysis will include all PY 2022-PY 2025 data.
Segmentation of impact results	The results will be segmented by: ▪ Rate to Driver v. Rate to Host ▪ Multi-family v. Workplace ▪ Local Capacity Area (LCA) ▪ Climate Zone
Estimation Method: Ex-Post	The date will be analyzed as follows: ▪ A panel regression with fixed effects and time effects that estimates the relationship between peak pricing and peak energy use (price elasticity) ▪ Ex-post tables will be produced for PYD. To do so, we will assume that customers would have enrolled in an otherwise appliable rate, EV-TOU-5, scaled to account for differences in revenue recovered. ▪ Impacts will be computed for every hour and customers by using elasticities to predict load under the VGI rate, and under the counterfactual rate, and taking the difference. ▪ Then, for each day type (top n load days, monthly peak days, monthly average day) and customer segment, impacts will be estimated by averaging over the relevant hours and customer segments.
Estimation Method: Ex-Ante	Ex-ante impacts for PYD are distinct from those in most other evaluations because the rate itself is a real-time price which changes as a function of weather. On average, prices are expected to be higher during 1-in-10 weather year conditions than during 1-in-2 weather year conditions. Furthermore, charging load, and price responsiveness is not very weather sensitive, at least after accounting for price variation. There is also evidence that price-sensitivity is relatively constant across days with no events and days with events. These facts inform the key steps for estimating customer-level ex ante impacts, which are as follows:

- Use three years of historical load data and prices: 2022-2024.
- Decide on an adequate segmentation to reflect changes in participant characteristics (e.g. MUD, Workplace)
- Estimate the price elasticity of demand for each customer segment during the analysis period.
- Estimate the relationship between the VGI rate and weather conditions using one model to predict the day-ahead hourly price, another model to predict system events, and another model to predict local events.
- Use the rate-weather models to predict the VGI rate for 1-in-2 and 1-in-10 weather year conditions.
- Develop an enrollment forecast that incorporates new charging station projections.
- Incorporate enrollment forecast with forecast VGI rate, estimated price elasticities, counterfactual rate, to estimate reference loads and impacts per household.
- Ex-ante tables will be produced for the VGI rate in compliance with the load impact protocols.

3 VGI 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	VGI 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 impacts is determined by the size of the population and the variability of the underlying data.
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?	The participant population is expected to increase modestly.
4	Are persistence estimates needed?	No.
5	Are additional M&V or survey activities needed?	No. The evaluation will be conducted using charging session 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?	No. There is no control group available. Impact estimation will use both within- and between-subjects variation.
13	Will the evaluation use a common methodology or pool data across utilities?	NA

4 EV-HP METHODS

Key issues that affect the EV-HP evaluation approach are:

- **Fleet growth over time.** The EVHP rate is designed to mitigate the disincentive to electrify under existing rates with demand charges. As fleets electrify, the number of vehicles charging will increase over time. We believe that this increase in fleet size has the potential to confound ex post load impacts.

- **Potential endogeneity of price due to omitted variables.** Variation in the time of use price is not randomly assigned. Peak and off-peak periods could occur at times that are be related to charging behavior in unobservable ways that result in biased estimates. For example, fleets could face constraints and need to charge in the evening regardless of price. Simply comparing consumption in high- and low-price periods will result in a finding of a high degree of price responsiveness, and in turn load impacts.

- **Lack of a control group.** Many potential omitted variables could be accounted for if participant charging could be compared with charging for a control group made up of non-participant submetered fleets. It is unclear whether non-participant data is available and is suitable for comparison with participants.

- **Small sample sizes.** We understand as of March 2024 there were 134 customers enrolled. This represents a small sample size and poses a challenge for detecting impacts. Even if a method produces unbiased estimates of load reductions, if the sample size is small, the probability of being able to detect an impact is low. This is an inherent limitation of the evaluation, and other than maximizing the use of available data, there is little to be done to overcome this problem.

- **Variable load across customers.** We speculate that because of differences in fleet size and utilization, that load is highly variable across customers. This increases the variance in the estimation sample and makes detecting an effect harder. Our proposed approach attempts to control for fleet size, but it remains to be seen how much of the variation in load can be explained by our proposed control variables.

Table 4 summarizes the key research questions pertinent to the evaluation of the EV-HP rate. Our plan is to proceed using within-subjects variation to evaluate EV-HP as an event-based resource. If non-participant data and pre-treatment data become available to use, we may be able to evaluate the non-event based TOU portion also.

Table 4: Key Research Questions

	Research Question
1	What were the demand reductions due to program operations and interventions in 2023 – for each event day and hour?
2	How does weather influence the magnitude of demand response?

3	How do load impacts vary for different customer sizes, locations, and customer segments?
4	What is the ex-ante load reduction capability for 1-in-2 and 1-in-10 weather conditions? And how well does it align with ex-post results?
5	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?
8	What concrete steps or experimental tests can be undertaken to improve program performance?

Table 5 summarizes the data sources, segmentation and estimation methods 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.

<div align="center">Table 5: Evaluation Methods EV-HP</div>

Methodology Component	Approach
Data Sources/Samples	All event season data for PY 2025 for all EV-HP participants that were enrolled for every event.
Segmentation of impact results	The results will be segmented by: ▪ Local Capacity Area (LCA) ▪ Climate Zone ▪ NAICS code ▪ Dual enrollment, if applicable
Estimation Method: Ex-Post	▪ To recover the causal effect of demand response event on charging demand, DSA will use a within-subjects approach. In this framework, a customer's average load in the same hour on non-event days is used to develop a counterfactual estimate of a customer's charging demand were the event never called. Observable differences between the event hour and non-event hour, such as month, weekend versus weekday, and holidays, are accounted for using control variables. ▪ Since charging load is typically not weather sensitive, the benefits of restricting non-event days to a set of hot proxy days may be outweighed by instead including the full set of non-event days and flexible weather controls to both better model counterfactual charging demand and achieve more precise estimates.

	▪ DSA will estimate effects on a set of placebo hot days and plot the impact-temperature relationship alongside event days to verify that the identification assumptions of the final model are met.
Estimation Method: Ex-Ante	Ex-ante impacts for EV-HP will be estimated as follows: ▪ Weather normalized customer regressions by segment for reference loads ▪ Regression of event percent impacts versus weather for percent reductions o If no clear weather-percent impact relationship is found weather will not be included in the ex ante impact model.

5 EV-HP EVALUATION PLANNING PROTOCOL

Table 6 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 6: Evaluation Planning Questionnaire

#	Study design issue	EV-HP 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 impacts is determined by the size of the population and the variability of the underlying data.
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?	The participant population is expected to increase.
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 5.
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?	No. There is no control group available. Impact estimation will use within-subjects variation.
13	Will the evaluation use a common methodology or pool data across utilities?	NA

6 DATA NEEDED

Demand Side Analytics delivered a data request for the VGI analysis on September 16th, 2025. At a high level, the data request includes five items:

1. A customer characteristic file for all sites on a PYD/VGI rate at any time in 2021 through 2025 and a random sample of residential non-participant sites.

2. PYD site characteristics

3. Hourly Vehicle charger sessions data for all EV chargers

4. Power Your Drive Hourly Pricing Data by location, ideally separating the hourly market prices, system capacity adder, and distribution capacity adder

5. Enrollment forecasts for PYD sties

Demand Side Analytics delivered a data request for the EV-HP analysis on September 16th, 2025. At a high level, the data request includes five items:

1. Customer characteristics for all sites on an EV-HP rate at any time in 2024 or 2025

2. Customer characteristics for any available fleets or similar sties not on EVHP for 2024-2025

3. Hourly interval data for EV-HP participant sites from October 1 2021 – September 30 2025

4. Hourly interval data for any available non-participant fleets or similar sites from October 1 2021 – September 30 2025

5. Enrollment forecasts for EV-HP rates

7 TIMELINE

The evaluation work has been scoped into seven tasks. All but Task 6 (Project Management) have corresponding deliverables, laid out in Table 7.

Table 7: 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	Integrated project database	March 1st, 2026	
	Database specifications and documentation	March 1st, 2026	