# Power Your Drive Research Report

**April 2021**


Prepared by Energetics on behalf of SDG&E

SDGE

A Sempra Energy utility

# Power Your Drive Research Report

## Table of Contents

## List of Tables



## List of Figures

# Executive Summary

San Diego Gas & Electric Company ("SDG&E") established and implemented the Power Your Drive Pilot ("PYD Pilot" or "Pilot") after it was approved by the California Public Utilities Commission ("CPUC" or "Commission") in January 2016.[1] SDG&E designed the Pilot to support California's goal of reducing greenhouse gas ("GHG") emissions by creating access to electric vehicles ("EV") charging infrastructure at workplaces and multi-unit dwellings ("MUDs") for the residents of the San Diego region.

The transportation sector is a major source of GHG emissions in California. SDG&E implemented the PYD Pilot with the goal to reduce GHG and criteria pollution emissions by encouraging EV adoption and increasing electric vehicle miles travelled. The PYD Pilot also trialed an innovative billing scheme—so far unique in California—that directly served drivers participating in the program on a dynamic electric rate which encourages drivers to charge when there is ample capacity on the electric grid and renewable electricity generation is generally high.

The PYD Pilot was a first of its kind EV infrastructure program with a focus on encouraging EV adoption by reducing barriers such as the expense and difficulty of installing charging equipment for key, underserved customer segments. SDG&E deployed over 3,000 Level 2 EV charging stations through the PYD Pilot. Thirty-nine percent of these sites are located in MUDs and 31% of sites are located in communities that face heavy pollution burdens, which the state and Commission refer to as disadvantaged communities ("DACs")—far in excess of the Decision's 10% DAC goal. By the end of 2020, approximately 4,500 EV driver customers had enrolled in the Pilot and consumed over 4 million kilowatt-hours ("kWh") of electricity, resulting in a net reduction of over 3.4 million kilograms of carbon dioxide ("$CO_2$") emissions.

Driver feedback indicates that the PYD Pilot increased the adoption of EVs in the San Diego region. Feedback collected from drivers participating in the Pilot through a February 2021 survey indicates that 60% of respondents who adopted an EV after SDG&E installed PYD chargers stated that the chargers' availability influenced their decision to purchase or lease an EV. Forty-three percent of drivers indicated that they drive more electric miles because of PYD chargers, and more than a third (37%) requested that more PYD chargers be made available.

The Pilot's cost from inception through December 2020 was $69.8 million, averaging approximately $275,000 per site. While SDG&E met the intended number of charging ports authorized by the Decision the Pilot exceeded the authorized budget. Through executing the Pilot, SDG&E significantly improved its understanding of the cost of transportation electrification ("TE") programs and enhanced its ability to successfully execute future programs.

[1] Public Utilities Commission of the State of California, *Decision Regarding Underlying Vehicle Grid Integration Application and Motion to Adopt Settlement Agreement*, Decision 16-01-045, approved January 28, 2016, https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M158/K241/158241020.PDF ("Decision").

## About This Report

This PYD Research Report ("Report") was prepared by Energetics with input and data from SDG&E and is the final report SDG&E is issuing on the Pilot, as required by Decision ("D.") 16-01-045.[2] Specifically, this Report provides the data outlined in the Decision to measure Pilot performance and cost-effectiveness.[3] Data for this Report extends from Pilot launch (June 2017) through December 31, 2020 unless otherwise noted.

**Table 1. PYD Research Report data requirements from the CPUC Decision**

| Required Data | Section in the Report |
|---|---|
| Actual VGI installation costs (total and average per site) | II-E |
| Actual VGI operating costs (over the fleet of VGI facilities) | II-E |
| Charging load profiles (from the VGI facility metered data for MUD and workplace locations, in aggregate and by circuit) | II-C |
| Estimated percentage of EV purchases related to the VGI Pilot Program (gathered through surveys of EV customers using the VGI facilities) | II-A-1 |
| Estimated VGI Pilot program-related increases in ZEV miles traveled per EV (gathered through surveys of EV customers using the VGI facilities) | II-A-1 |
| EV customer input on the VGI mobile and web applications, the VGI rate and overall convenience and ease of use of the VGI facility (gathered through surveys of EV customers using the VGI facilities) | II-A-2 |
| VGI kWh usage by price, over time (gathered through the SDG&E VGI billing data) | II-E |
| Where available, EV related kWh usage at home will be reviewed with VGI kWh usage at workplace VGI facilities (gathered through the SDG&E VGI billing data) | II-C |
| Where possible, determine whether EV-TOU or EV-TOU2 adoption has increased as a result of the VGI Pilot | II-A-1 |
| Customer (EV drivers and site Hosts) enrollment by site and VGI pricing plan (i.e., VGI Rate-to-Driver and VGI Rate-to-Host) | II-C |
| Under the VGI Rate-to-Host, load management plans and pricing or fees, including those measures taken that encourage the facilitation of the integration of renewable energy | II-C |
| Estimates of fuel cost savings through the use of the VGI Facility, under both the VGI Rate-to-Driver and VGI Rate-to-Host pricing plans | II-D |
| VGI Facility utilization rates | II-C |
| Deployment of VGI Facilities within or adjacent to a Disadvantaged Community, including EV car-sharing deployment | II- A-1 |
| Status of program implementation to date | I |
| Comparing the installations of non-utility EVSE to VGI EVSE | II-E |
| Surveys of customer and driver decisions to adopt PEVs | A |
| Rate of achievement of supplier diversity and workforce objectives | II-E |

[2] D.16-01-045, Attachment 2 at 15 (Appendix B). SDG&E submits this Report 18 months after the last PYD facility was installed and operational, which was September 2019 and October 2019 respectively.

[3] In its testimony supporting the PYD Pilot Application, SDG&E indicated that it would conduct a cost-effectiveness analysis, however, SDG&E submits that D.16-01-045 did not explicitly require such analysis. Table 1 summarizes the type of data to be reported as set forth in D.16-01-045 at 140 and Attachment 2 at 15. The data contained herein may be used to inform a cost-effectiveness analysis should the Commission determine one is necessary.

# I. Introduction

San Diego Gas & Electric Company ("SDG&E") established the Power Your Drive Pilot ("PYD Pilot" or "Pilot") after it was approved by the Decision in January 2016. The Pilot was designed to reduce greenhouse gas ("GHG") and criteria pollutants emissions, increase adoption of electrical vehicles ("EVs"), and integrate EV charging with the electric grid through a day-ahead hourly electric rate. The Commission authorized SDG&E to install at least 3,000 Level 2 charging stations through the Pilot at workplaces and multi-unit dwellings ("MUDs") such as apartments and condominiums. Installing EV chargers at MUDs and workplaces is critical to meeting California's EV adoption goals.

As authorized by the Commission, SDG&E installed, owns, and maintains all charging stations installed through the Pilot. SDG&E coordinated the design, permitting, construction, and commissioning of the charging stations. Once a PYD site is commissioned SDG&E handles the billing, coordinates with EV service providers ("EVSP") to provide customer support, and maintains the charging equipment throughout its lifecycle. This "turnkey" ownership structure is intended to simplify the customer experience, improve the reliability of chargers, and in particular, encourage site hosts in MUDs to adopt EV chargers.

All chargers installed through the PYD Pilot are billed on the innovative SDG&E Vehicle-Grid Integration ("VGI") electric rate, which features a dynamic electricity price intended to discourage drivers from charging during peak hours. Drivers at PYD Pilot Rate-to-Driver ("RTD") sites are directly billed on the VGI rate—a unique billing arrangement intended to maximize driver response to dynamic price signals and is only possible through SDG&E's ownership of PYD charging stations. Sites that opted not to have drivers directly billed on the VGI rate—Rate-to-Host ("RTH") sites—are required to develop a load management plan to limit driver charging during peak periods.

Site hosts who participate in the Pilot are charged a nominal one-time participation payment unless the site is within a disadvantaged community ("DAC"),[4] in which case the participation payment is waived. Customers have the option to choose from two EVSPs, both of whom have been qualified to manage the electric vehicle supply equipment ("EVSE", commonly referred to as "EV chargers"). The Decision authorizing the Pilot set the goal of deploying at least 40% of charging stations in MUD communities and at least 10% in DACs, which are burdened by higher-than-average levels of pollution.

SDG&E installed a total of 3,040 charging ports at 254 locations through the PYD Pilot, with the final site commissioning in September 2019 and operational in October 2019.[5] The Pilot significantly exceeded its DAC installation target and nearly met the MUD target. Today, approximately 4,500 drivers are enrolled in the Pilot and PYD stations have dispensed over 4 million kilowatt-hours ("kWh") of electricity, avoiding the emittance of more than 3.4 million kilograms of carbon dioxide ("$CO_2$") from gasoline powered vehicles.

[4] Pursuant to the Decision, the Pilot defines a DAC by using the California Environmental Protection Agency's CalEnviroscreen 2.0 tool to select the top quartile most polluted communities within SDG&E service territory.
[5] As of August 2020, there are 3,033 charging ports related to the Pilot as one site required its charging stations to be relocated (at site owner's expense) reducing the number of charging ports by seven.

# II. Program Overview and Results

SDG&E proposed the PYD Pilot in April 2014 to reduce barriers to EV adoption and reduce GHG emissions in the San Diego region. The Commission approved a modified version of the Pilot in January 2016, which significantly reduced the proposed size of the Pilot and reduced the initial roll-out budget from the $65 million requested by SDG&E to $45 million.[6]

The Commission also approved three light-duty EV charging pilots by each large California investor-owned utility in 2016.[7] Each of these pilots installed EV charging in MUDs and workplaces, with a focus on extending access to EV charging to traditionally underserved communities. The Commission approved different EVSE ownership structures for each pilot: while SDG&E owns and operates all the EV chargers installed through the PYD Pilot, Southern California Edison Company ("SCE") owns no chargers installed through its Charge Ready Pilot. Pacific Gas and Electric Company ("PG&E") was authorized to own some but not all chargers installed through their EV Charge Network.

The utility light-duty EV charging pilots also tested different billing and rate structures. Both PG&E and SCE's pilots served site hosts on utility time-of-use ("TOU") rates; site hosts have the option to pass these price signals along to drivers but are not required to do so. All EV charging stations in the PYD Pilot are served on the unique dynamic VGI rate and the Pilot offers the unique Rate-to-Driver billing option where drivers' charging costs appears directly on their SDG&E bill. This dynamic rate and direct billing are intended to increase the vehicle-grid integration benefits of the Pilot by giving drivers a greater incentive to charge during grid-friendly hours than on relatively static TOU rates.

SDG&E completed construction on the PYD Pilot in September 2019 with the final site becoming operational the following month. Figure 1 shows the geographic deployment of the sites, which are widely dispersed through SDG&E's service territory in San Diego County and southern Orange County. High level Pilot outcomes are presented in Figure 2.

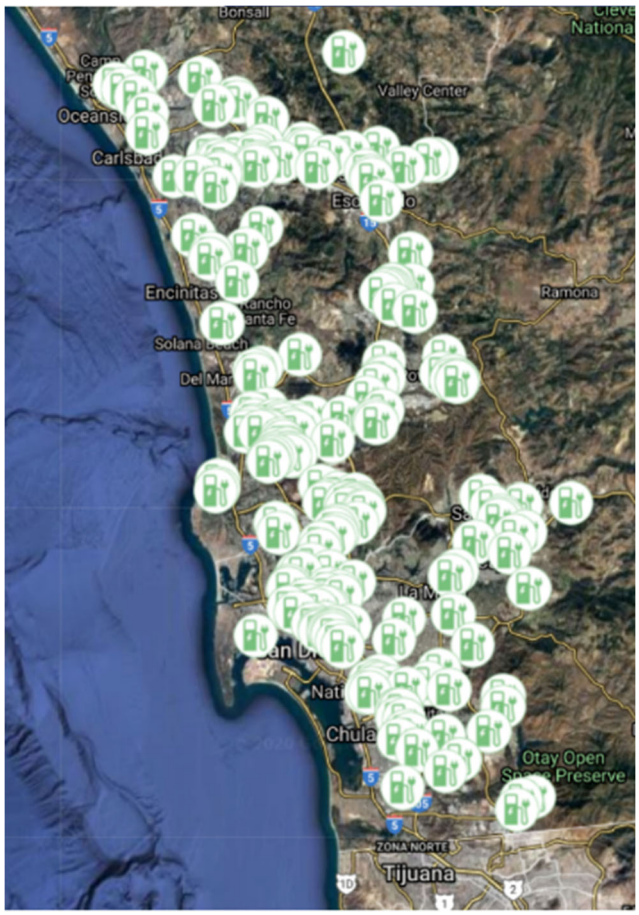



**Figure 1. SDG&E Power Your Drive Pilot site map**
**Source: SDG&E, https://www.sdge.com/pyd-map**

[6] D.16-01-045 at 3.
[7] See D.16-01-023 and D.16-12-065.

**Figure 2. High-level PYD Pilot outcomes**

- **254 CHARGING SITES CONSTRUCTED:**
  - **100 AT MUDS (24 IN DACS)**
  - **154 AT WORKPLACES (56 IN DACS)**
  - **199 ON RATE-TO-DRIVER BILLING**
  - **55 ON RATE-TO-HOST BILLING**
- **3,040 CHARGING PORTS INSTALLED AND COMMISSIONED**
  - **898 AT MUDS**
  - **1,694 AT WORKPLACES**
- **APPROXIMATELY 4,500 EV DRIVER CUSTOMERS BY THE END OF 2020**
- **OVER 4 MILLION KWH OF CHARGING PORT DISPENSED ELECTRICITY BY THE END OF 2020**

The PYD Pilot met many of its goals, including improving the understanding of the market, costs, and customer behavior. SDG&E installed 3,040 charging stations at 254 sites through the PYD Pilot, which was not enough to meet consumer demand. Interest from potential site hosts significantly exceeded the number of sites SDG&E was able to install through the PYD Pilot. Drivers have continued to enroll in the PYD Pilot, with approximately 4,500 drivers enrolling in the first four years. The PYD Pilot also successfully deployed the VGI rate and remains by far the widest deployment of a dynamic electric rate for EV charging in California to date. No other utility TE program has included true Rate-to-Driver billing that directly charges drivers as the utility customer of record.

The PYD Pilot was also notably successful at reaching MUDs, which are a hard-to-reach market segment and important equity goal. Thirty-nine percent of PYD sites are MUDs. This is a significantly better record of reaching MUDs than the other utility light-duty Pilots: to date 30% of the charging ports in PG&E's EV Charging Network are in MUDs, as are 23% of projects in SCE's Charge Ready Pilot and Bridge Program.[8] The PYD Pilots success in reaching MUDs may be due to its unique end-to-end utility ownership, which simplifies the participation process and reduces risk for site hosts. The Pilot also widely exceeded its target deployment level in DACs; while the Commission set a 10% DAC deployment target, 31% of PYD Pilot sites are located in these communities.

The Decision required SDG&E to install a minimum of 3,000 charging stations through the PYD Pilot. While SDG&E met this deployment target, the PYD Pilot significantly exceeded the budget authorized by the Commission. To install 3,040 charging stations SDG&E spent approximately $69.8 million, at an all-in per-port cost of approximately $23,000.[9]

[8] Pacific Gas and Electric Company, "EV Charge Network Quarterly Report: Report Period July 1, 2020 – September 30, 2020," at 10; Southern California Edison Company's Charge Ready Pilot Quarterly Report: 4th Quarter, 2020, March 1, 2021, at 17.

[9] These actual costs exceeded the approximately $15,000 per port overall cost adopted by the Decision's $45 million budget. SDG&E believes that its all-in cost per port achieved by the Pilot is roughly in line with the total cost of PG&E's and SCE's respective light-duty EV charging pilot programs.

The PYD Pilot revealed numerous lessons learned for SDG&E and stakeholders. Over the course of deploying the Pilot, SDG&E streamlined the qualification and customer sign-up process, producing efficiencies. The Rate-to-Driver billing system also proved costly to implement and required the development of new IT capabilities. As the cost of installing PYD Pilot sites was primarily driven by labor and materials costs SDG&E believes there is limited potential to reduce these installation costs.

## A. Survey Results

SDG&E collected feedback from drivers participating in the PYD Pilot through a survey administered in February 2021. The survey was emailed to Pilot participants and differentiated between drivers participating in Rate-to-Driver and Rate-to-Host billing. Survey questions were designed to answer key PYD Pilot objectives set forth in D.16-01-045:

**Primary Objectives**

- Estimate the number of vehicle purchases influenced by PYD activity and facilities
- Collect feedback on the PYD mobile and web application and enrollment process
- Identify whether drivers with PYD chargers at workplaces use an EV TOU or demand response rate for charging at home
- Identify any PYD-related influence on electric miles driven
- Determine whether drivers rely on other (non-PYD) charging stations to support their driving activity

The online survey was sent directly to PYD customers on February 24, 2021 and closed on March 8, 2021. The survey was sent to 2,180 PYD customers and 195 responded. Table 2 summarizes the breakdown of the survey responses. Responses by all respondents (n=195) have a margin of error of 7%, which is an acceptable margin of error for survey studies. Responses by less than the full set of respondents—for example those only answered by Rate-to-Driver participants—have a higher margin of error. In other words, findings based on less than 195 responses are less likely to reflect PYD participants as a whole.

**Table 2. PYD Survey Response Summary**

| | n | Percent Total | | Total EVs Owned | | |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 or more |
| **Total Responses** | 195 | 100% | | | | |
| **RTD Driver** | 151 | 77% | | | | |
| **RTH Driver** | 44 | 23% | | | | |
| **BEV (only) Driver** | 117 | 60% | → | 105 | 8 | 4 |
| **PHEV (only) Driver** | 68 | 35% | → | 63 | 5 | 0 |
| **BEV and PHEV Drivers** | 10 | 5% | → | N/A | 9 | 1 |

PYD Pilot charging stations will remain in service for years. As this survey was administered approximately 18 months after the PYD Pilot, construction was completed, participants in the Pilot at this time remain relatively early adopters whose behavior may differ from customers who will join the Pilot in the future and this survey is unlikely to capture all drivers who will adopt an EV due to the Pilot.

## 1. PYD Pilot Influence on EV Adoption and Electric Miles Travelled

Survey results indicate that PYD stations have some influence on drivers adopting EVs but that many participants in the Pilot to date already drove an EV before PYD chargers were installed. Drivers participating in the Pilot frequently utilize PYD chargers and many drivers—particularly plug-in hybrid electric vehicle ("PHEV") drivers—have increased their electric miles travelled due to PYD chargers.

Respondents were asked to rank the factors influencing their adoption of EVs. Results are shown in Table 3 for both battery EV ("BEV") and PHEV vehicles.

**Table 3. Ranking and average score (3 for "most influential" to 0 for "no influence") of influencing factors on decision to lease or purchase an EV (72 PHEV responses and 116 BEV responses)**

| Average Score | PHEV Acquisition Influencing Factor | Average Score | BEV Acquisition Influencing Factor |
|---|---|---|---|
| 2.3 | Fuel Cost Savings | 2.3 | Fuel Cost Savings |
| 2.2 | Environmental Benefits | 2.3 | Features and Technology of EVs |
| 2.1 | Rebates/Incentives | 2.1 | Environmental Benefits |
| 1.8 | Features and Technology of EVs | 2.0 | Rebates/Incentives |
| 1.8 | Increase in EV models available | 1.7 | High-Occupancy Vehicle ("HOV") Access |
| 1.7 | Decreasing price of EVs | 1.7 | Increase in EV models available |
| 1.5 | HOV Access | 1.6 | Decreasing price of EVs |
| 1.4 | PYD Workplace Charger | 1.2 | PYD EV Rates |
| 1.3 | PYD EV Rates | 1.1 | PYD Workplace Charger |
| 1.2 | Reliability of PYD Charging Facilities | 1.0 | Reliability of PYD Charging Facilities |
| 1.2 | PYD MUD Charger | 0.9 | PYD MUD Charger |

Drivers of both PHEVs and BEVs ranked EV attributes like fuel costs savings and environmental benefits as more influential to their decision to adopt EVs than aspects of the PYD Pilot.

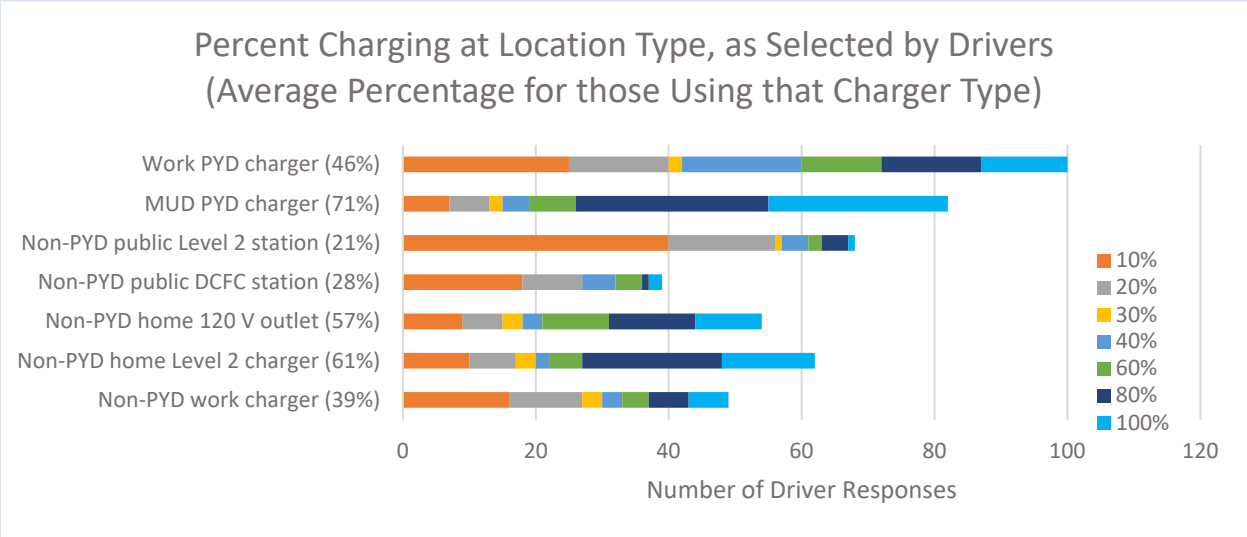
Of the surveyed group, 57% (104 of 182 total responses) stated they owned an EV before PYD charging was available to them. Many future EV drivers may be influenced by the presence of PYD chargers today but have not had the opportunity to adopt an EV yet. Of the drivers who purchased or leased an EV after PYD charging stations were installed, 60% (110 of 181) indicated that they were influenced by PYD station availability.

In its Ninth Semi Annual Report,[10] SDG&E estimated that 70% of drivers were on a path to purchase an EV due to the presence of PYD charging stations. These conflicting points highlight potential problems in ascertaining consumer behavior but demonstrate access to infrastructure influences consumer behavior.

[10] SDG&E, Electric Vehicle-Grid Integration Pilot Program ("Power Your Drive") Ninth Semi-Annual Report, October 14, 2020, https://www.sdge.com/sites/default/files/regulatory/R.18-12-006%20Ninth%20Oct%202020%20PYD%20Final%20Report%2010%2014%202020.pdf

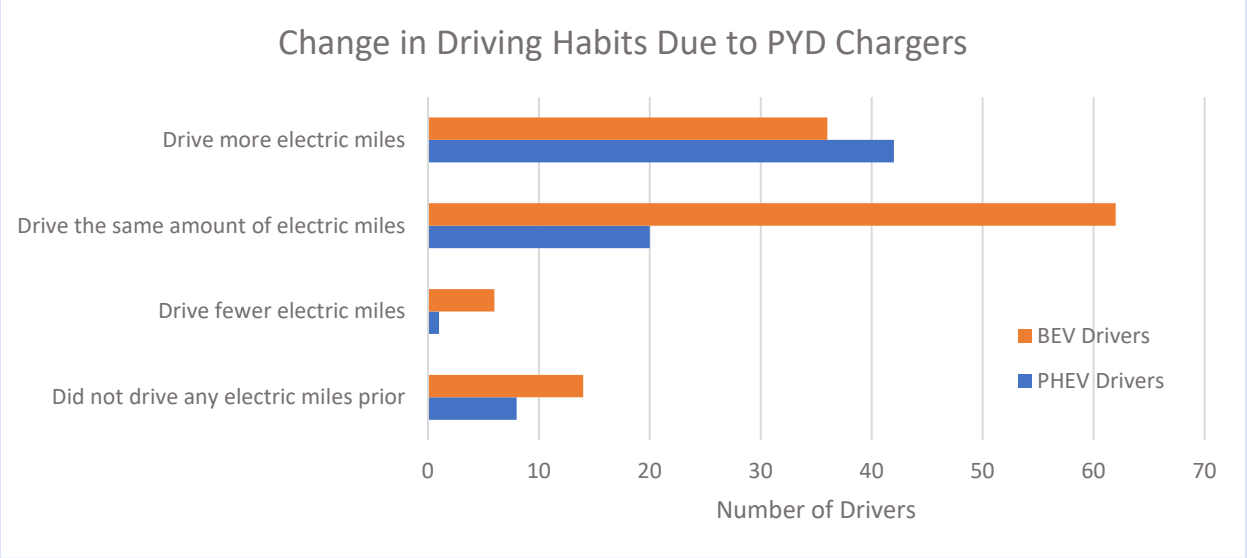
Drivers participating in the PYD Pilot frequently use PYD stations. Forty-three percent of surveyed drivers reporting that they use PYD stations **to meet 80% or 100% of their charging needs.** Figure 3 below shows the percentage drivers selected for each location.

**Figure 3. Response to "Where do you typically charge your plug-in hybrid or all-electric vehicle (EV)?" (195 responses)**




Overall, **43% (72 out of 180 respondents) indicated that they drive more electric miles as a result of the Pilot** as shown in Figure 4.

**Figure 4. Response to "How have your overall driving habits changed since accessing PYD chargers?" (180 responses)**




PHEV drivers indicated that the presence of PYD chargers has increased the number of miles that they drive on electricity, rather than relying on their vehicle's gasoline engine. The majority of BEV drivers reported driving the same number of electric miles after PYD chargers were installed, likely due to the fact that since all BEV miles are electric miles the presence of PYD chargers does not give drivers reason to drive more overall.

Drivers with access to PYD workplace chargers were asked to identify their domestic electricity rate plan. More than 30% (32 out of 104 responses) were on one of SDG&E's EV TOU plans, and more than half (54 out of 104) were on some TOU rate as shown in Table 4. The relatively high proportion of PYD workplace drivers not on residential EV TOU rates may indicate that these drivers do not charge their vehicles at home. Also, this reflects a possible opportunity to help ensure new EV customers have access to greater understanding of electric rate options for their home.

**Table 4. Responses to "Which type of electricity pricing plan do you currently have for your home?" (104 responses)**

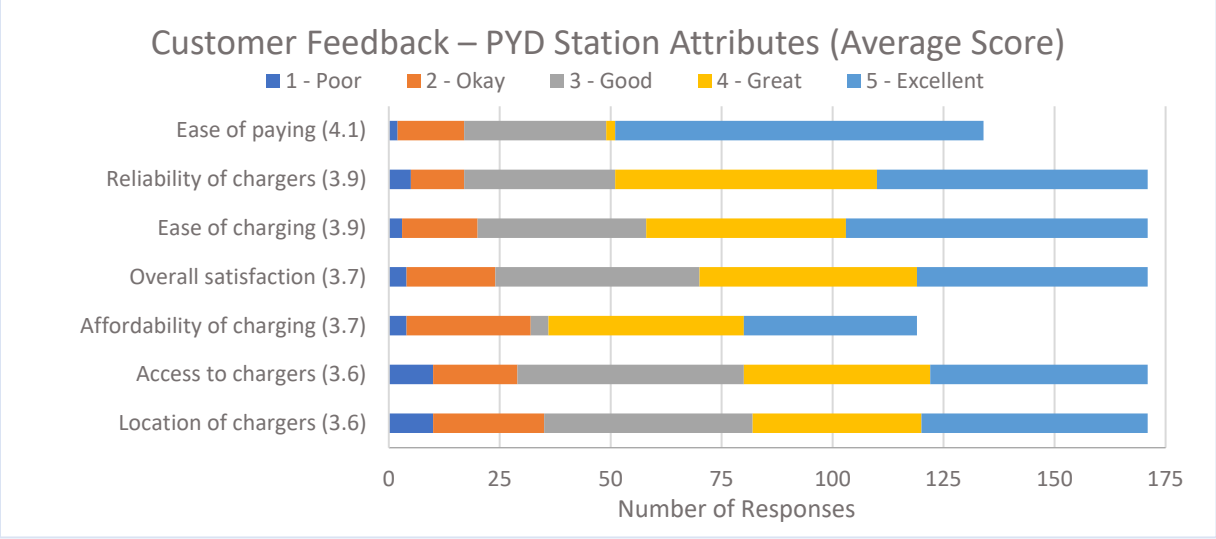
| Electricity Rate Plan | Responses |
|---|---|
| **EV TOU 2 or EV TOU 5 (house and vehicle billed on same account)** | 27 |
| **Domestic TOU** | 22 |
| **Standard Tiered** | 20 |
| **Electric Vehicle EV TOU (vehicle is billed separately from home)** | 5 |
| **I don't know** | 15 |

## 2. Driver Satisfaction with the PYD Pilot

Drivers were asked to rate their satisfaction with various Pilot elements and were given the option to provide further feedback. These elements included the PYD stations, the enrollment process in general, and the enrollment process using EVSP mobile applications and SDG&E website.

Some of the survey questions allowed drivers to select multiple answers that resulted in over 200 responses as seen below. Overall, customers gave the PYD stations high ratings, with 36% (403 of 1,108 responses among the various station attributes) in the "excellent" category and 25% (279 of 1,108 responses among the various station attributes) in the "great" category as shown in Figure 5. The station-specific element that was rated highest was the ease of paying for charging**,** which 48% of drivers (83 of 134 responses) selected as "excellent."

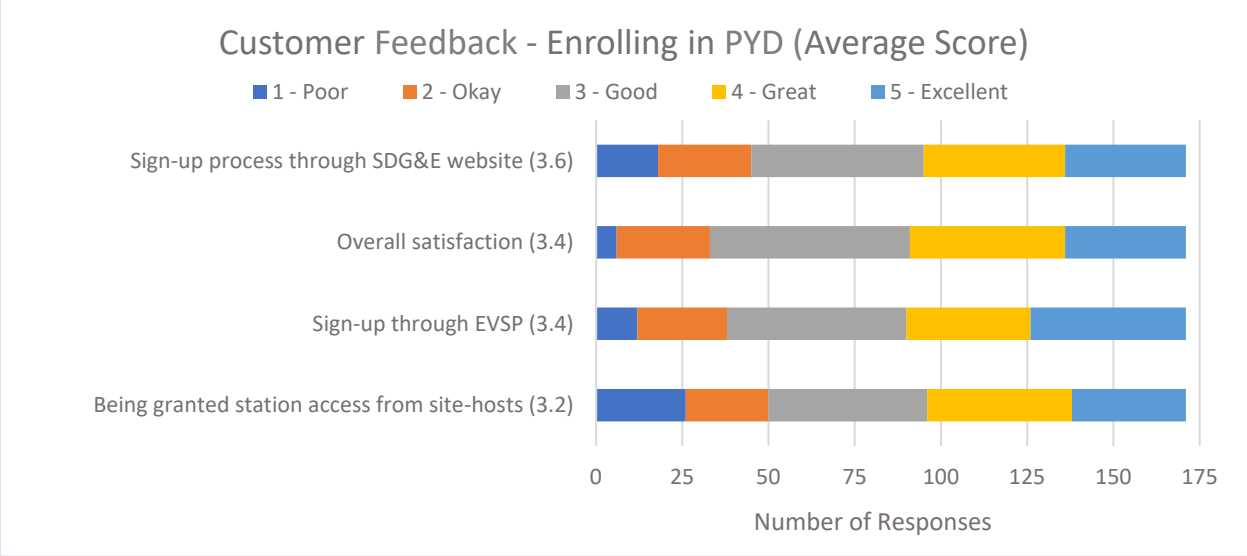
**Figure 5. Response to "Rate your experience with the following attributes of PYD charging stations from 5 (excellent) to 1 (poor)" (172 responses)**



**When further feedback was requested, more than a third of the drivers (37%) who provided detail said they would like more PYD charging to be available, noting that work, home, and public locations were all needed.**

Drivers were generally satisfied with PYD enrollment, the PYD mobile application, and PYD website.

**Figure 6. Response to "Rate your experience enrolling in the PYD program from 5 (excellent) to 1 (poor)" (171 responses)**




When prompted to provide further feedback, 60% of the respondents (28 of 47 responses) mentioned a problem or complication with enrollment. The feedback describes the process as confusing, with too many steps; multiple emails, phone calls, and contacts were required to be officially part of the Pilot. Responses that mentioned the changing prices also noted that this element was confusing, and customers were not able to set pricing limits for charging as they expected. More specifically, customers noted their set pricing limit was not applied and charging either occurred or unexpectedly did not occur. Feedback about using the mobile application was only slightly more positive than feedback about using the website.

**Figure 7. Response to "Rate your experience with the mobile app you use for PYD from 5 (excellent) to 1 (poor)" (171 responses)**

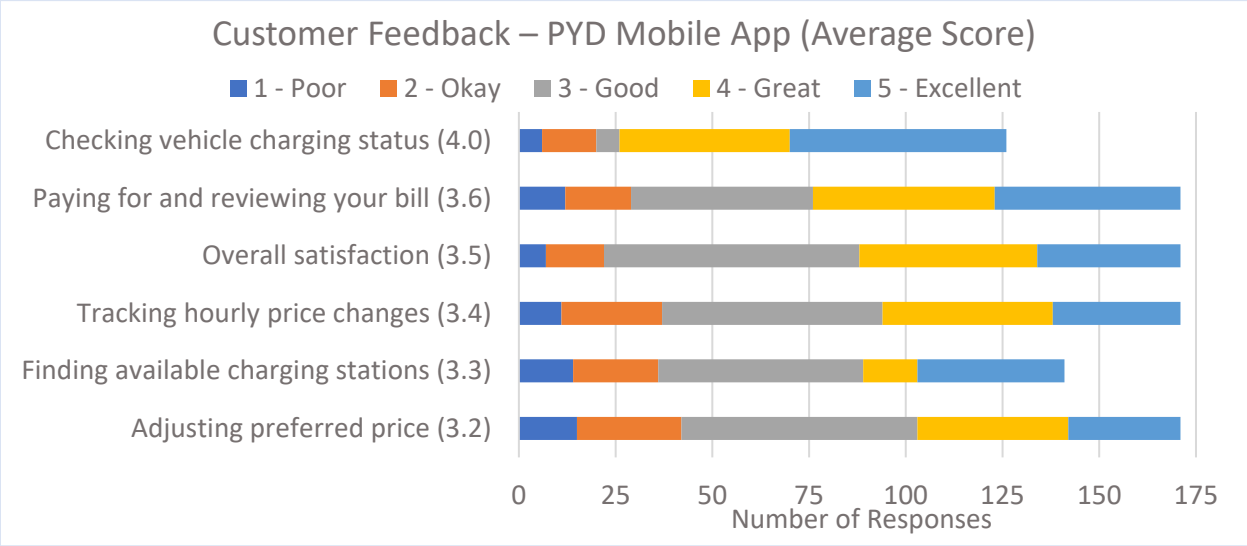
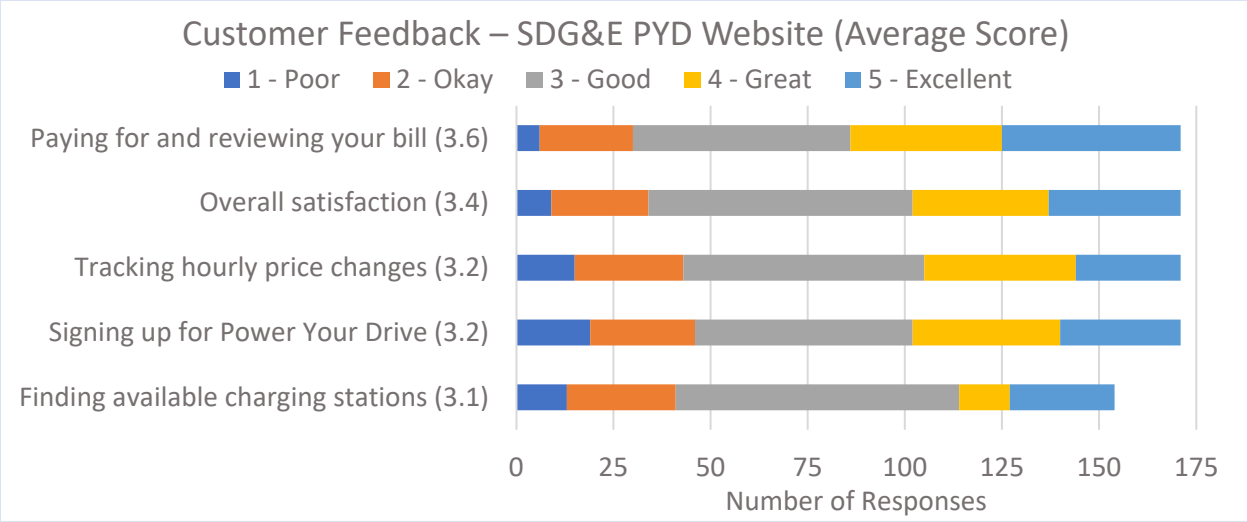



**Figure 8. Response to "Rate your experience with the SDG&E PYD website from 5 (excellent) to 1 (poor)" (171 responses)**



## B. Equity

It is critical that the benefits of EV adoption be accessible to all Californians and equity is a cornerstone of state transportation electrification policy.[11] Today these benefits are not equally accessible. Residents of single-family homes can easily charge EVs overnight at home. However, renters and residents of MUDs are often unable to charge their vehicles at their residences, leaving them reliant on workplace and public charging if they are able to adopt EVs at all. This may create equity issues as the cost of charging at public locations can be significantly higher than electric rates available through the PYD Pilot. Access to reasonably priced charging stations at MUDs is an important goal for the region.

The PYD Pilot was successful in meeting its equity goals. Thirty-nine percent of Pilot sites are MUDs, which nearly met the Decision's 40% target and significantly exceeded the MUD penetration of other utility light-duty EV charging pilots. PYD Pilot's utility end-to-end ownership model likely increased MUD participation by reducing risk for property managers. The risk of incurring future maintenance costs may have discouraged property managers from participating in other utility light-duty charging pilots, which did not offer full utility ownership of the EVSE.

Throughout the course of the PYD Pilot SDG&E worked to increase MUD participation. During the initial months of deployment SDG&E was not on track to meet the Decision's 40% MUD deployment target. In response SDG&E issued a request for proposals for external outreach and support services and a MUD market assessment. While securing these external resources added to Pilot costs, they were critical to reaching MUDs. SDG&E also initially set a ten port minimum for PYD Pilot sites, which was intended to reduce per-port costs by distributing fixed site costs over more charging ports. However, many property managers were unwilling to commit ten parking spaces to EV charging and were unable to participate in the Pilot. In response SDG&E lowered the minimum size for MUDs to five ports, which allowed many more MUDs to participate but contributed to higher per-port costs.

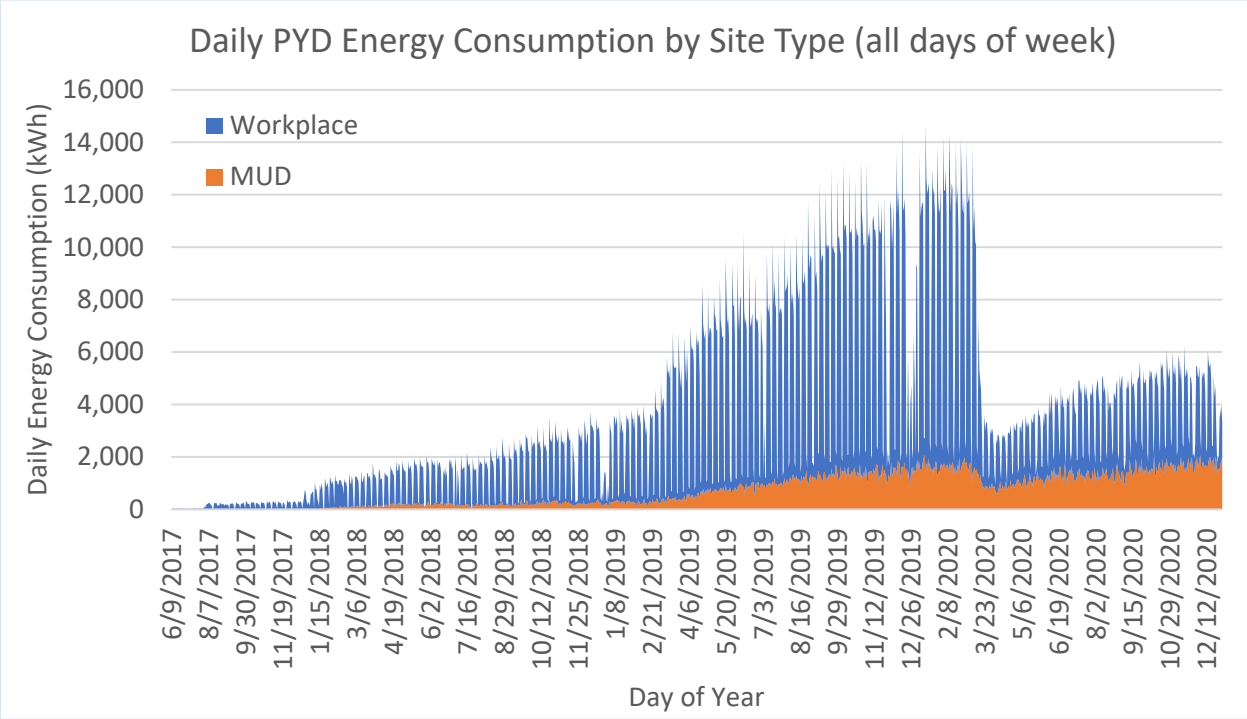
The PYD Pilot had a 10% deployment target for DACs, which is a state term for communities facing heavier than average pollution burdens. Thirty-one percent of PYD sites are located in DACs, far exceeding the Decision target. The Commission allowed SDG&E to use a definition of DACs that included the top quartile most polluted communities within SDG&E service territory. This definition was critical to reaching underserved communities in SDG&E's service territory which are excluded from the state-level DAC definition.

## C. Site Usage and Vehicle-Grid Integration

Energy consumption at PYD sites has generally grown since the start of the Pilot before dramatically falling with the onset of the COVID-19 pandemic. Usage of PYD Pilot sites has again grown since Spring 2020 but has not reached the consumption level seen before the COVID-19 pandemic travel restrictions. At the start of the pandemic PYD sites overall were approaching 14 megawatt-hours ("MWh") of consumption on the busiest weekdays and more than 3 MWh on weekend days. Figure 9 indicates total daily consumption of the Pilot. In particular, it shows that workplace sites represented nearly 85% of charging energy consumption before the onset of the pandemic but, as of the end of 2020, had not returned to pre-pandemic consumption levels.

[11] SB 350, Section 32, codified at Public Utilities Code 740.12(a)(1)(C).

**Figure 9. Daily PYD energy consumption by site type (all days of week)**



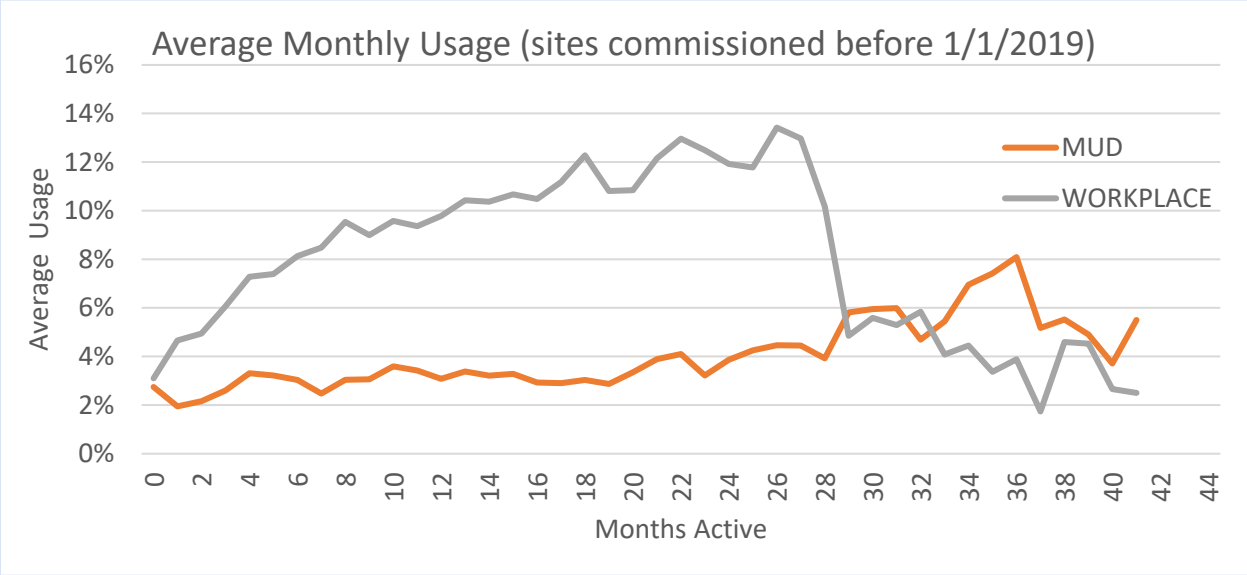

PYD site usage has similarly gradually increased since the start of the Pilot. Figure 10 and Figure 11 show the average site power usage[12] as a percentage of the site's installed capacity. Prior to the start of the COVID-19 pandemic, workplace sites had an average monthly usage of approximately 16-18% for sites commissioned after January 1, 2019. For reference, an 8-hour per day workweek is approximately 24% of a typical week, suggesting that his is a reasonable upper ceiling for workplace usage rate.[13]

For the earliest PYD sites commissioned usage at workplace sites increased relatively gradually until the start of the COVID-19 pandemic, which began approximately 26-28 months after these sites' commissioning date. Usage at MUD sites was much less affected by the COVID-19 pandemic.

[12] Usage in this context equals monthly consumption in kWh divided by (hours in a month multiplied by installed charging capacity); e.g., 3,600 kWh / (24 hours * 30 days * 10 kW of charging ports) = 50%

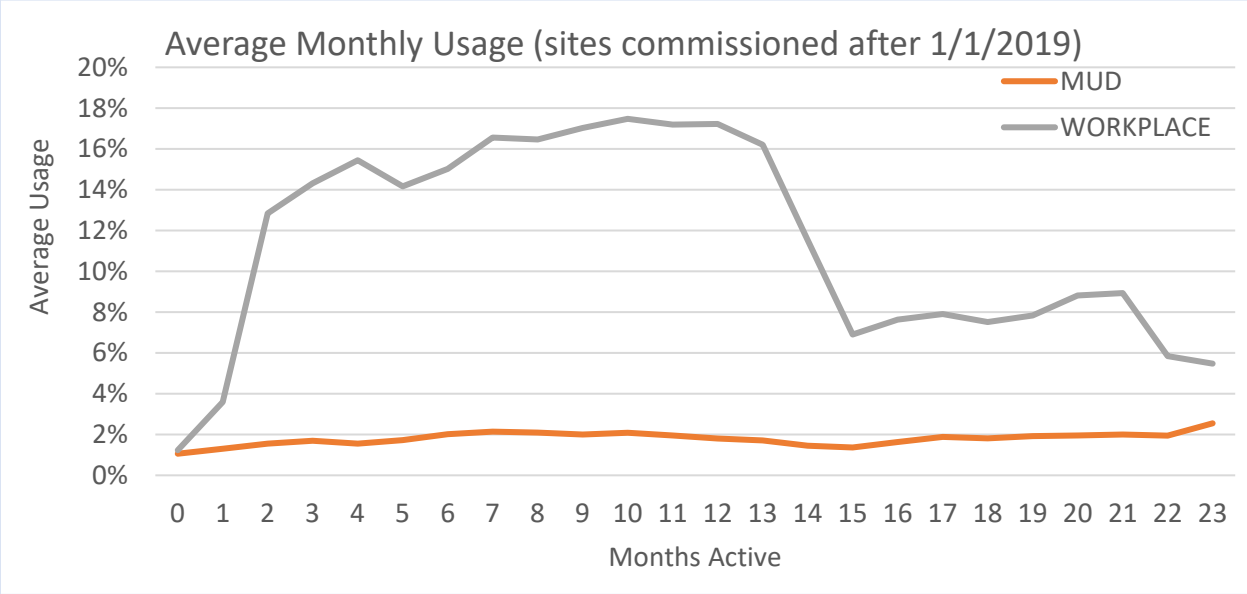
[13] (5 weekdays * 8 hours per weekday) / (7 days * 24 hours per day) = 23.8%

**Figure 10. Average monthly usage of sites commissioned before January 1, 2019**




Usage at sites commissioned after January 1, 2019 show a much faster increase in usage rates, which may be due to improved education and outreach for sites commissioned later in the Pilot. The COVID-19 pandemic began roughly 15 months after the start of the dataset presented in Figure 11.

**Figure 11. Average monthly usage of sites commissioned after January 1, 2019**




All charging stations in the PYD Pilot are served on the VGI rate, an innovative dynamic electric rate with an hourly price that reflects grid conditions and renewable energy generation. The VGI rate's hourly pricing enables far more granular price signals than standard TOU rates. The pricing periods for TOU rates change only infrequently; the VGI rate periods of high and low prices can vary hour to hour based on the needs of the grid.

The VGI rate consists of several components:

- A base rate that recovers the cost of operating the transmission and distribution system and administering Public Purpose Programs, among other costs;
- The California Independent System Operator ("CAISO") day-ahead energy price, with a day-of adjustment;
- An hourly adder charged during approximately the top 150 hours of annual demand on the California grid; and
- An hourly adder charged during approximately the top 200 hours of annual demand on a customer's individual distribution circuit.

The VGI rate charged to drivers in the PYD Pilot varies from hour to hour based on grid conditions. When asked through the survey how often they checked electricity prices before charging their vehicles, 60% of drivers (108 of 181 responses) checked "very often" or "sometimes," and 38% (68 of 181) indicated they "never" checked prices before charging. A higher percentage of RTH drivers (54% or 21 of 39 responses) indicated "never" checked prices before charging.

Sites participating in the PYD Pilot may choose between two billing options: Rate-to-Driver and Rate-to-Host. Rate-to-Driver sites are the large majority of PYD Pilot sites, as shown in Table 5.

**Table 5. Rate-to-Driver and Rate-to-Host Sites**

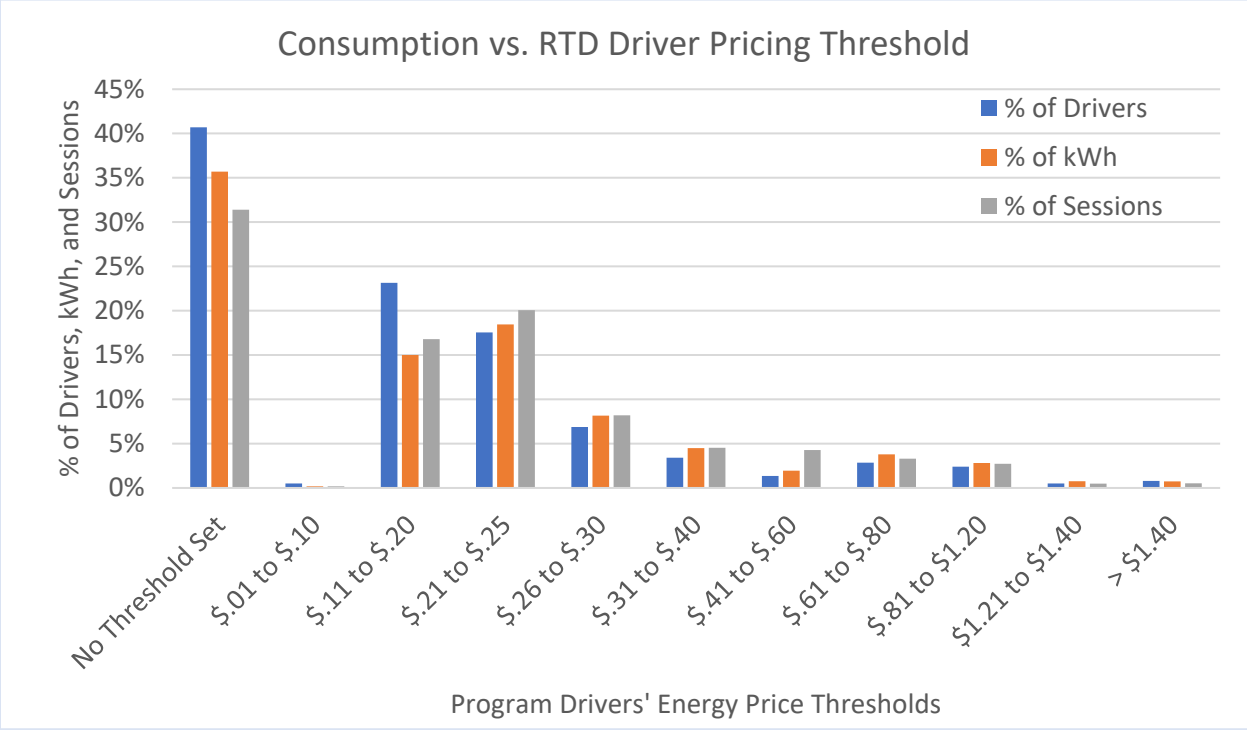
| | Rate-to-Driver | Rate-to-Host |
|---|---|---|
| **Number of ports** | 199 sites, 2,204 ports | 55 sites, 836 ports |
| **Percent of total ports** | 72% | 28% |
| **Number of drivers** | 2,027 | 2,440 |

Drivers at Rate-to-Drivers sites can set the maximum price that they are willing to pay for electricity through a smartphone application. If the VGI rate exceeds this threshold price while the driver is charging, their vehicle will automatically stop charging, providing a responsive mechanism for reducing load on the grid during peak hours. Drivers can choose to override the automatic throttling of charging if the VGI rate exceeds their threshold. Participants typically override their threshold in situations where they need to charge regardless of the cost.

Nearly half of the overall PYD drivers are enrolled in RTD sites. Of those, 40% had not elected a maximum price threshold, 10% selected thresholds above $0.40 per kWh and 50% of drivers elected pricing limited up to $0.40 per kWh.[14] Energy under $0.20 per kWh represented 90% of the total energy consumption for drivers overall. Figure 12 highlights that no-threshold drivers have more charging sessions compared to groups with higher limits.

[14] Pricing thresholds were reported as of Q1 2021, though drivers may have changed their settings in the past.

**Figure 12. Consumption vs. RTD driver pricing thresholds**




Drivers appear to shift their charging behavior in response to high price periods. When asked through SDG&E's survey 44% of drivers (80 out of 180 responses) indicated that they have delayed charging in response to high prices "many times." Drivers utilizing RTD billing are notably more successful at avoiding charging during high price periods than drivers at RTH sites, suggesting that the VGI rate is more effective at encouraging grid-friendly charging when it is directly served to drivers at SDG&E-owned charging stations.

**Figure 13. RTH opportunity and resultant energy purchasing by rate**

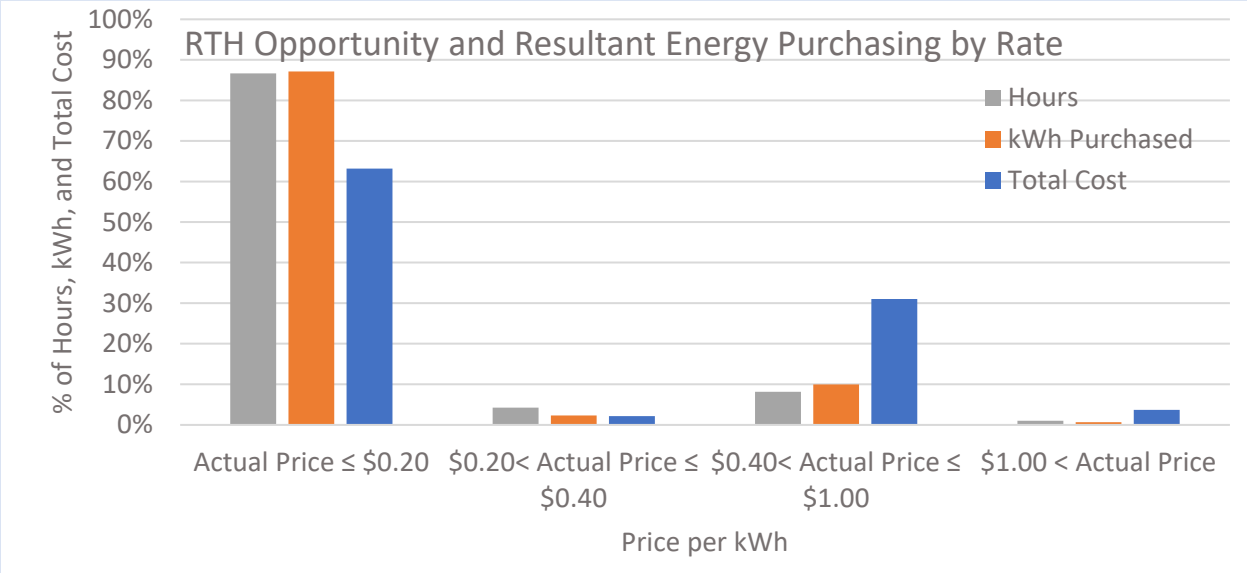
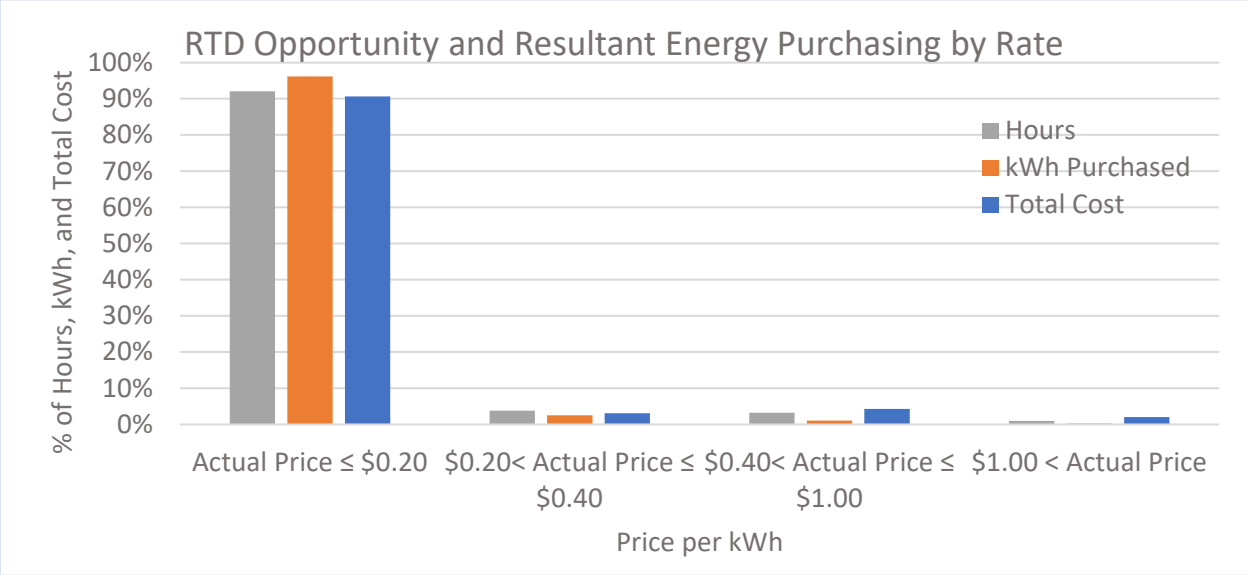
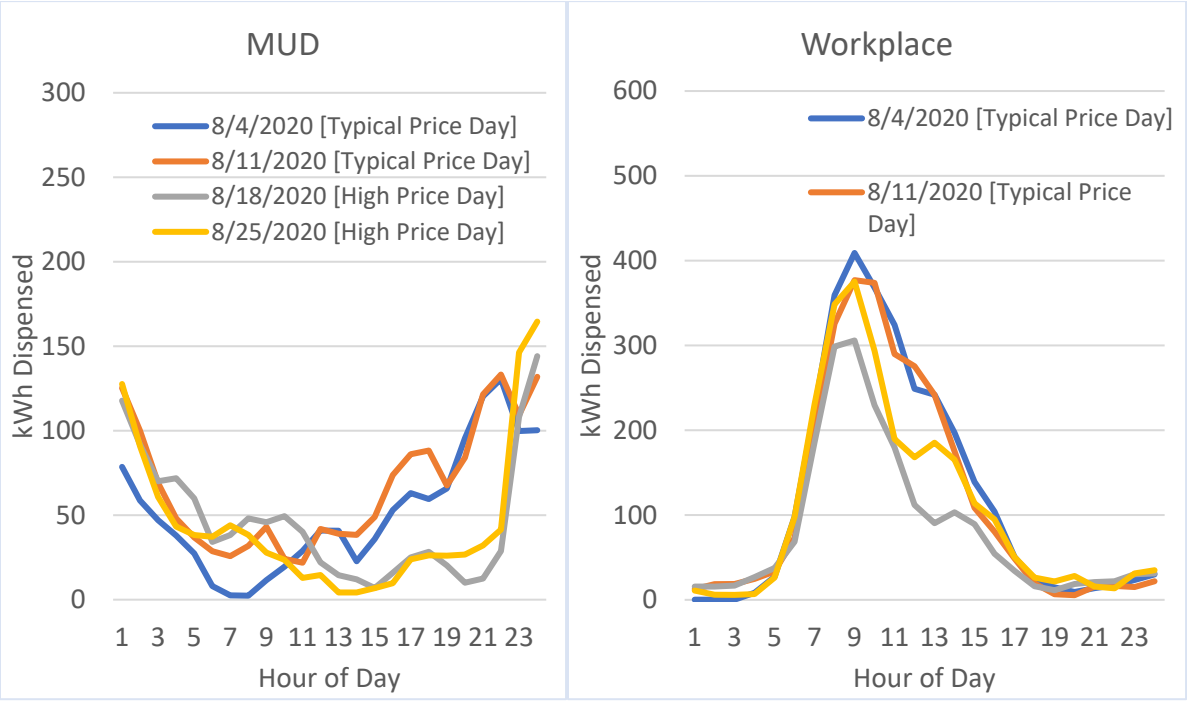


**Figure 14. RTD opportunity and resultant energy purchasing by rate**




Both workplaces and MUDs show significant responses to high price days. As shown in Figure 15, on low price days charging at MUDs increases during the evening hours. However, on high price days when the grid is constrained in the evening hours charging appears delayed to past 9pm. Drivers at workplaces also appear to delay charging in response to high prices. Charging at PYD workplace sites peaks when drivers arrive at work and falls off gradually throughout the day. On high price days workplace load is significantly reduced starting in the midday, typically when CAISO prices rise or system or circuit adders are applied.

**Figure 15. Example load shift on high-priced days at MUD and workplace sites**



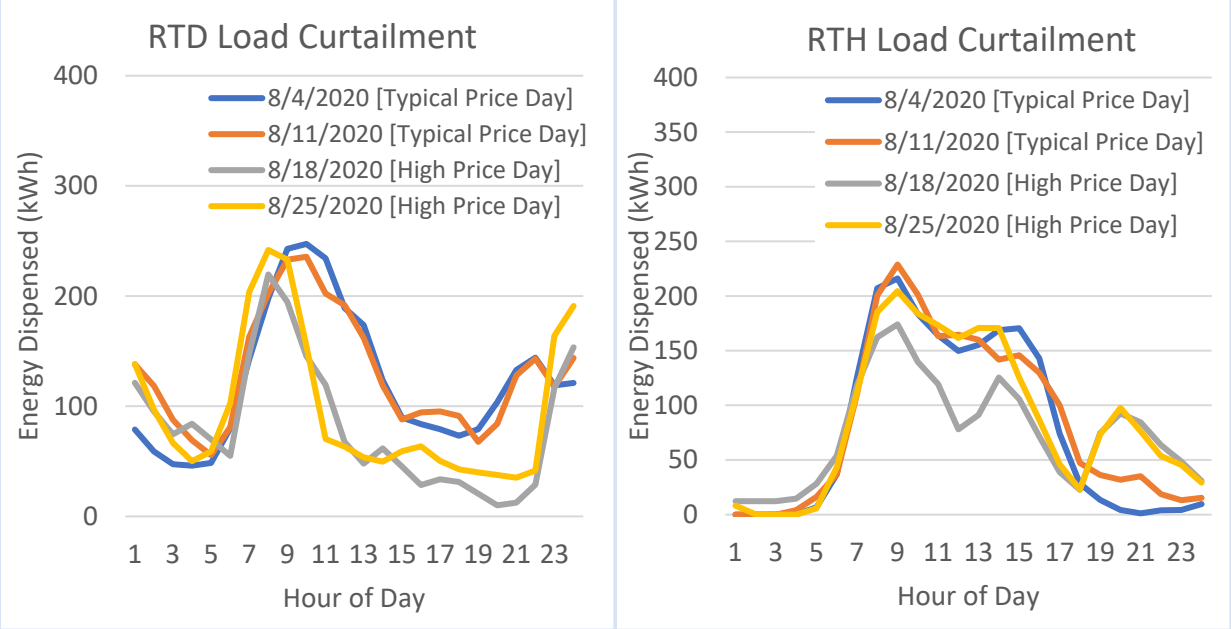
At Rate-to-Host sites the site host and not drivers are the utility customer of record directly exposed to the VGI rate. Rate-to-Host site hosts are required to follow a load management plan to reduce charging during periods of high demand. RTH sites follow a variety of load management plans, as show in Table 6.

**Table 6. Rate-to-Host Load Management Plans**

| Load Management Plan | Percent of RTH sites |
|---|---|
| **Powering down or shutting off PYD chargers during high price intervals** | 56% |
| **Send email alerts to drivers on high price days** | 27% |
| **Only allow charging during certain time periods** | 13% |
| **Other** | 4% |

Figure 16 shows how each billing group responded to two days of regular pricing and two days of high pricing. Drivers at RTH sites generally appear less successful at avoiding periods of high prices than RTD sites. While energy over $0.40 per kWh accounts for 5% of RTD consumption, $0.40/kwh energy accounts for 35% of RTH host costs. This suggests that the RTD billing mechanism is more effective at linking driver charging behavior to grid conditions than other methods.

**Figure 16. Example of RTH/RTD load curtailment (Tuesdays in August 2020)**




## D. Fuel Cost Savings and Emissions Reductions

Drivers participating in the PYD Pilot have avoided burning over half a million gallons of gasoline from inception through December 2020. These avoided emissions will only increase in coming years as PYD charging stations continue to be used.

The PYD Pilot has also produced significant savings for drivers due to the lower cost of electricity compared to gasoline shown in Table 7.[15] PYD drivers collectively have already saved over a million dollars by charging at PYD stations, compared to gasoline they would have purchased to travel an equivalent distance.

[15] Calculated using SDG&E's internal methodology.

**Table 7. Estimated PYD Pilot fuel cost savings**

| Estimated Fuel Cost Savings | RTD | RTH |
|---|---|---|
| **Usage (kWh)** | 2,276,759 | 2,062,849 |
| **Average $/kWh** | $0.17 | $0.23 |
| **Total Cost** | $394,631 | $466,670 |
| | | |
| **Gasoline Equivalent (Gallons)[16]** | 274,308 | 248,536 |
| **Average $/gal[17]** | $3.58 | $3.58 |
| **Total Cost** | $982,024 | $889,759 |
| | | |
| **Estimated Savings** | $587,393 | $423,089 |
| **Average Savings per kWh** | $0.26 | $0.21 |

SDG&E estimates that the PYD Pilot has significantly reduced GHG emissions that would have otherwise been emitted by fossil fuel powered internal combustion engine ("ICE") vehicles. The Pilot has enabled 13 million zero emission miles, which represents more than 3.4 million kilograms ("kg") of $CO_2$ emissions reduced.

Table 8 illustrates the Pilot's estimated GHG emissions savings based on $CO_2$ equivalent emissions reduction. Of note, the methodology used to determine GHG emissions savings in this Report is an alternative to the one used in previous PYD Pilot Semi-Annual Reports. The first column shows the $CO_2$ emissions that would be generated by the ICE vehicles if they were driven the same number of miles instead of the EVs. The number of kWh provided through the Pilot can be used to determine the approximate number of miles traveled, which in turn is used to calculate how many gallons of gasoline would have been consumed if ICE vehicles were used instead to travel the same distance. This fuel consumption can then be used to calculate the amount of $CO_2$ emissions that would have been emitted by ICE vehicles. The calculations are based on the following assumptions: average EV efficiency of 3 miles per kWh, average ICE vehicle fuel economy of 24.9 miles per gallon, and 8.89 kg of $CO_2$ emitted per gallon of gasoline consumed by an ICE vehicle.[18,19] The following is an illustrative example of the calculation:

- One charging session supplies 10 kWh to an EV
  - 10 kWh x 3 miles per kWh = 30 miles
- Equivalent ICE vehicle $CO_2$ emissions produced
  - 30 miles / 24.9 miles per gallon of gasoline = 1.2 gallons of gasoline
  - 1.2 gallons of gasoline x 8.89 kg of $CO_2$ per gallon of gasoline = 10.7 kg of $CO_2$

[16] Calculated using EPA average 24.9 miles per gallon of gasoline ICE vehicle fuel economy and 3 miles per kWh EV efficiency.
[17] San Diego August 2019 - July 2020 average retail fueling station gasoline price
[18] U.S. Environmental Protection Agency, "Highlights of the Automotive Trends Report," EPA-420-S-21-001 January 2021, https://www.epa.gov/automotive-trends/highlights-automotive-trends-report.
[19] U.S. Energy Information Administration, "Carbon Dioxide Emissions Coefficients," February 2, 2016, https://www.eia.gov/environment/emissions/co2_vol_mass.php.

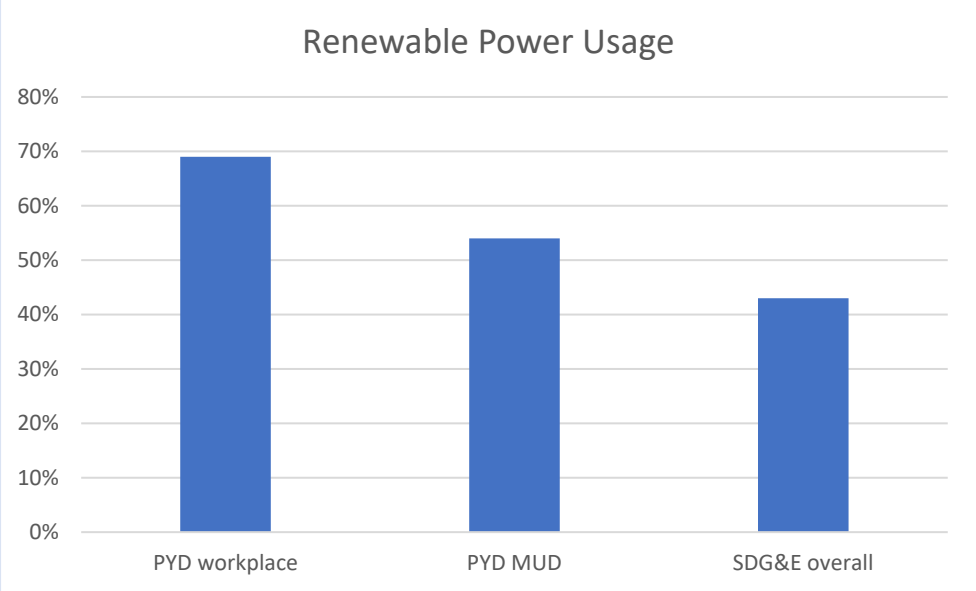
The second column presents the estimated $CO_2$ emissions associated with the production of the electricity dispensed by the Pilot's charging stations. This number is calculated based on the carbon intensity values from California Air Resources Board's Low Carbon Fuel Standard for California average grid electricity used as a transportation fuel in California.[20] The third column presents the net $CO_2$ emissions reduction by subtracting the emissions generated during electricity production from the emissions generated by the ICE vehicles.

**Table 8. PYD Pilot $CO_2$ emissions reduction**

| Year | ICE Vehicle $CO_2$ Emissions (kg) | Electricity $CO_2$ Emissions (kg) | Net $CO_2$ Emissions Reduction (kg) | Fuel Avoided (gal) |
|---|---|---|---|---|
| **2017** | 28,294 | 8,300 | 19,994 | 3,183 |
| **2018** | 511,704 | 130,934 | 380,770 | 57,560 |
| **2019** | 2,248,386 | 573,983 | 1,674,403 | 252,912 |
| **2020** | 1,841,168 | 495,829 | 1,345,339 | 207,105 |
| **Total** | **4,629,552** | **1,209,046** | **3,420,506** | **520,760** |

Sixty-six percent of PYD Pilot's electricity consumption is generated by renewable energy sources, as estimated from January 1, 2019 through December 31, 2020. This calculation does not use the same process as the California Energy Commission's Power Content Label but provides a similar benchmark of SDG&E's alignment with renewable energy generation.

**Figure 17. Renewable Power Consumption**




[20] California Air Resources Board, *California Average Grid Electricity Used as a Transportation Fuel in California and Electricity Supplied under the Smart Charging or Smart Electrolysis Provision*, Low Carbon Fuel Standard Annual Updates to Lookup Table Pathways, revised January 16, 2020, https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/comments/tier2/elec_update.pdf.

The very high renewable consumption from PYD workplaces highlights the importance of workplace charging, which allows EVs to charge during periods of high solar power generation that may otherwise be curtailed.

## E. Pilot Costs and Revenues

Senate Bill ("SB") 350 establishes that utility transportation electrification programs should seek to minimize overall costs and maximize overall benefits.[21] The PYD Pilot minimized overall costs to the extent possible. Nearly 60% of Pilot costs were construction and materials, which there is little scope to reduce. Indeed, other programs have recorded similar costs for installing EV charging. For example, a recent budget request from the California Department of General Services requests over $24,500 per port for installing Level 2 EV chargers; these costs have increased, not decreased, in the period that the PYD Pilot was being deployed.[22]

EV infrastructure programs may reduce public costs by requiring increased customer contributions or requiring customer ownership of the EVSE. However, it is important to remember that these program design choices do not reduce overall costs, just the portion of the cost borne by the public. The PYD Pilot offers end-to-end utility ownership and did not require customer contributions from customers in DACs. These choices contributed to the cost of the Pilot, but also likely contributed to its success at reaching disadvantaged communities and MUDs.

To facilitate construction for hundreds of project sites, SDG&E assigned groups of projects to general contractors. Doing so made for the most competitive costs and expedited the construction process. However, each group of projects was treated as one large project and therefore did not reveal unique site costs. A given general contractor would bid, using an all-inclusive cost, on a group of projects nearly ready for construction. As a result of this approach, per-site costs were estimated as directly proportional to the number of charging ports installed for all cost categories. Where possible, this report presents costs per site or per site-type.

Table 9 shows the breakdown of costs among different categories as well as the variance between the budget set forth in D.16-01-045 and the actual Pilot costs. Through December 2020, $69.8 million has been spent on the Pilot, with an overall 38.3% rate of achievement of supplier diversity and workforce objective.

[21] SB 350, PU Code Section 740.12 2.b.

[22] Department of General Services, ZEV Five-Year Infrastructure Investment Plan FY2021-22 Budget Change Proposal, January 11, 2021, https://esd.dof.ca.gov/Documents/bcp/2122/FY2122_ORG7760_BCP4424.pdf

**Table 9. PYD Pilot costs as of December 2020**

| | Scaled Decision | Dec 2020 PTD Actual | Variance |
|---|---|---|---|
| **Materials** | $4,792,000 | $13,989,607 | ($9,197,607) |
| **Construction** | $28,894,000 | $27,057,588 | $1,836,412 |
| **Engineering Design** | $1,004,000 | $7,442,332 | ($6,438,332) |
| **Environmental Testing** | - | $647,465 | ($647,465) |
| **Internal Labor** | $825,000 | $2,411,590 | ($1,586,590) |
| **IT Billing System Upgrade** | $1,564,000 | $3,325,324 | ($1,761,324) |
| **Third Party Project Support** | - | $6,432,784 | ($6,432,784) |
| **Other** | $943,000 | $1,520,700 | ($577,700) |
| **Non-Direct Costs (AFUDC, Loaders)** | $3,429,000 | $6,946,272 | ($3,517,272) |
| **Contingency** | $3,549,000 | - | $3,549,000 |
| **Total** | **$45,000,000** | **$69,773,662** | **($24,773,662)** |

Most of the projects represent installed total charging capacity from 50 to 100 kW. The average allocated cost was approximately $275,000 per site. The smallest 80% of projects account for 60% of installed capacity. The largest 4 sites represent 10% of installed capacity.

SDG&E's installation of charging stations through the PYD Pilot differs from non-utility installations in several important ways. All PYD construction work was performed by union signatories earning a good wage. All electrical work was performed by licensed C-10 electrical contractors with EV Infrastructure Training Program certification. This high standard upheld safety but may have resulted in higher labor costs than non-utility installations.

Offering the Rate-to-Driver billing also required significant IT work and testing in order to successfully bill the VGI rate directly to drivers – no other utility TE program has offered this billing feature, which increased the uptake of renewable power. Separately-metering EV load also required serving all PYD sites with a new line of service, which also required additional construction and electrical work.

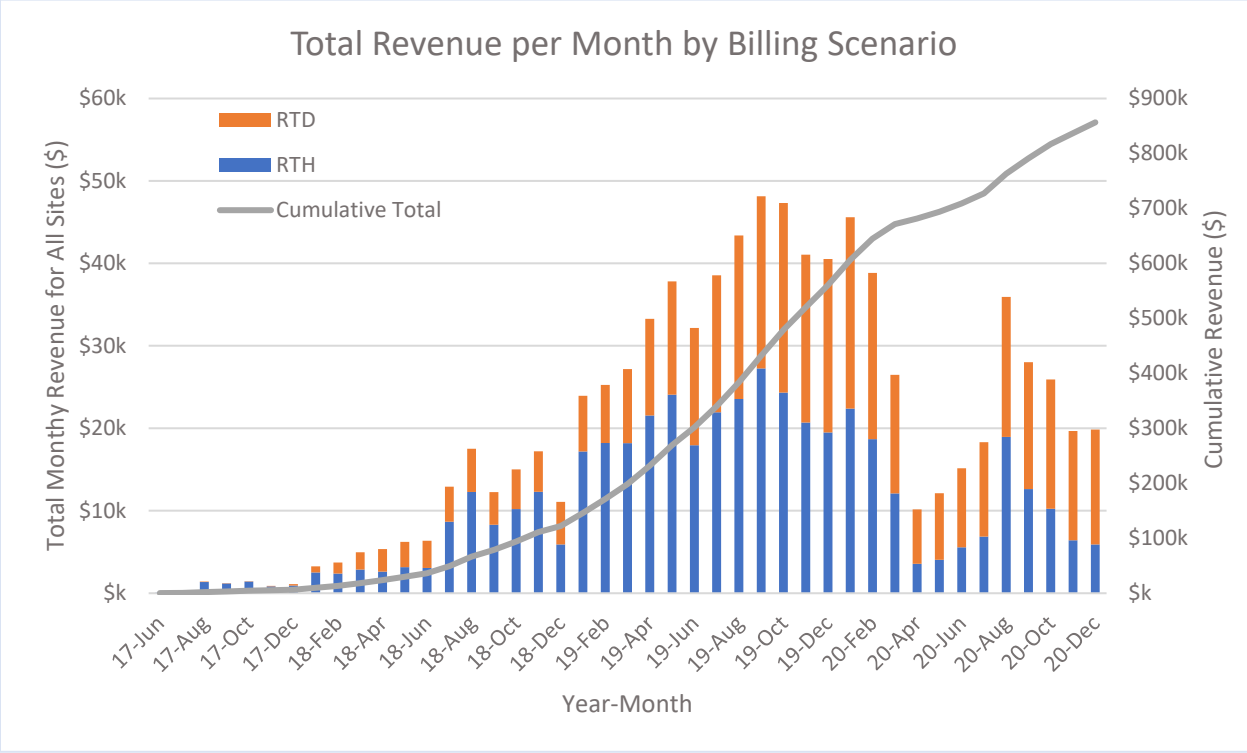
Ongoing maintenance costs for PYD Pilot are tracked in SDG&E's VGI memorandum account. As of December 2020, there has been $5.49 million in operating cost expenditures recorded as shown in the table below. The annual ongoing maintenance cost has averaged $903 per port for the years 2019 and 2020. In addition to the costs below, SDG&E collected $1.1 million in participation payments as credits to the VGI memorandum account.

**Table 10. Ongoing Maintenance Costs**

| Ongoing Expense Category | Category Description | 2019 | 2020 | 2019-2020 |
|---|---|---|---|---|
| Billing System | Resolution of customer enrollment and site setup, auditing and validation of pricing & bill calculations, billing investigation and analysis, issuing rebate/rebill and policy adjustments, vendor data transfers and communication with charging stations. | $565,622 | $442,307 | $1,007,928 |
| Customer Engagement | Operational follow-up, field inquiries, back office issue resolution, and other related customer service tasks. Education and outreach, website content & tools, marketing materials. | $534,817 | $160,421 | $695,237 |
| SDG&E Rates/Distribution Circuit Modeling | Circuit level load modeling for VGI rate calculations and rate analysis. | $70,329 | - | $70,329 |
| Access Control | Ongoing Wireless Service Fees payable to Third Party EVSP Vendors. | $164,400 | $614,371 | $778,771 |
| Customer Support & Billing Integration | IT Application support services including maintenance of the application systems, interfaces, and help desk services. | $701,811 | $530,838 | $1,232,649 |
| Equipment Replacement Costs | Material and labor costs for maintaining, troubleshooting, and replacing EVSEs. | $853,311 | $850,145 | $1,703,455 |
| | | **$2,890,289** | **$2,598,081** | **$5,488,370** |

By the end of 2020, PYD sites had generated about $850k in revenue through electricity sales. Revenue from PYD sites was substantially impacted by the COVID-19 pandemic but has begun to recover.

**Figure 18. Revenue generated by billing scenario[23]**




# III. Conclusion

SDG&E installed over 3,000 EV charging stations that serve approximately 4,500 EV drivers through the PYD Pilot. The number of drivers charging at PYD stations is likely to increase as these stations remain in use for years to come. SDG&E additionally developed Rate-to-Driver billing and the dynamic VGI rate through the Pilot, both of which remain unique in California. The Pilot directly supports state law and California's zero-emission vehicle adoption goals while enabling over thirteen million electric miles driven in SDG&E's service territory, a number expected to continue to grow so long as PYD charging stations remain in service. The Pilot has also proved popular with drivers and positively influenced participants' decision to adopt EVs or increased their electric miles driven. By providing access to charging to those who reside in multi-unit dwellings, the Pilot has taken the necessary steps to ensure that the EV transition is equitable and accessible to the San Diego region.

When SDG&E proposed the PYD Pilot in 2014, there were only a few long-range BEVs on the market and no California utility had completed a large-scale TE pilot. The PYD Pilot's innovative billing arrangements, unique dynamic rate, and success in installing chargers in MUDs have paved the way for future TE infrastructure. Implementing the Pilot has provided important data on EV adopters' charging behavior and preferences; the data and lessons learned from the Pilot will remain valuable to the Commission and stakeholders for years to come. SDG&E looks forward to leveraging the experience designing and implementing the PYD Pilot in future TE programs to further integrate EV charging with the grid, renewables, and other customer benefits.

[23] Revenue reflects final price, the lower of day-ahead or real time.

# Acronyms

| | |
|---|---|
| BEV | Battery Electric Vehicle |
| CAISO | California Independent System Operator |
| $CO_2$ | Carbon Dioxide |
| CPUC | California Public Utilities Commission |
| D | Decision |
| DAC | Disadvantaged Community |
| EV | Electric Vehicle |
| EVSE | Electric Vehicle Supply Equipment |
| EVSP | Electric Vehicle Service Provider |
| gal | Gallon(s) |
| GHG | Greenhouse Gas |
| HOV | High-Occupancy Vehicle |
| ICE | Internal Combustion Engine |
| kg | Kilogram(s) |
| kW | Kilowatt(s) |
| kWh | Kilowatt-Hour(s) |
| MWh | Megawatt-Hour |
| MUD | Multi-Unit Dwelling |
| PG&E | Pacific Gas and Electric Company |
| PHEV | Plug-in Hybrid Electric Vehicle |
| PYD | Power Your Drive |
| RTD | Rate-to-Driver |
| RTH | Rate-to-Host |
| SDG&E | San Diego Gas & Electric Company |
| SB | Senate Bill |
| SCE | Southern California Edison Company |
| TOU | Time of Use |
| TE | Transportation Electrification |
| TE | Transportation Electrification |
| VGI | Vehicle-Grid Integration |